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WASTE MANAGEMENT

PHASE 14 SOLID WASTE PERMIT APPLICATION

VOLUME VI OF VI

Draft Construction Bid Documents

Crossroads Landfill

Norridgewock, Maine

Prepared for

Waste Management Disposal Services of Maine, Inc.

357 Mercer Road
Norridgewock, Maine

Prepared by

Geosyntec Consultants, Inc.
289 Great Road, Suite 202
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Project BE0232

October 2019

STATE OF MAINE
SCOTT M. LUETTICH
No. 7452
LICENSED
PROFESSIONAL ENGINEER

1. INTRODUCTION

1.1 Purpose and Organization

This document presents Volume VI – Draft Construction Bid Documents of the Phase 14 Solid Waste Permit Application at the Crossroads Landfill (Crossroads). This document was prepared by Mr. Nick J. Yafrate, Mr. Youngmin Cho, and Mr. Scott M. Luettich, P.E. (Maine PE # 7452), all of Geosyntec Consultants (Geosyntec), for Waste Management Disposal Services of Maine, Inc. (WMDSM).

This document was prepared to satisfy the requirements established in applicable sections of Chapter 401.2.I & J of the Maine Solid Waste Management Rules (Maine SWMR), effective 2 November 1998 (revisions effective 12 April 2015) for submittal of a solid waste permit application. This document represents Volume VI of the Phase 14 Solid Waste Permit Application package, which, in its entirety, is organized as follows:

- Volume I Application Form and General Information Requirements
- Volume II Natural Resources Protection Act (NRPA) Application
- Volume III Geologic and Hydrogeologic Assessment
- Volume IV Landfill Engineering Report
- Volume V Operations Manual
- Volume VI Draft Construction Bid Documents

1.2 Quality Assurance Manuals and Technical Specifications

Pursuant to Chapter 401.2.I and J of the Maine SWMR, the Crossroads Quality Assurance Manual (QAM) for the landfill cell and final closure construction are provided in Appendices VI(a) and VI(b), respectively. The Construction Specifications for the landfill cell and final closure construction are provided in Appendices VI(c) and VI(d), respectively. To account for the change in construction technologies and testing methods, the QAM and specifications will be revised for Phase 14 during preparation of the construction documents for each cell. And as noted on the Table of Contents for the Specifications, the minimum allowable interface shear strength requirements for the liner and final cover components (as established in the veneer stability calculation package) will be incorporated into the project specifications. As such, the attached QAMs and specifications should be considered preliminary for permitting (not approved yet for construction).

APPENDIX VI(a)

Quality Assurance Manual

– Cell Construction

Prepared for:

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QUALITY ASSURANCE MANUAL
LANDFILL CELL CONSTRUCTION

CROSSROADS LANDFILL
NORRIDGEWOCK, MAINE

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Project Number: BE0232C
September 2019

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1. INTRODUCTION

1.1 Purpose of QAM

This Quality Assurance Manual (QAM) establishes the quality-assurance monitoring and documentation activities that will be implemented during the construction of waste-disposal units (e.g., liner systems and final cover systems) and related facilities (erosion control structures, access roads, etc.) at the Crossroads Landfill Facility in Norridgewock, Maine. The purpose of the QAM is to provide specific procedures that will be followed by Construction Quality Assurance (CQA) personnel in order to assure the Owner that the construction was performed in accordance with the Drawings and Specifications.

The organization of this QAM is generally parallel to the organization of the sections presented in Division 02 of the Specifications. Much of the information presented in the QAM was extracted from Waste Management, Inc.'s *Quality Assurance Guidance Document for the Installation of Lining Systems*, dated June 1996.

1.2 Construction Quality Assurance and Construction Quality Control

This QAM is a site-specific document which addresses the following: (i) CQA personnel responsibilities and authorities; (ii) monitoring and testing activities that will be performed during construction; and (iii) CQA documentation requirements. In the context of this document, Construction Quality Assurance and Construction Quality Control are defined as follows:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA personnel to assure conformity of the construction with the requirements of the Drawings, Specifications, and QAM. CQA is provided by a party independent from production and installation (i.e., independent of the Contractor or Geosynthetics Installer).
- Construction Quality Control (CQC) refers to those actions taken by the Contractor, Manufacturers, or Suppliers, including their designated representatives, to ensure that the materials and the workmanship meet the requirements of the Drawings, Specifications, QAM and all components of the Contract Documents.

1.3 Project Personnel

1.3.1 Organization of Personnel

The project organization chart depicting the key roles and lines of communication for construction at the Crossroads Landfill is provided in Figure 1. Definitions for these terms are provided in Section 01100 of the Specifications. Project Manager refers to the Owner's Representative and shall apply equally to the term Construction Manager. The duties and responsibilities of the CQA individuals identified in Figure 1 are described below.

1.3.2 CQA Engineer-of-Record

The CQA Engineer-of-Record will serve as the certifying engineer for construction of the work. He will review all clarifications and changes, which may affect the design and will serve as technical reviewer of the CQA Final Report. He will also be directly accessible to the Project Manager, Designer, and CQA personnel for technical direction during construction. The CQA Engineer-of-Record must provide clear documentation demonstrating construction experience on at least 5 previous landfill projects and must be a licensed Professional Engineer (Civil) in the State of Maine.

1.3.3 CQA Site Manager

The CQA Site Manager will interact on a frequent basis with all project personnel and will have authority over CQA personnel. He must provide clear documentation demonstrating on-site field work experience on at least 5 previous landfill projects, and/or an appropriate level of NICET certification. The responsibilities and duties of the CQA Site Manager include the following:

- be familiar with the basic concepts used to develop the Drawings and Specifications;
- evaluate conformance of materials and construction with the requirements of the Drawings and Specifications;
- be familiar with other site-specific documentation, including the Contractor's bid;
- attend the meetings described in Section 1.5 of this QAM;

- assist the Project Manager in preparing documentation for Requests for Information (RFI) or other clarifications to the Drawings and/or Specifications;
- administer the CQA program (i.e., assign and manage CQA personnel, review field reports, and provide review of CQA related issues);
- review as-built survey information submitted by the Contractor;
- coordinate and review the CQA Surveyor's work products;
- prepare the Weekly Field Summaries; and
- prepare the CQA Final Report.

1.3.4 Soils Quality Assurance Laboratory (Soil QAL)

The Soil QAL will have experience in the physical testing of soils and concrete, and be familiar with, and properly-equipped to perform the geotechnical testing required by the QAM.

1.3.5 Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL)

The Geosynthetic QAL will have experience in testing the types of geosynthetics to be used on the project, and be familiar with, and properly equipped to perform the testing required by the QAM. The Geosynthetic QAL will be certified by the Geosynthetic Accreditation Institute Laboratory Accreditation Program (GAI-LAP).

1.3.6 Construction Quality Assurance Technician(s)

CQA personnel will be responsible for on-site CQA activities. The general duties of CQA personnel will include the following:

- be familiar with the CQA requirements for the project;
- perform daily CQA activities;
- attend CQA-related meetings discussed in Section 1.5 of this QAM;
- verify the calibration and condition of on-site CQA equipment;
- assign locations for testing and sampling;
- coordinate collection and shipping of laboratory test samples;

- review and report results of laboratory testing and Manufacturer and Contractor testing;
- review and assist the CQA Site Manager or Project Manager in approving the Contractor's submittals;
- prepare CQA daily field reports that include descriptions of the construction progress and any relevant observations;
- provide daily field reports and logs to the CQA Site Manager for review;
- report any unresolved deviations from the Drawings and Specifications to the CQA Site Manager; and
- assist in preparing the CQA final report.

Relative to earthwork construction, the duties of CQA personnel will include the following:

- check stockpile or borrow sources periodically for variability of the soils, and verify that conformance testing is carried out;
- field-test soil moisture content and monitor moisture conditioning activities by the Contractor;
- field-test soil density and monitor earthwork activities;
- collect soil samples for laboratory conformance testing;
- examine soil surfaces for signs of excessive wetting, desiccation, or other defects prior to placement of overlying materials;
- monitor scarification between lifts and before recompaction or proof rolling that is required to repair deteriorated areas;
- establish, with the Project Manager, additional test requirements beyond those in the Specifications and/or QAM, when necessary.

Relative to the geosynthetics, theGeosynthetic QAC technician(s) will either be NICET certified, or will work under the review of a NICET – certified supervisor. CQA personnel will:

- review Manufacturer and Contractor certifications and documentation and make appropriate recommendations to the Geosynthetic Installer;
- review the Geosynthetic Installer's personnel qualifications for conformance with those pre-approved for work on site;
- monitor material delivery when possible to document if materials are damaged prior to or during unloading;
- monitor on-site transport and storage;
- coordinate conformance testing to verify material properties;
- obtain samples for laboratory conformance testing;
- monitor placement operations; and
- monitor repair operations.

In addition to these duties, CQA personnel will take note of on-site activities that could result in damage to the soils, geosynthetics, or other components of the project. Observations so noted will be reported as soon as possible to the Contractor and when necessary to the Project Manager.

1.3.7 Construction Quality Assurance Surveyor

A CQA Surveyor will provide survey data to verify as-built documentation of the Contractor's work. Responsibilities of the CQA Surveyor are presented in Section 2 of the QAM.

1.4 <u>Applicable References</u>

Organizations whose standards are referenced in the QAM and the Specifications are as follows:

- AASHTO - American Association of State Highway and Transportation Officials;
- ASTM -American Society for Testing and Materials;

- GSI - Geosynthetic Institute;
- MEDOT - Maine Department of Transportation;
- OSHA - Occupational Safety and Health Administration; and
- ME SWMR - Maine Department of Environmental Protection Solid Waste Management Rules
- MEDEP BMPs – Maine Department of Environmental Protection Best Management Practices

Any reference to standards of any society, institute, association, or governmental agency will pertain to the edition in effect as of the date of this QAM, unless stated otherwise.

1.5 Site and Project Meetings

1.5.1 Pre-Construction Meeting

Prior to initiating construction activities at the site, select requirements set forth in the Contract Documents for the project will be addressed in a pre-construction meeting. At a minimum, the meeting will be attended by the Contractor, CQA Site Manager, Designer, and the Project Manager.

The purpose of this meeting is to begin planning for coordination of tasks, to present the schedule and sequence of work, to discuss anticipated problems which might cause difficulties and delays in construction, and to present the procedures for clarifications and field changes to the Drawings or Specifications.

The pre-construction meeting should include discussion of the following activities:

- review the responsibilities of each party;
- confirm the lines of authority and communication;
- communicate to all parties any relevant documents;
- review critical design details of the project;
- address any appropriate modifications to the QAM;
- address any appropriate modifications to the Drawings or Specifications so that the fulfillment of design specifications or performance standards can be achieved;

- establish an understanding by the parties of the QAM and QA and QC procedures;
- establish work area security and safety protocol in accordance with the Owner's and the Contractor's health and safety plans;
- describe soil borrow source locations;
- establish soil stockpiling locations;
- confirm the methods for documenting and reporting, and for distributing documents and reports;
- confirm acceptance and approval process for task completion prior to schedule sequence advancement; and
- establish procedures for processing applications for payment.

Items discussed during the pre-construction meeting will be documented by a person designated at the beginning of the meeting, and minutes will be transmitted to all parties within one week of the meeting.

1.5.2 Progress Meetings

A weekly progress meeting (via teleconference or at the site) will be held each week during construction between select CQA personnel, the Contractor, and the Project Manager. The Engineer-of-Record and Designer will participate in the weekly meetings when appropriate. Current progress, planned activities for the upcoming week, and any new business or revisions to the work will be discussed at this meeting. The Project Manager will document in the meeting minutes any problems, decisions, or questions arising at this meeting. Any matters requiring action which are raised in this meeting will be reported to the appropriate parties. Minutes of weekly progress meetings will be distributed to each party present at the meeting and other designated parties.

Daily progress meetings will be held between the CQA Site Manager and the Contractor prior to the start of work, during the day, and/or following the completion of work at the end of the day. The purpose of these meetings will be to review the previous day's activities, review the upcoming day's activities and identify any needs or potential construction problems. Major items discussed during these meetings will be documented in the CQA personnel's daily field reports.

1.5.3 Problem or Work Deficiency Meetings

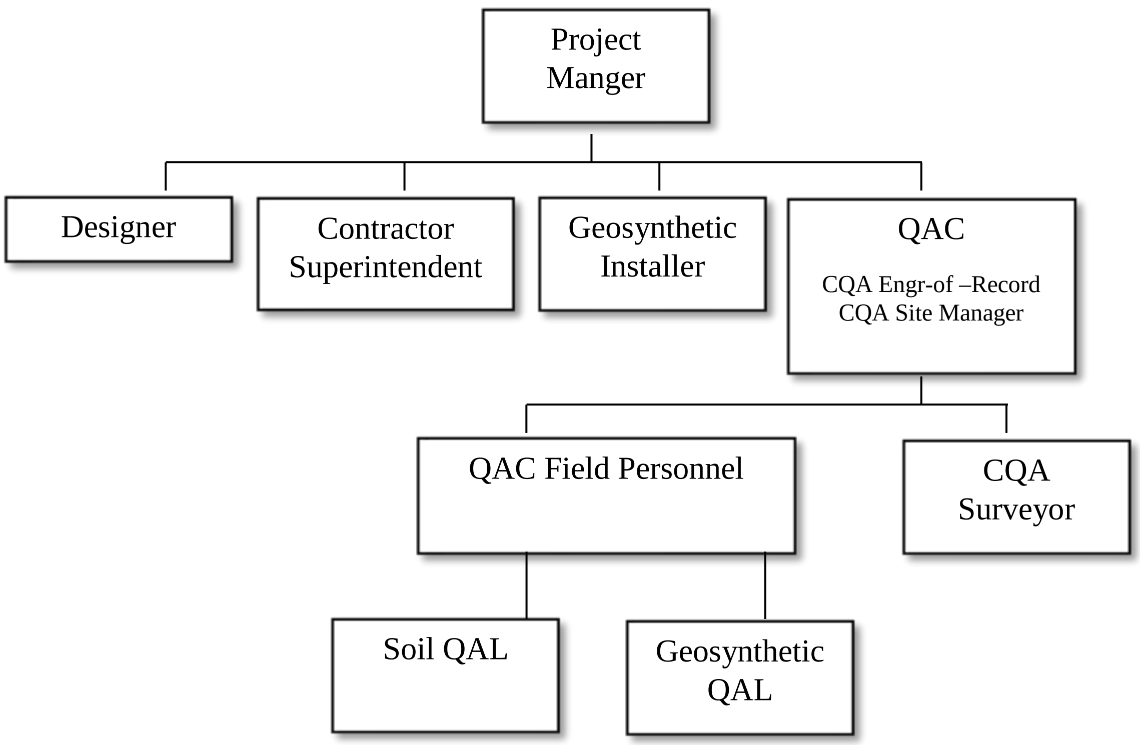
Special meetings will be held by the Project Manager when and if problems or deficiencies are present or judged likely to occur. At a minimum, these meetings will be attended by the Contractor, the Project Manager, and select CQA personnel. The purpose of these meetings will be to define and resolve 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.

Items discussed during these meetings will be documented by the Project Manager, and if deemed necessary, minutes will be transmitted to affected parties.

FIGURE 1

LINES OF COMMUNICATION
WMDSM - CROSSROADS LANDFILL



2. CQA SURVEYING

2.1 Introduction

CQA Surveying of lines and grades will be conducted on an ongoing basis during construction to independently verify the work of the Contractor. (The responsibilities of the Contractor's Surveyor are described in Section 01160 of the Specifications.) The CQA Surveyor will use existing control monuments at the site and the control monuments established by the Contractor's Surveyor during construction. The QAC will coordinate the CQA Surveyor's field work for all aspects of the work.

2.2 Surveying Personnel

CQA Surveying will be performed under the direct supervision of a registered Land Surveyor licensed in the State of Maine, who may also be the senior surveyor on site. The survey crew will consist of the senior surveyor and as many surveying assistants as required to satisfactorily perform and complete the work. Personnel will be experienced in all aspects of surveying, including detailed, accurate documentation, and generation of Record Drawings.

2.3 Precision and Accuracy

The survey instruments used by the CQA Surveyor will be sufficiently precise and accurate to meet the needs of the project as defined in the Specifications. Survey instruments will be capable of reading to a precision of 0.01 ft and with a setting accuracy of 10 seconds. Calibration certificates for survey instruments will be submitted on request to the QAC prior to the initiating CQA surveying activities at the site.

2.4 Scope of CQA Surveying

The scope of CQA surveying will include, but not necessarily be limited to:

- verifying the horizontal and vertical coordinates of selected construction control points;
- verifying layer thickness, especially of soil components of the liner system or final cover system;
- providing record information regarding the horizontal alignment and vertical profile of leachate-collection pipes and site drainage piping;

- providing detailed record information of the locations of geomembrane seams, destructive tests, and major repairs;
- providing sufficient survey information of interim conditions such that, if requested by the Project Manager, material quantities can be calculated; and
- providing Record Drawings, including plan sheets of the important liner system or final cover system components, and geomembrane panel layout drawings.

It will be the responsibility of the CQA personnel and the CQA Surveyor to coordinate the CQA surveying work such that areas are promptly surveyed, interim results are reviewed, and approval is granted for the Contractor to proceed with subsequent work in the areas. The QAC will report any nonconformancies or inconsistencies to the Contractor promptly to minimize delays in the construction.

2.5 Documentation

Original field CQA survey notes will be retained by the senior CQA Surveyor. A copy of these notes will be given to the QAC by email at the end of each day or surveying task, as requested by the CQA personnel. The CQA Surveyor will be required to produce interim verification documentation (e.g. partial "draft" record drawing) as the job progresses, at the request of the CQA personnel.

3. INSTRUMENTATION

3.1 Overview

This section of the QAM addresses the CQA program to be implemented by the QAC with regard to protection and installation of site instrumentation. Items in this section include piezometers, monitor wells, slope inclinometers, Shape Accelerometer Arrays (SAA's), and settlement plates. Supply and installation of the site instrumentation will most likely be performed by a Specialty Contractor/Consultant (separate from the Construction Contractor) with experience in hydrogeologic and/or geotechnical instrumentation. Likewise, certification of the installation will be provided by a specialty hydrogeologic or geotechnical consultant that may be separate from the QAC.

The purpose of this section is to describe the general CQA activities related to on-site instrumentation for which the QAC will be responsible. Detailed information regarding monitoring/certification of the actual instrumentation is not addressed herein. The following CQA activities are discussed in the remainder of this section:

- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

3.2 Field Evaluation/Monitoring of Construction Techniques

The QAC will assist the Project Manager in coordinating installation activities for the site instrumentation, as requested, and will inform the Contractor of existing or proposed instrumentation activities as they might affect (or be affected by) construction activities.

The QAC will observe the locations of existing and proposed instrumentation, and will verify that, prior to initiating work in these areas, the Contractor has installed all necessary measures to adequately mark and protect the instrumentation, as set forth in Section 02100 of the Specifications. The QAC will routinely verify that the Contractor maintains the markers and protective measures.

3.3 Deficiencies, Problems, and Repairs

The QAC will report any deficiencies and noncompliances in the instrumentation markings and/or protective measures to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the QAC and Project Manager. The Contractor will promptly correct the deficiency to the satisfaction of the QAC, or as directed by the Project Manager.

4. TEMPORARY EROSION CONTROL

4.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to temporary erosion and sediment controls. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

4.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Contractor will be required to provide the QAC with the quality control information and certification from the supplier(s) of temporary seed, mulches or matting, and silt fence as set forth in Section 02120 of the Specifications.

The QAC will examine all of the suppliers' certifications to verify that the property values listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor for the temporary erosion and sedimentation materials that will be used at the site. The QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the materials.

4.3 Field Evaluation/Monitoring of Construction Techniques

The QAC will observe the Contractor's work activities and will verify that, prior to initiating work in any given area, temporary erosion and sediment controls, as set forth in Section 02120 of the Specifications and the Erosion and Sedimentation Control Plan (ESCP) have been installed. The QAC will routinely verify that the Contractor keeps the site free from excessive sediment and in as neat a condition as possible. This includes the project area, haul roads, borrow areas, stockpile areas, and the entrance area to the Crossroads facility.

The QAC will perform weekly inspections of the Contractor's temporary erosion and sediment controls and will perform an inspection of the controls within one working day of any rain event exceeding ½ inch. The Contractor may accompany the QAC during these inspections or may perform independent inspections as set forth in the Specifications and ESCP. The QAC will be responsible for reviewing the Contractor's erosion control inspection checklist forms within one working day of the Contractor submitting the forms.

The QAC will verify that stockpiles are located as shown on the Drawings or as approved by the Project Manager and that the Contractor has installed and is frequently maintaining all erosion and sedimentation control measures around these areas, as set forth in the Specifications and ESCP.

4.4 Deficiencies, Problems, and Repairs

The QAC will report any deficiencies and noncompliances in the erosion and sedimentation controls to the Contractor. The extent of the deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the QAC and Project Manager. The Contractor will promptly correct any deficiency to the satisfaction of the QAC or as directed by the Project Manager.

5. CLEARING, GRUBBING, AND STRIPPING

5.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to clearing, grubbing, and stripping. The following CQA activities are addressed in this section:

- field evaluation/monitoring of construction techniques; and
- deficiencies and problems.

5.2 Field Evaluation/Monitoring of Construction Techniques

Formal testing for clearing, grubbing, and stripping is not required. However, the QAC will perform the following monitoring activities for clearing, grubbing, stripping, and stockpiling of on-site soils:

- verifying that trees and cleared vegetation are disposed of in proper areas;
- verifying that minimal disturbance to areas surrounding the limits of work occurs during clearing and grubbing activities;
- monitoring the location and configuration of stockpile areas and verify the separation of adjacent stockpiles of different materials; and
- documenting that proper erosion controls are implemented and maintained around the areas to be cleared, grubbed, or stripped, and around soil stockpiles.

5.3 Deficiencies and Problems

Deficiencies, problems, or other nonconformancies with the Construction Documents will be documented and reported by the QAC to the Contractor and the Project Manager.

6. EXCAVATION AND STORAGE OF SILT CLAY

6.1 Overview

This section of the QAM addresses the CQA program to be implemented by the QAC with regard to excavation and storage of silt clay. The following CQA activities are discussed in the remainder of this section:

- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

6.2 Field Evaluation/Monitoring of Construction Techniques

The QAC will become familiar with the locations from which the Contractor will excavate silt clay materials, as set forth on the Drawings. The QAC will routinely verify that the Contractor follows the requirements set forth in Section 02140 of the Specifications when excavating, transporting, and stockpiling silt clay materials. Specifically, the QAC will work closely with the Contractor prior to or during excavation to evaluate the condition of the silt clay (e.g., moisture content) in an effort to facilitate re-use of the material to the extent practicable. The QAC will also verify that the Contractor takes all precautions necessary to avoid mixing the silt clay with other materials that the silt clay is stockpiled in the area(s) designated on the Drawings, or as directed by the Project Manager, and that unsuitable material is not used.

6.3 Deficiencies, Problems, and Repairs

The QAC will report any deficiencies and noncompliances in the silt clay excavation activities to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the QAC and Project Manager. The Contractor will correct any deficiency to the satisfaction of the QAC, or as directed by the Project Manager.

7. WICK DRAINS / UNDERDRAIN

7.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to the wick-drain and underdrain components to be installed prior to placement of the liner system. The wick drain material will be supplied and installed by the Contractor or the Wick-Drain Subcontractor. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

7.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Contractor will be required to provide the QAC with the quality control information and certifications for earthen materials (e.g., Underdrain Collection Sand Layer, Silt-clay Borrow, Drainage Sand, and 1½ -inch Crushed Stone) as set forth in Section 02200 of the Specifications. The QAC will examine all information and certifications in accordance with the procedures set forth in Section 8 of this QAM to verify that the property values meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor for all earthen materials used at the site. The QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the wick drains and/or underdrain components.

Prior to construction, the Contractor will be required to provide the QAC with the quality control information and certifications from the wick-drain manufacturer as set forth in Section 02170 of the Specifications. The QAC will examine all wick-drain manufacturer's certifications to verify that the property values listed on the manufacturer's certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor for all wick drain and underdrain materials used at the site. Prior to construction, the Contractor will be required to provide the QAC with manufacturer’s literature for a sample of the strip drain material (if used). The QAC will examine the submittal and verify the proposed strip drain material meets or exceeds the Specifications. The QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the wick drains and/or underdrain components.

7.3 Material Conformance Testing

Conformance sampling of the earthen materials related to wick-drain and underdrain construction would be performed in accordance with Section 8 of this QAM.

Conformance sampling of the geotextile materials related to wick-drain and underdrain construction would be performed in accordance with Section 11 of this QAM, if required by the Designer.

Conformance sampling of the wick-drain may be performed by the QAC either prior to or upon delivery of rolls to the site, as requested by the Project Manager. The QAC will obtain samples and forward them to the Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL) for testing to evaluate whether the material meets the requirements of the Specifications and the manufacturer's list of certified properties.

Unless otherwise specified, samples will be 10-ft long by the full roll width. The QAC will mark each sample with the following information:

- date sampled
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the wick-drain material are given in Table 7-1.

All conformance test results will be reviewed by the QAC before installation of the wick drains. Any nonconformance of the material’s physical properties will be promptly reported to the Contractor. The following procedure will apply whenever a wick-drain sample fails a conformance test conducted by the Geosynthetic QAL:

- The Contractor will be required to replace all of the rolls of wick-drain within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Contractor, wick-drain manufacturer and the Project Manager all agree, the QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetic QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of wick-drain on site and a sample from every roll that is subsequently delivered from the same wick-drain manufacturer must be conformance tested by the Geosynthetics QAL.

During conformance testing, the QAC will also verify that the wick-drain manufacturer has identified all rolls of wick-drain with the following information:

- name of Manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The QAC will record all of the above information for each roll delivered to the site using a Material Inventory Log form for the wick-drain material.

There are no specific conformance sampling and testing requirements for strip drains.

7.4 Field Evaluation/Monitoring of Construction Techniques

Field evaluation/monitoring of the earthen materials related to wick-drain and underdrain construction would be performed in accordance with Section 9 of this QAM.

Field evaluation/monitoring of the geotextile materials related to wick-drain and underdrain construction would be performed in accordance with Section 13 of this QAM.

During unloading and storage, the Contractor and/or the Wick-drain Subcontractor will be required to keep the wick-drain and strip drain material off the ground and protect the wick-drain and strip drain material from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Specifications require that the wick-drain rolls be wrapped, shipped, and stored in heavy-duty covering.

The QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Contractor. Any damaged rolls will be rejected by the QAC and/or Project Manager and required to be repaired or replaced by the Contractor.

The Contractor and/or the Subcontractor will be required to handle and deploy all wick-drain and strip drain in such a manner as to ensure the wick-drain and strip drain is not damaged and that the underdrain is constructed in accordance with the Drawings and Specifications. The QAC will verify compliance with the following:

- the locations of all buried work (e.g., the conveyance pipes and geotechnical instrumentation) are clearly marked so as to preclude disturbance or damage by subsequent activities;
- immediately prior to placing the geotextile separator, the subgrade is graded in accordance with the Drawings, and is free of obstructions and protrusions that could affect the underdrain on wick-drain installation;
- placement procedures for the sand blanket do not result in contamination of the sand by mud, dirt, or other materials;
- immediately prior to wick-drain placement, the sand blanket surface is free of moisture, dirt, contamination, or obstructions that could potentially damage the wick-drains;
- the ground surface elevation for each wick drain has been pre-determined, and the installer is implementing the rigorous controls required to ensure the correct depth of each wick drain installed;
- the location and depth of each wick drain is recorded;
- each wick drain extends 6 to 12 inches above the top of the sand blanket;
- efforts are made to install the wicks plumb;
- the locations of the strip drains are as depicted on the drawings;

- strip drains are placed on top of the underdrain sand with the protection board on top (i.e., dimples down);
- efforts are made to lay strip drain flat on the underdrain sand surface;
- efforts are made not to entrap soil in any exposed ends of strip drains;
- efforts are made to minimize the presence of wrinkles in the geotextile separator over the sand blanket, and all seams are sewn in accordance with the Specifications (see also Section 13 of this QAM);
- care is taken by the Contractor not to entrap stones, soil, dust, or moisture that could damage or cause clogging to the underdrain;
- a visual examination of the underdrain is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and
- the geotextile separator is not left exposed for longer than the maximum allowable period (as set forth in the Specifications) after placement unless a longer exposure period is approved by the Designer.

The QAC will verify that the components of the wick-drain (i.e., geotextile-geonet-geotextile) are spliced to like-components in adjacent wick-drain strips, as required in the Specifications.

The QAC will verify that the Contractor places soil materials (i.e., the compacted clay layer) on top of underdrain layer such that:

- the wick-drains and underdrain (geotextile separator) materials are not damaged;
- wrinkles in the geotextile separator over the sand blanket are minimized; and
- excess tensile stresses are not produced in the geotextile separator over the sand blanket.

7.5 Deficiencies, Problems, and Repairs

The QAC will report to the Contractor and/or the Wick-drain Subcontractor any unresolved deficiencies in the underlying subgrade prior to underdrain/wick-drain placement and will not approve of wick-drain installation until the deficiencies are resolved to the satisfaction of the QAC and in accordance with the Specifications.

The QAC will verify that any damage (e.g., holes or tears) in the wick-drains and/or geotextile separator are repaired in accordance with the Specifications, and that care is taken by the Contractor to remove any soil or other material which may have contaminated or otherwise detrimentally affected the performance of the sand blanket.

The QAC will document deficiencies or noncompliance with the specified requirements and report them to the Contractor and/or the Wick-drain Subcontractor. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the QAC.

The Soil will confirm that the wick drains having tip elevations deeper than specified are grouted, unless approval is received from MEDEP.

The Contractor and/or the Wick-drain Subcontractor will correct the deficiency to the satisfaction of the QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor and/or Wick Drain Subcontractor in the area of the deficiency.

TABLE 7-1
MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR WICK-DRAINS

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Geotextile Component		
Equivalent Opening Size	ASTM D 4751	1 per 200,000 linear ft
Wick-drain Composite		
Transmissivity (2)	ASTM D 4716	1 per 200,000 linear ft

Notes:

1. Testing shall be performed at listed frequency, for each type of wick drain used for the work.
2. Transmissivity tests on wick-drain samples shall be performed using the conditions set forth in Specification Section 02170, or as defined by the Designer.

8. EARTHWORK

8.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to general earthwork. General earthwork consists of placement and compaction of all soil, stone, or gravel components of the work, Soil Barrier Layer (which is covered in Section 9 of the QAM) and Topsoil (which is covered in Section 18 of the QAM). The following CQA activities are discussed in this section:

- Pre-construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

8.2 Pre-construction Qualifying of Material Sources

Prior to construction with any given soil, stone, or gravel material, the QAC will receive test results from the Contractor for a sample of each material taken from the proposed source. The QAC will review the test results to ensure that each material meets the requirements set forth in the Specifications. Results of the pre-construction qualifying tests may be counted toward the conformance testing frequency requirements, provided the results meet the specified material properties. The QAC may also request that the Contractor provide a sample of each material for additional testing, if further pre-construction qualification testing by the QAC is warranted.

If a pre-construction qualifying sample fails to meet the requirements of the Specifications, the QAC will notify the Contractor. Use of the material will not be allowed until the material is prequalified by further tests. Additional tests, if necessary, will be performed by the QAC at the request of the Project Manager at the Contractors' expense.

8.3 Material Conformance Testing

During construction, a conformance testing program will be implemented by the QAC to verify that the physical properties of the earthwork materials meet the specified material properties. The QAC will obtain soil samples for conformance testing from the borrow source, on-site stockpiles, or from trucks as they unload material in the work area. The laboratory test methods and frequencies required for conformance testing are given in the following tables:

- Table 8-1a: Drainage Sand
- Table 8-2a: Granular Working Mat / Underdrain Collection Layer
- Table 8-3a: Silt Clay Borrow
- Table 8-4a: Granular Common Borrow
- Table 8-5a: Cohesive Common Borrow
- Table 8-6a: Structural Fill
- Table 8-7a: Granular Fill
- Table 8-8a: ¾-Inch Crushed Stone
- Table 8-9a: 1½-Inch Crushed Stone
- Table 8-10a: Riprap

If a sample fails a conformance test, the QAC will notify the Contractor and use of the material represented by that sample will not be allowed. Additional tests will be performed by the QAC as directed by the Project Manager, or the Contractor will use material from a different source.

8.4 Field Evaluation/Monitoring of Construction Techniques

The QAC will monitor and document the earthwork activities. Monitoring the construction work for the earthwork materials will include the following:

- monitoring the thickness of lifts as loosely placed and after being compacted;
- documenting the type of construction equipment and methods used to place and compact the material;
- observing the action of the compaction and heavy hauling equipment on the construction surface (i.e., penetration, pumping, cracking, etc.) to detect inadequate compaction;
- verifying that proper equipment and methods are used to place soil or stone over geosynthetic components of the liner system or final cover system, and that wrinkles or excess tensile stresses to underlying geosynthetics are minimized; and

- verify that only low-ground pressure equipment traverses over lined areas unless an approved thickness of protective soil is first placed.

8.5 Field Testing of Work Products

8.5.1 Routine Field Testing

Field testing (primarily density and moisture content testing) of placed/compacted earthwork materials will be performed by the QAC during construction to evaluate the Contractor's work product with respect to the requirements of the Specifications. The test methods and frequencies for CQA field testing are given in Tables 8-1b through 8-10b for the various materials, as previously listed in Section 8.3 of this QAM. Sampling and test locations will be selected by the QAC.

Moisture/density testing will be performed primarily using a nuclear gauge (in accordance with ASTM 6938). The QAC will perform several Oven Moisture content tests (ASTM D2216) on any given material at the outset of construction to evaluate requirements for moisture offsets for the nuclear gauge and during construction at a minimum frequency of one per 25 nuclear moisture/density tests. The QAC will also routinely verify the dry density calibration of the nuclear gauge throughout construction using methods such as Sand Cone (ASTM D1556) and/or Drive Cylinder (ASTM D2937) density testing.

The QAC will be responsible for submitting enough samples to the Soil QAL to meet the minimum testing frequency for Standard or Modified Proctor compaction testing for each soil as set forth in Tables 8-1a through 8-10a. The QAC will also have the Soil QAL perform additional compaction tests as necessary to evaluate variability in material and will perform Proctor check-points as frequently as needed to verify that the correct Proctor curve is being referenced.

It is also the responsibility of the QAC to monitor placement and compaction of soil in the liner system anchor trench. The QAC will verify that the backfilling techniques do not damage the geosynthetics in or near the anchor trench. Moisture and density testing of the backfill should be performed by the QAC at a frequency of once every 50 linear feet measured along the anchor trench.

8.5.2 Special Testing

A special testing frequency will be used at the discretion of the QAC when initial testing or visual observations of construction performance indicates a potential problem. Additional testing for suspected areas will be considered when:

- the compactor rollers slip during compaction operations;
- the lift thickness is greater than specified;
- the material is at highly variable moisture content;
- dirt-clogged rollers are used to compact the material;
- the materials properties are highly variable;
- the degree of compaction is doubtful; or
- as directed by the Designer or Project Manager.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions;
- breakdown of equipment;
- at the start and finish of grading;
- if the material initially fails to meet compaction requirements; or
- the work area is reduced.

8.6 Deficiencies, Problems, and Repairs

If a deficiency or noncompliance is discovered, the QAC will promptly evaluate the extent and nature of the defect. The extent of the deficient area will be evaluated by additional tests, observations, a review of records, or other means deemed appropriate (e.g., proof rolling by the Contractor).

After defining the extent and nature of a defect, the QAC will notify the Contractor, and at times, the Project Manager, to schedule appropriate retests after the work deficiency is corrected.

If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to the Project Manager or Designer suggested alternative solutions for approval. All retests recommended by the QAC must verify that the deficiency has been corrected before additional work is performed by the Contractor in the area of the deficiency.

TABLE 8-1a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR DRAINAGE SAND

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Particle-Size Analysis (2)	ASTM D6913	1 per 2,500 yd^3
Moisture Content	ASTM D2216	1 per 2,500 yd^3
Stand Proctor Compaction	ASTM D698	1 per source
Remolded Permeability (3)	ASTM D2434	5 per acre/lift
Carbonate Content	ASTM D4373	1 per source

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.
3. Remolded permeability to be performed on sample compacted to at least 88% of its Standard Proctor maximum dry density (light compactive effort).

TABLE 8-1b

FIELD TESTING REQUIREMENTS FOR DRAINAGE SAND

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
Layer Thickness	Grade Markers or Test Holes	5 per acre/lift

TABLE 8-2a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GRANULAR WORKING MAT AND UNDERDRAIN COLLECTION LAYER [(4)]

TEST	METHOD	MINIMUM FREQUENCY OF TESTING [(1)]
Particle-Size Analysis [(2)]	ASTM D6913	1 per 2,000 yd^3
Remolded Permeability [(3)]	ASTM D2434	Prequalification

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.
3. Remolded permeability to be performed on sample compacted to at least 88% of its Standard Proctor maximum dry density (i.e., loosely compacted).
4. The uppermost 2-ft on the base of the landfill shall be considered the underdrain layer. Material below 2-ft is considered granular working mat.

TABLE 8-2b

FIELD TESTING REQUIREMENTS FOR GRANULAR WORKING MAT AND UNDERDRAIN COLLECTION LAYER

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
Layer Thickness (Underdrain Layer Only)	Grade Markers or Test Holes	1 per acre

TABLE 8-3a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR SILT CLAY BORROW

TEST	METHOD	MINIMUM FREQUENCY OF TESTING [1]
Particle-Size Analysis [2]	ASTM D6913	1 per 2,500 yd^3
Moisture Content	ASTM D2216	1 per 2,500 yd^3
Atterberg Limits	ASTM D4318	1 per 2,500 yd^3
Standard Proctor Compaction	ASTM D698	1 per 5,000 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Particle-size analysis includes hydrometer.

TABLE 8-3b

FIELD TESTING REQUIREMENTS FOR SILT CLAY BORROW

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
In-Place Density [1]	ASTM D6938	5 per acre per lift
In-Place Moisture [1]	ASTM D6938	5 per acre per lift
Loose-Lift Thickness	Grade Markers or Test Holes	2 per acre per lift

Notes:

1. Moisture/density testing for silt clay borrow to backfill the anchor trench will be performed at a frequency of at least one test per 100 linear ft measured along the anchor trench.

TABLE 8-4a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GRANULAR COMMON BORROW

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Particle-Size Analysis (2)	ASTM D6913	1 per 5,000 yd^3
Modified Proctor Compaction	ASTM D1557	1 per 5,000 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 8-4b

FIELD TESTING REQUIREMENTS FOR GRANULAR COMMON BORROW

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 8-5a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR COHESIVE COMMON BORROW

TEST	METHOD	MINIMUM FREQUENCY OF TESTING [1]
Particle-Size Analysis [2]	ASTM D6913	1 per 5,000 yd^3
Standard Proctor Compaction	ASTM D698	1 per 5,000 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Particle-size analysis includes hydrometer.

TABLE 8-5b

FIELD TESTING REQUIREMENTS FOR COHESIVE COMMON BORROW

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 8-6a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR STRUCTURAL FILL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Particle-Size Analysis (2)	ASTM D6913	1 per 2,500 yd^3
Modified Proctor Compaction	ASTM D1557	1 per 5,000 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle-Size Analysis is not required.

TABLE 8-6b

FIELD TESTING REQUIREMENTS FOR STRUCTURAL FILL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 8-7a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GRANULAR FILL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Particle-Size Analysis (2)	ASTM D6913	1 per 5,000 yd^3
Modified Proctor Compaction	ASTM D1557	1 per 5,000 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 8-7b

FIELD TESTING REQUIREMENTS FOR GRANULAR FILL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 8-8a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR 3/4 - INCH CRUSHED STONE

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Particle-Size Analysis (2)	ASTM D6913	1 per 2,500 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 8-8b

FIELD TESTING REQUIREMENTS FOR 3/4 - INCH CRUSHED STONE

(NOT APPLICABLE)

TABLE 8-9a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR 1-1/2 - INCH CRUSHED STONE

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Particle-Size Analysis (2)	ASTM D6913	1 per 2,500 yd^3
Carbonate Content	ASTM D3042	1 per source

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 8-9b

FIELD TESTING REQUIREMENTS FOR 1-1/2 - INCH CRUSHED STONE

(NOT APPLICABLE)

TABLE 8-10a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR RIPRAP

TEST	METHOD	MINIMUM FREQUENCY OF TESTING [1]
Particle-Size Analysis	Visual Inspection	1 per 1,000 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.

TABLE 8-10b

FIELD TESTING REQUIREMENTS FOR RIPRAP

(NOT APPLICABLE)

9. SOIL BARRER LAYER

9.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to the Soil Barrier (Compacted Clay) Layer. The following CQA activities are discussed in this section:

- Pre-construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

9.2 Pre-construction Qualifying of Material Sources

Prior to Soil Barrier Layer construction, the QAC will participate in monitoring the construction of a test pad using material taken from the proposed borrow source. The QAC will review results of the soil property testing performed during the test pad program; these test results will serve as the pre-construction qualifying test results for the Soil Barrier Layer material. The QAC may also request that the Contractor provide a sample of the material for additional testing, if further pre-construction qualification testing by the QAC is warranted.

If a test pad is not performed for this specific project, then the requirements Chapter 401, Appendix A of the Maine Solid Waste Management Rules will be met.

If, a pre-construction qualifying sample fails to meet the requirements of the Specifications, the QAC will notify the Contractor. Use of the material will not be allowed until the material is prequalified by further tests. Additional tests, if necessary, will be performed by the QAC at the request of the Project Manager at the Contractor's expense.

9.3 Material Conformance Testing

During construction, a conformance testing program will be implemented by the QAC to verify that the physical properties of the Soil Barrier Layer material meets the properties set forth in Sections 02200 and 02240 of the Specifications. The QAC will obtain soil samples for conformance testing from the borrow source, on-site stockpiles, or from trucks as they unload material in the work area. The laboratory test methods and frequencies required for conformance testing of the Soil Barrier Layer material are given in Table 9-1a.

If a sample fails a conformance test, the QAC will notify the Contractor and use of the material represented by that sample will not be allowed. Additional tests will be performed by the QAC as directed by the Project Manager at the Contractor's expense.

9.4 Field Evaluation/Monitoring of Construction Techniques

Prior to approving placement of Soil Barrier Layer material, the QAC will observe proof rolling of the Silt Clay subgrade. The proof rolling will be performed by the Contractor in accordance with Section 02240 of the Specifications. The QAC must be present during proof rolling and will either: (i) document that the subgrade is firm and approved for placement of Soil Barrier Layer material, or (ii) will inform the Contractor where subgrade improvement activities are required. The QAC will monitor and document subgrade improvements made by the Contractor.

The QAC will monitor and document the Contractor's activities required to excavate, transport, place, and compact the Soil Barrier Layer material. Monitoring the construction work for the Soil Barrier Layer will be on a full-time basis and will include the following:

- verify that the material is being obtained from the proper location in the borrow source;
- verifying that subgrade conditions have not deteriorated since being approved;
- monitoring the thickness of lifts as loosely placed and as compacted;
- verifying that the moisture conditioning equipment and methods are in accordance with the Specifications;
- verifying that the surface is sealed at the end of each shift using the equipment and methods are in accordance with the Specifications;
- observing the action of the compaction and heavy hauling equipment on the surface of each lift of the Soil Barrier Layer, which might indicate sufficient compaction, is not being achieved (i.e., penetration, pumping, cracking, etc.);

- verifying that the type of construction equipment and methods (e.g. number of passes) used to place and compact the material meets the requirement of the Specifications; and
- verifying that the surface of the soil barrier layer (i.e., the geomembrane subgrade) is prepared immediately prior to geomembrane placement in accordance with the Specifications.

9.5 Field Testing of Work Product

9.5.1 Routine Field Testing

Field testing (primarily density and moisture content testing) of placed/compacted Soil Barrier Layer material will be performed by the QAC during construction to evaluate the Contractor's work product with respect to the requirements of the Specifications. The test methods and frequencies for CQA field testing of the Soil Barrier Layer material are given in Table 9-1b. Sampling and test locations will be selected by the QAC.

9.5.2 Special Testing

A special testing frequency will be used at the discretion of the QAC when initial testing or visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the compactor rollers slip during compaction operations;
- the lift thickness is greater than specified;
- the material is at highly variable moisture content;
- dirt-clogged rollers are used to compact the material;
- the materials properties are highly variable;
- the degree of compaction is doubtful; or
- as directed by the Designer or Project Manager.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions;

- breakdown of equipment;
- at the start and finish of grading;
- if the material initially fails to meet compaction requirements; or
- the work area is reduced.

9.6 Deficiencies, Problems, and Repairs

If a deficiency or noncompliance is discovered, the QAC will promptly evaluate the extent and nature of the defect. The extent of the deficient area will be evaluated by additional tests, observations, a review of records, or other means deemed appropriate (e.g., proof rolling by the Contractor).

After defining the extent and nature of a defect, the QAC will notify the Contractor, and at times, the Project Manager, to schedule appropriate retests after the work deficiency is corrected.

If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to the Project Manager or Designer suggested alternative solutions for approval. All retests recommended by the QAC must verify that the deficiency has been corrected before approval is given for the Contractor to perform additional work in the area of the deficiency.

TABLE 9-1a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR SOIL BARRIER LAYER MATERIAL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING [(1)]
Particle-Size Analysis [(2)]	ASTM D6913	1 per 2,500 yd^3
Atterberg Limits	ASTM D4318	1 per 2,500 yd^3
Moisture Content	ASTM D2216	1 per 2,500 yd^3
Standard Proctor Compaction	ASTM D698	1 per 2,500 yd^3
Remolded Permeability [(3)]	ASTM D5084	1 per 5,000 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Particle Size Analysis includes hydrometer.
3. Remolded permeability to be performed on sample compacted to at least 95% of its Standard Proctor maximum dry density, at a moisture content of +1 to +4% above the optimum moisture content, or as otherwise directed by the Designer. Specimen to be consolidated at an effective confining pressure of 10 psi and permeated with water using gradients recommended in ASTM D 5084.

TABLE 9-1b

FIELD TESTING REQUIREMENTS FOR SOIL BARRIER LAYER

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
In-Place Density	ASTM D6938	10 per acre per lift
In-Place Moisture	ASTM D6938	10 per acre per lift
Loose Lift Thickness	Grade Markers or Ruler	10 per acre per lift
Lift Bonding	Observation of test holes and along anchor trench excavation	1 per acre and every 50 linear ft along anchor trench

Notes:

1 Should soils exposed on the sidewalls of a test hole be smeared due to the method of excavating the test hole (i.e., using an excavator), the QAC will use a hand shovel to expose un-smeared soils in order to observe lift bonding.

10. GEOMEMBRANE

10.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to the polyethylene (PE) geomembrane component of the liner system or final cover system. The geomembrane will be supplied the Owner and installed by the Geosynthetics Installer, under direct contract with the Owner. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

10.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Geosynthetic Installer will provide the QAC with the quality control information and certifications from the geomembrane manufacturer as set forth in Section 02400 of the Specifications.

The QAC will examine all geomembrane manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Geosynthetic Installer for all geomembrane used at the site. The QAC will report any deviations from the above requirements to the Geosynthetic Installer prior to approving deployment of the geomembrane.

Additionally, if a plant visit is requested by the Project Manager, the QAC will visit the geomembrane manufacturer’s plant for the purpose of verifying that manufacturing quality control procedures are in conformance with the Specifications. The plant visit must be performed during the manufacturing of the geomembrane rolls for the project. While at the plant, the QAC will review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures, as follows:

- verify that the measurements of properties by the geomembrane manufacturer are properly documented and test methods used are acceptable;
- spot inspect the rolls and verify that they are free of holes, blisters, or any sign of defects or contamination by foreign matter;
- review packaging and transportation procedures to verify that these procedures are not damaging the geomembrane;
- verify that all rolls are properly labeled; and
- verify that extrusion rods and/or beads manufactured for the field seaming of the geomembrane are derived from the same base resin type as the geomembrane.

The QAC will document their plant visit and upon completion of the visit, forward the documentation to the Project Manager.

In addition to the above pre-qualification evaluation process, the QAC should be aware that a direct shear testing program may be developed and performed under the direction of the Designer for new products and or liner-component interfaces. This program may or may not include the geomembrane; therefore, the QAC should inquire of the Project Manager and/or Designer regarding this at the outset of the project. If applicable, the results of any such program shall be approved by the Designer as a part of the initial pre-qualification process.

10.3 Material Conformance Testing

Conformance sampling of the geomembrane may be performed by the QAC either at the manufacturing plant or upon delivery of the rolls to the site, as requested by the Project Manager. The QAC will obtain samples and forward them to the Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL) for testing to evaluate whether the material meets the requirements of the Specifications and the geomembrane manufacturer's list of certified properties.

Conformance samples will be taken by the QAC unless otherwise specified, samples will be 2-ft long by the roll width. The QAC will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the geomembrane are given in Table 10-1.

All conformance test results will be reviewed by the QAC before approving deployment of the geomembrane. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetic Installer. The following procedure will apply whenever a geomembrane sample fails a conformance test conducted by the Geosynthetics QAL:

- The Geosynthetic Installer will be required to replace all of the rolls of geomembrane within the batch from which the nonconforming sample was obtained.
- Alternatively, if the Geosynthetic Installer, geomembrane manufacturer, and the Project Manager all agree, the QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests in Table 10-1. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geomembrane on site and a sample from every roll that is subsequently delivered from the same geomembrane manufacturer must be conformance tested by the Geosynthetic QAL.

During conformance testing, the QAC will also verify that the geomembrane manufacturer has identified all rolls of geomembrane with the following information:

- name of manufacturer;

- product identification;
- thickness;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The QAC will record the above information for each roll delivered to the site using a Material Inventory Log form for the geomembrane.

10.4 Field Evaluation/Monitoring of Construction Techniques

10.4.1 Proposed Panel Layout

Prior to construction, the QAC will review the proposed panel layout plan submitted by the Geosynthetic Installer. The purpose of the review will be to become familiar with the proposed orientation of the panels, the general installation sequencing, the quantities of materials needed for the job, and to assess whether the proposed installation will be in accordance with the Specifications. The QAC will make written review comments, sign the proposed panel layout plan indicating that the review has taken place, and return it to the Project Manager.

10.4.2 Transportation, Handling, and Storage

During unloading and storage, the Contractor and/or the Geosynthetic Installer will be required to keep the geomembrane off the ground and protect the geomembrane from precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

The QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Geosynthetic Installer. Any damaged rolls will be rejected by the QAC and the Project Manager and will be required to be repaired or replaced by the Geosynthetic Installer.

10.4.3 Field Panel Identification

The QAC will ensure that each field panel is given an identification number. This identification number will be agreed upon by the QAC and Geosynthetic Installer and will allow for the geomembrane roll numbers to be traceable to the field panel identification numbers.

The QAC will document the relationship between roll numbers, factory panels, and field panel identification numbers. The field panel identification numbers will be used for all quality assurance/quality control records.

10.4.4 Field Panel Placement

The QAC will monitor field panel placement and verify that field panels are installed in general accordance with the overall panel orientation indicated on the Geosynthetics Installer's proposed panel layout plan. CQA personnel will record the field panel identification number, manufacturers roll number, location, date of installation, and dimensions of each field panel. The QAC will label each panel in the field with its panel identification number using a semi-permanent marker (e.g., paint stick). To avoid confusion, the QAC will use a different color marker than used by the Geosynthetic Installer.

Prior to deployment, the QAC will observe the work area and will verify that soil subgrade surfaces have been fully approved by members of the QAC project team. It is the responsibility of the QAC to provide subgrade acceptance forms to the Geosynthetic Installer and verify that they have been signed prior to deployment.

The QAC will monitor geomembrane deployment and verify compliance with the following:

- ambient temperatures are within the limits required by the Specifications, and wind is not excessive;
- deployment vehicles or other equipment do not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
- the prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement, without excessive moisture (e.g., dew, ponding, etc.);
- the anchor trench is of the proper dimensions and in suitable condition, without loose or wet soils underlying the geomembrane;

- personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;
- the method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- the method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- adequate temporary loading and/or anchoring (e.g., sand bags, tires) have been placed to prevent uplift by wind; and
- direct contact with the geomembrane is minimized in areas where excessive traffic may be expected (e.g., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials).

The QAC will observe the geomembrane panels, after placement and prior to seaming, for damage, and will advise the Geosynthetic Installer if any panels, or portions of panels, are rejected or needed to be repaired. Damaged panels or portions of damaged panels, which have been rejected, will be marked and their removal from the work area will be recorded by the QAC.

The QAC will be responsible for monitoring placement and compaction of soil backfill in anchor trenches. The QAC will verify that the backfilling techniques do not damage the geosynthetics and will perform moisture and density testing in accordance with the procedures set forth in Section 8.5 of the QAM.

10.4.5 Field Panel Seaming

10.4.5.1 Panel Layout

The QAC will review and become familiar with the proposed panel layout plan previously submitted by the Geosynthetic Installer. In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented up and down, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 ft beyond the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Designer. A seam numbering system compatible with the field panel identification numbering system will be established by the QAC prior to any seaming.

10.4.5.2 Seaming Equipment and Products

Extrusion Fillet Process

The QAC will perform the following activities during the extrusion fillet welding process:

- verify and document that the extrusion-welding apparatus is permanently marked with an identification number;
- verify that the extrusion-welding apparatus is equipped with gauges giving the temperature in the apparatus and at the nozzle;
- verify that the extrudate is comprised of the same resin as the geomembrane sheeting;
- monitor extrudate temperatures, ambient temperatures, and geomembrane sheet temperatures at appropriate intervals;
- verify that a suitable number of spare operable seaming apparatus are maintained on site;
- verify that the extruder is purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel;
- verify that the proper amount of geomembrane grinding has been performed and that over-grinding has not occurred;
- confirm that the electric generator is placed on a smooth base such that no damage occurs to the geomembrane; and
- confirm that a smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

Fusion Process

The QAC will perform the following activities during the fusion welding process:

- verify and document that the fusion-welding apparatus is a self-propelled device and that it is permanently marked with an identification number;
- verify that the fusion-welding apparatus is equipped with gauges giving the applicable temperatures and welding speed;
- verify that a suitable number of spare operable seaming apparatus are maintained on site;

- confirm that the electric generator is placed on a smooth protective base such that no damage occurs to the geomembrane;
- confirm that, for cross seams, the edge of the cross seam is ground to a smooth protective incline (top and bottom) prior to welding;
- verify that a smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage; and
- verify that a movable protective layer is used, as necessary, directly below each overlap of geomembrane that is to be seamed to prevent build-up of moisture between the sheets.

10.4.5.3 Seam Preparation

The QAC will monitor that:

- weather conditions for seaming are within the limits required by the Specifications, unless approved otherwise by the QAC and the Designer;
- prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;
- if seam overlap grinding is required, the process is completed according to the Geomembrane Manufacturer's instructions and/or the Specifications, whichever is the more stringent, prior to the seaming operation, and in a way that does not damage the geomembrane;
- the grind depth shall not exceed 10 percent of the geomembrane thickness;
- grinding marks do not appear beyond the extrudate after it is placed; and
- seams are aligned with the fewest possible number of wrinkles and “fish mouths”.

10.4.5.4 Overlapping and Temporary Bonding

The QAC will monitor that:

- the panels of geomembrane have a finished overlap of a minimum of 3 inches for extrusion welding and 5 inches for fusion welding, and sufficient overlap has been provided to allow peel tests to be performed on the seam;

- no solvent or adhesive is used; and
- the procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus is controlled such that the geomembrane is not damaged.

10.4.5.5 Seaming in Critical Areas

The QAC will be familiar with the locations of all appurtenances, geomembrane penetrations (e.g. risers for leachate collection cleanout pipes or gas vents) and critical areas (e.g. sumps, tie-in seams with previous phases, etc.) identified on the Drawings. The QAC will closely monitor seaming techniques in these locations, and will verify that:

- connection of the geomembrane to appurtenances have been made in accordance with the details set forth in the Drawings and Specifications;
- the Geosynthetic Installer uses extreme care while welding around appurtenances, since neither destructive nor nondestructive testing may be possible in these areas;
- rigorous visual inspection of all welds in these locations is performed by both the Geosynthetic Installer and the QAC.

10.5 <u>Field Testing of Work Product</u>

10.5.1 Trial Seams

Trial seam testing will be performed by the Geosynthetic Installer. The QAC will observe and document the Geosynthetic Installer's trial seam testing procedures and verify they are in accordance with the Specifications. CQA personnel will document identification numbers of trial seam samples and record the results. Each sample will also be marked with the date, time, machine temperature(s) and setting(s), seaming unit identification number , and name of seaming technician.

10.5.2 Nondestructive Seam Testing

Nondestructive field seam testing will be performed by the Geosynthetic Installer to check the continuity of seams. During the Geosynthetic Installer's nondestructive testing of field seams, the QAC will confirm that seams are tested over their full length using either the vacuum test or the air pressure test. The QAC personnel will verify that nondestructive testing has been performed on all of the seams and document the results.

Any required seam repairs identified as a result of failed nondestructive seam testing will be made by the Geosynthetics Installer in accordance with the Specifications. The QAC will:

- observe the repair procedures;
- observe the retesting procedures; and
- document the results.

10.5.3 Destructive Testing

10.5.3.1 Location and Frequency

The QAC will select all destructive seam test sample locations in order to accomplish the sampling and testing frequencies set forth in the Specifications. Sample locations will be established by the QAC according to the guidelines given below.

- Test locations will be determined during seaming at the discretion of the QAC. In general, the locations should be selected to provide good spatial coverage of the tests, and to meet the minimum destructive test frequency set forth in the Specifications. Selection of additional test locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential indication of deficient welding.
- The Geosynthetic Installer will not be informed in advance of the locations where the seam samples will be taken.

10.5.3.1 Sampling Procedures

The Geosynthetics Installer will cut the destructive samples at the locations designated by the QAC, under observation of the QAC, when possible. The QAC will mark each sample accordingly and record the sample location on the standardized Seam and Panel Repair Location Log. The QAC will confirm that the requirements of the Specifications are followed with respect to initial field testing, sample size, and distribution of portions.

The QAC will monitor that holes in the geomembrane resulting from destructive seam test sampling are promptly repaired by the Geosynthetic Installer in accordance with repair procedures described in the Specifications. The QAC will document that the continuity of the new seams in the repaired area have been nondestructively tested.

10.5.3.3 Field Destructive Testing

The QAC will monitor that test strips are tested for peel adhesion and shear in the field by the Geosynthetic Installer, using a gauged tensiometer in accordance with the Specifications. The QAC will document using the appropriate standardized field forms: the date, seaming unit identification number , seaming technician identification, destructive sample number, and pass or fail description. If the field tests meet the Specification requirements, the QAC will coordinate shipping of the samples to the Geosynthetic QAL for formal destructive testing.

10.5.3.4 Laboratory Destructive Testing

Destructive test samples will be tested by the Geosynthetics QAL in accordance with the testing procedures given in the Specifications. The Geosynthetic QAL should provide test results no more than 24 hours after they receive the samples. The QAC will promptly review the test results and report the results to the Geosynthetic Installer, including notification of approval, or any inconsistencies or nonconformances.

10.5.3.5 Procedures for Destructive Test Failure

The QAC will document that the procedures set forth in the Specifications are implemented whenever a sample fails a destructive test, whether that test was conducted in the field or by the Geosynthetics QAL. The Geosynthetics QAC will monitor that the Geosynthetic Installer follows a logical and rigorous procedure for tracking the extent of the seam represented by the failing destructive test (e.g., a tie-in seam or a seam made by the apparatus and/or operator used in the failing seam).

All failed seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken or the entire seam is reconstructed and retested. In cases exceeding 150 ft of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing. Repairs will be made in accordance with the Specifications. The QAC will document the actions taken in conjunction with destructive test failures.

10.6 Defects and Repairs

10.6.1 Inspection for Defects

All seams and non-seam areas of the geomembrane will be examined by the Geosynthetics QAC for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane should be clean at the time of examination.

10.6.2 Repair Procedures

The Geosynthetics QAC will monitor the Geosynthetic Installer's repair activities for portions of the geomembrane where destructive test samples were obtained, or areas exhibiting a flaw or failing test results. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Geosynthetic Installer and the Geosynthetics QAC.

In addition, the following conditions will be monitored by the Geosynthetics QAC:

- surfaces of the geomembrane which are to be repaired are abraded no more than one hour prior to the repair;
- all surfaces are clean and dry at the time of the repair;
- all seaming equipment used in repairing procedures has been pre-approved;
- the repair procedures, materials, and techniques have been pre-approved in advance of the specific repair;
- patches or caps extend at least 6 in. beyond the edge of the defect, and all corners of patches are rounded; and
- all tee seams are extrusion welded a minimum of 4 inches beyond the intersection in all directions.

The QAC will observe all repair areas and verify that the repairs were completed in accordance with the Specifications.

10.6.3 Verification of Repairs

The QAC will number and log each repair, and document that the repair areas have been non-destructively tested using approved methods. Repairs, which pass the nondestructive test, will be taken as an indication of an adequate repair. Large caps may be of sufficient extent to require destructive test sampling, at the discretion of the QAC, or as required in the Specifications. The QAC will observe non-destructive testing of repairs and will record the number of each repair, date, and test outcome.

TABLE 10-1
MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GEOMEMBRANE

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Density	ASTM D1505/D792	1 per 100,000 ft^2
Thickness (2)	ASTM D5199/ D5994	1 per 100,000 ft^2
Tensile Strength at Yield	ASTM D6693	1 per 100,000 ft^2
Tensile Strength at Break	ASTM D6693	1 per 100,000 ft^2
Elongation at Yield	ASTM D6693	1 per 100,000 ft^2
Elongation at Break	ASTM D6693	1 per 100,000 ft^2
Puncture Resistance	ASTM D4833	1 per 100,000 ft^2
Carbon Black Content	ASTM D1603/D4218	1 per 100,000 ft^2
Carbon Dispersion	ASTM D5596	1 per 100,000 ft^2

Notes:

1. Test shall be performed at a frequency of one per lot or at listed frequency, whichever is greater. A lot shall be as defined by ASTM D4354, unless defined otherwise by the QAC.

2. Thickness of smooth geomembrane shall be measured in accordance with ASTM D5199. Thickness of textured geomembrane shall be measured in accordance with ASTM D5994.

11. GEOTEXTILES

11.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to geotextile components of the liner system, which are defined as any geotextile located within the lined footprint. For geotextiles that are located outside the lined footprint, manufacturer's literature that demonstrates the geotextile meets or exceeds the specified properties will be adequate for "preconstruction qualifying of material sources," and no "material conformance testing" will be required. This section does not pertain to the heat-bonded geotextile component of drainage geocomposite materials, which is covered in Section 12 of the QAM. The following CQA activities are discussed in this section:

- Pre-construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

11.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Contractor will be required to provide the QAC with the quality control information and certifications for geotextile materials (i.e., to be used for components of the working mat, sand blanket, stone trenches, sideslope riser/cleanouts, gravity conveyance pipes, etc.) as set forth in Section 02510 of the Specifications. The QAC will examine all information and certifications in accordance with the procedures set forth in Section 11 of this QAM to verify that the property values meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor for all geotextile materials used at the site. The QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the wick drains and/or underdrain components.

11.3 Material Conformance Testing

Conformance sampling of the geotextile(s) will be performed by the QAC upon delivery of rolls to the site, unless otherwise directed by the Project Manager. The QAC will obtain samples and forward them to the Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL) for testing to evaluate whether the material meets the requirements of the Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the QAC and unless otherwise specified, samples will be 2-ft long by the roll width. The QAC will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the geotextiles are given in Table 11-1.

All conformance test results will be reviewed by the QAC before installation of the geotextile. Any nonconformance of the material's physical properties will be promptly reported to the Contractor and/or Geosynthetic Installer. The following procedure will apply whenever a geotextile sample fails a conformance test conducted by the Geosynthetic QAL:

- The Contractor and/or Geosynthetic Installer will be required to replace all of the rolls of geotextile within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Contractor and/or Geosynthetic Installer, geotextile manufacturer, and the Project Manager all agree, the QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geotextile on site and a sample from every roll

that is subsequently delivered from the same geotextile manufacturer must be conformance tested by the Geosynthetics QAL.

During conformance testing, the QAC will also verify that the geotextile manufacturer has identified all rolls of geotextile with the following information:

- name of Manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The QAC will record all of the above information for each roll delivered to the site using a Material Inventory Log form for the geotextile.

11.4 Field Evaluation/Monitoring of Construction Techniques

During shipment and storage, the Contractor and/or the Geosynthetic Installer will be required to keep the geotextile off the ground and protect the geotextile from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Specifications require that the geotextile rolls be shipped and stored in opaque and watertight wrappings.

The QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Contractor and/or the Geosynthetic Installer. Any damaged rolls will be rejected by the QAC and Project Manager and will be required to be repaired or replaced by the Contractor or the Geosynthetic Installer.

The Contractor and/or the Geosynthetic Installer will be required to handle all geotextile in such a manner as to ensure the geotextile is not damaged. The QAC will verify compliance with the following:

- immediately prior to geotextile placement, the subgrade is free of sharp protrusions or other obstructions that could potentially damage the geotextile;

- in the presence of wind, the geotextile is weighted with sandbags (or equivalent ballast weight approved by the QAC), and that sandbags remain until replaced with an overlying layer;
- efforts are made to minimize the presence of wrinkles in the geotextile, and if necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles;
- a visual examination of the geotextile is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and
- the geotextile is not left exposed for longer that the maximum allowable period (as set forth in the Specifications) after placement unless a longer exposure period is approved by the Designer.

The QAC will verify that, where required in the Specifications, geotextiles are continuously sewn, the geotextiles are overlapped a minimum of 6 inches prior to seaming, and that sewing is performed using polymeric thread and stitching type, as required in the Specifications.

The QAC and/or the QAC will verify that the Contractor places all soil and aggregate materials on top of geotextiles such that:

- the geotextile and underlying materials are not damaged;
- wrinkles are minimized; and
- excess tensile stresses are not produced in the geotextile.

11.5 Deficiencies, Problems, and Repairs

CQA personnel will report to the Contractor and/or the Geosynthetic Installer any unresolved deficiencies in the subgrade prior to geotextile placement and will not approve of geotextile deployment until the subgrade deficiencies are resolved to the satisfaction of the QAC and in accordance with the Specifications.

The QAC will verify that any holes or tears in the geotextile are repaired in accordance with the Specifications, and that care is taken to remove any soil or other material, which may have penetrated the torn geotextile.

The QAC will document deficiencies or noncompliance with the specified requirements and report them to the Contractor and/or Geosynthetic Installer. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the QAC.

The Contractor will correct the deficiency to the satisfaction of the QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor and/or Geosynthetic Installer in the area of the deficiency.

TABLE 11-1
MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GEOTEXTILES

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Mass Per Unit Area	ASTM D5261	1 per 100,000 ft^2
Apparent Opening Size (O_{95})	ASTM D4751	1 per 100,000 ft^2
Grab Strength	ASTM D4632	1 per 100,000 ft^2
Trapezoidal Tear Strength	ASTM D4533	1 per 100,000 ft^2
Puncture Strength	ASTM D6241	1 per 100,000 ft^2

Note:

1. All tests on this table are to be performed a minimum of once per source for each type of geotextile used on the project.

12. DRAINAGE GEOCOMPOSITE/GEONET

12.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to the geocomposite drainage layer component of the liner system. The geocomposite will be supplied by the Owner and installed by the Geosynthetic Installer, under direct contract with the Owner . The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

12.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Geosynthetic Installer will provide the QAC with the quality control information and certifications from the double-sided geocomposite manufacturer as set forth in Section 02520 of the Specifications.

The QAC will examine all geocomposite manufacturer's certifications to verify that the property values listed on the manufacturer's certifications meet or exceed the Specifications and that proper and complete documentation has been provided by the Geosynthetic Installer for all geocomposite used at the site. The QAC will also verify that the manufacturer of the nonwoven geotextile component(s) of the geocomposite provides certification that the geotextile is continuously inspected for the presence of needles using a metal detector. The QAC will report any deviations from the above requirements to the Geosynthetic Installer prior to approving installation of the geocomposite.

The geocomposite will be considered as passing the pre-qualification process if the quality control information and certifications meet or exceed the Specifications.

In order to further pre-qualify the proposed geocomposite product, the hydraulic transmissivity of the material will be evaluated by the Geosynthetic QAL using ASTM D4716. The test will be run on three separate samples sandwiched between a 60-mil textured HDPE geomembrane (beneath the geocomposite) and drainage sand (above the geocomposite), at a hydraulic gradient of 0.10 under the following confining conditions:

- Sample #1 - confining pressure of 1,100 psf with a seating time of 15 minutes;
- Sample #2 – confining pressure of 3,700 psf with a seating time of 15 minutes; and
- Sample #3 – confining pressure of 6,750 psf with a seating time of 15 minutes, then again after 100 hours.

The hydraulic transmissivity of Samples #1 and #2 will be submitted to the Designer for review. The hydraulic transmissivity of Sample #3 measured after the 100-hour loading period will be used to determine whether the material meets the required transmissivity in the Specifications. The hydraulic transmissivity of Sample #3 measured after the 2-hour loading period will be used as the minimum allowable value for all subsequent conformance tests of the geocomposite.

In addition to the above pre-qualification evaluation process, the QAC should be aware that a direct shear testing program may be developed and performed under the direction of the Designer for new products and or liner-component interfaces. This program may or may not include the geocomposite; therefore, the QAC should inquire of the Project Manager and/or Designer regarding this at the outset of the project. If applicable, the results of any such program shall be approved by the Designer as a part of the initial pre-qualification process.

12.3 <u>Material Conformance Testing</u>

Conformance sampling of the geocomposite may be performed by the QAC either at the manufacturing plant or upon delivery of rolls to the site, as requested by the Project Manager. The QAC will obtain samples and forward them to the Geosynthetic QAL for testing to evaluate whether the material meets the requirements of the Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the QAC, unless otherwise specified, samples will be 2-ft long by the full roll width. The QAC will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the geocomposite are given in Table 12-1.

All conformance test results will be reviewed by the QAC before installation of the geocomposite. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetic Installer. The following procedure will apply whenever a geocomposite sample fails a conformance test conducted by the Geosynthetic QAL:

- The Geosynthetic Installer will be required to replace all of the rolls of geocomposite within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Geosynthetic Installer, geocomposite manufacturer and the Project Manager all agree, the QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geocomposite on site and a sample from every roll that is subsequently delivered from the same geocomposite manufacturer must be conformance tested by the Geosynthetics QAL.

During conformance testing, the QAC will also verify that the geocomposite manufacturer has identified all rolls of geocomposite with the following information:

- name of Manufacturer;

- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The QAC will record all of the above information for each roll delivered to the site using a Material Inventory Log form for the geocomposite.

12.4 Field Evaluation/Monitoring of Construction Techniques

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the geocomposite off the ground and protect the geocomposite from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Specifications require that the geocomposite rolls be shipped and stored in opaque and watertight wrappings.

The QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Geosynthetic Installer. Any damaged rolls will be rejected by the QAC and the Project Manager and required to be repaired or replaced by the Geosynthetic Installer.

The Geosynthetic Installer will be required to handle and deploy all geocomposite in such a manner as to ensure the geocomposite is not damaged. The QAC will verify compliance with the following:

- immediately prior to geocomposite placement, the underlying geomembrane surface is free of moisture or obstructions that could potentially damage the geocomposite;
- in the presence of wind, the geocomposite is weighted with sandbags (or equivalent ballast weight approved by the QAC), and that sandbags remain until replaced with the overlying protective cover soil layer;

- efforts are made to minimize the presence of wrinkles in the geocomposite, and if necessary, the geocomposite is positioned by hand after being unrolled to minimize wrinkles;
- care is taken by the Geosynthetic Installer not to entrap stones, soil, dust, or moisture that could damage or cause clogging to the geocomposite;
- a visual examination of the geocomposite is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and
- the geocomposite is not left exposed for longer than the maximum allowable period (as set forth in the Specifications) after placement unless a longer exposure period is approved by the Designer.

The QAC will verify that the components of the geocomposite (i.e., geotextile-geonet-geotextile) are sewn, joined, and/or overlapped to like-components in adjacent geocomposite panels, as required in the Specifications.

The QAC will verify that the Contractor and/or Geosynthetics Installer places soil or geosynthetic materials on top of geocomposites such that:

- the geocomposite and underlying materials are not damaged;
- wrinkles are minimized; and
- excess tensile stresses are not produced in the geocomposite.

12.5 Deficiencies, Problems, and Repairs

The QAC will report to the Geosynthetic Installer any unresolved deficiencies in the underlying geomembrane prior to geocomposite placement and will not approve of geocomposite deployment until the geomembrane deficiencies are resolved to the satisfaction of the QAC and in accordance with the Specifications.

The QAC will verify that any holes or tears in the geocomposite are repaired in accordance with the Specifications, and that care is taken by the Contractor to remove any soil or other material, which may have penetrated the torn geocomposite.

The QAC will document deficiencies or noncompliance with the specified requirements and report them to the Geosynthetic Installer. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the QAC.

The Geosynthetic Installer will correct the deficiency to the satisfaction of the QAC. If a project specification criterion cannot be met or unusual weather conditions hinder work, then the QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the QAC must verify that the deficiency has been corrected before any additional work is performed by the Geosynthetics Installer in the area of the deficiency.

TABLE 12-1
MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR DRAINAGE GEOCOMPOSITE/GEONET

TEST	METHOD	MINIMUM FREQUENCY OF TESTING (1)
Geotextile Component(s)		
Mass per Unit Area	ASTM D5261	1 per 100,000 ft^2
Geonet Component		
Polymer Specific Gravity	ASTM D1505	1 per 100,000 ft^2
Thickness	ASTM D5199	1 per 100,000 ft^2
Geocomposite		
Transmissivity (4)	GRI GC-8 (2)/ASTM D4716 (3)	1 per 200,000 ft^2

Notes:

1. Testing shall be performed at a frequency of one per lot or at listed frequency, whichever is greater, for each type of geocomposite used for the work. A lot shall be as defined by ASTM 4354, unless defined otherwise by the QAC.

2. Pre-qualifying transmissivity test on geocomposite shall be performed using the conditions set forth in Section 12.2 of this QAM.

3. Conformance tests shall be performed with the geocomposite sandwiched between a 60-mil smooth geomembrane on the bottom and drainage sand above at a hydraulic gradient of 0.02. The transmissivity shall exceed the transmissivity measured on Sample #3 of the prequalifying test set forth in Section 12.2 of this QAM.

4. Transmissivity tests on double-sided geocomposite shall be performed using the conditions set forth in Paragraph 2.04A of Specification Section 02520.

13. GEOSYNTHETIC CLAY LINER

13.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to the geosynthetic clay liner (GCL) component of the liner system . The GCL will be supplied by the Owner and installed by the Geosynthetic Installer, under direct contract with the Owner. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

13.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the supplier of the GCL will provide the QAC with the quality control information and certifications from the GCL manufacturer as set forth in the Section 02530 of the Specifications.

The QAC will examine all GCL manufacturer's certifications to verify that the property values listed on the manufacturer's certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the supplier of the GCL to be used at the site.

In addition to the above pre-qualification evaluation process, the QAC should be aware that a direct shear testing program may be developed and performed under the direction of the Designer for new products and or liner-component interfaces. This program may or may not include the GCL; therefore, the QAC should inquire of the Project Manager and/or Designer regarding this at the outset of the project. If applicable, the results of any such program shall be approved by the Designer as a part of the initial pre-qualification process.

13.3 Material Conformance Testing

Conformance sampling of the GCL may be performed by the QAC either at the manufacturing plant or upon delivery of rolls to the site, as requested by the Project

Manager. The QAC will obtain samples and forward them to the Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL) for testing to evaluate whether the material meets the requirements of the Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the QAC, unless otherwise specified, samples will be 2-ft long by the full roll width. The QAC will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the GCL are given in Table 13-1.

All conformance test results will be reviewed by the QAC before installation of the GCL. Any nonconformance of the material's physical properties will be promptly reported to the Geosynthetic Installer. The following procedure will apply whenever a GCL sample fails a conformance test conducted by the Geosynthetic QAL:

- The Geosynthetic Installer will be required to replace all of the rolls of GCL within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Geosynthetic Installer, GCL manufacturer and the Project Manager all agree, the QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of GCL

on site and a sample from every roll that is subsequently delivered from the same GCL manufacturer must be conformance tested by the Geosynthetics QAL.

During conformance testing, the QAC will also verify that the GCL manufacturer has identified all rolls of GCL with the following information:

- name of Manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The QAC will record all of the above information for each roll delivered to the site using a Material Inventory Log form for the GCL.

13.4 Field Evaluation/Monitoring of Construction Techniques

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the GCL off the ground and protect the GCL from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Specifications require that the GCL rolls be shipped and stored in opaque and watertight wrappings.

The QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Geosynthetic Installer. Any damaged rolls will be rejected by the QAC and the Project Manager and required to be repaired or replaced by the Geosynthetic Installer.

The Geosynthetic Installer will be required to handle and deploy all GCL in such a manner as to ensure the GCL is not damaged. Prior to GCL deployment directly on silt-clay, the QAC will observe the area and will confirm that the soil subgrade surface has been fully approved by the QAC project team. During installation, the QAC will verify compliance with the following:

- immediately prior to GCL placement, the underlying silt-clay subgrade, geotextile, or geocomposite surface is free of moisture or obstructions that could potentially damage the GCL;
- the GCL is installed with the correct orientation (i.e., with the correct side up);
- efforts are made to keep the GCL placed to minimize the presence of wrinkles in the GCL, and if necessary, the GCL is positioned by hand after being unrolled to minimize wrinkles;
- excessive amounts of bentonite do not ravel out along the edges of the GCL;
- care is taken by the Geosynthetic Installer not to entrap stones, soil, dust, or moisture that could damage the GCL;
- in the presence of wind, the GCL is weighted with sandbags (or equivalent ballast weight approved by the QAC), and that sandbags remain until replaced with the overlying geomembrane;
- a visual examination of the GCL is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present;
- prior to geomembrane deployment, the QAC grants approval for the GCL to be covered;
- no more GCL is deployed during each day than can be covered by the end of the day with seamed geomembrane; and
- the GCL is not left exposed for longer than the maximum allowable period (as set forth in the Specifications) after placement unless a longer exposure period is approved by the Designer.

The QAC will verify that the GCL panels are overlapped as required in the Specifications. The QAC will also confirm that the Designer is made aware of any end-to-end GCL seams on slopes, and that any special overlapping or connecting methods required by the Designer are implemented by the Geosynthetic Installer.

The QAC will verify that the Geosynthetics Installer places the geomembrane on top of the GCL such that:

- the GCL and underlying materials are not damaged;

- wrinkles are minimized;
- excess tensile stresses are not produced in the GCL; and
- the geomembrane extends at least 2 ft beyond the underlying GCL, and the leading edge of the geomembrane has adequately ballast to avoid wind uplift and reduce the likelihood of surface water running under the geomembrane and hydrating the GCL.

13.5 Deficiencies, Problems, and Repairs

The QAC will report to the Geosynthetic Installer any unresolved deficiencies in the underlying soil or geosynthetic subgrade surface prior to GCL placement, and will not approve of GCL deployment until the deficiencies are resolved to the satisfaction of the QAC and in accordance with the Specifications.

The QAC will verify that any holes or tears in the GCL are repaired in accordance with the Specifications, and that care is taken by the Contractor and/or Geosynthetic Installer to remove any soil or other material, which may have penetrated the torn GCL.

The QAC will document deficiencies or noncompliance with the specified requirements and report them to the Geosynthetic Installer. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the QAC.

The Geosynthetic Installer will correct the deficiency to the satisfaction of the QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the QAC must verify that the deficiency has been corrected before any additional work is performed by the Geosynthetics Installer in the area of the deficiency.

TABLE 13-1
MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GEOSYNTHETIC CLAY LINER (GCL)

TEST	METHOD	MINIMUM FREQUENCY OF TESTING [1]
Mass per Unit Area	ASTM D5993	1 per 100,000 ft^2
Grab Strength	ASTM D4632	1 per 100,000 ft^2
Puncture Resistance	ASTM D4833	1 per 100,000 ft^2
Peel	ASTM D6496	1 per 100,000 ft^2
Index Flux	ASTM D5887	1 per 250,000 ft^2

Notes:

1. Testing shall be performed at a frequency of one per lot or at the listed frequency, whichever is greater. A lot shall be as defined by ASTM D 4354, unless defined otherwise by the QAC.

14. SITE PIPING

14.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to installation of site (storm-water drainage) piping. Items in this section include reinforced concrete pipe (RCP), polyethylene (PE) drain pipe, flexible PE underdrain pipe, and product-specific pipe (such as ADS pipe products). Also included to some degree in the section are related materials such as pipe fittings, pipe bedding, and trench backfill. This section does not address HDPE leachate collection or transfer piping which is covered in Section 17 of the QAM. The following CQA activities are discussed in this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

14.2 Pre-Construction Qualifying of Material Sources

14.2.1 Drainage Pipe

Prior to shipment of the pipe and fittings, the Contractor will be required to provide the QAC with the quality control information and certifications from the pipe manufacturer as set forth in Section 02560 of the Specifications.

The QAC will examine all of the pipe manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the project specifications, and that proper and complete documentation has been provided by the Contractor for all drainage pipe, fittings, and other pipe-accessories used at the site. The QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the pipe.

The QAC will verify that the following information is printed at frequent intervals on, or otherwise clearly provided for the drainage pipe used on the project:

- name and/or trademark of the pipe Manufacturer;
- nominal pipe size;

- manufacturing standard reference (e.g., AASHTO M170, ASTM F405, etc.); and
- a production code from which the date and place of manufacture can be determined.

If, during pre-construction qualifying, any of the piping fails to meet the Specifications, the QAC will notify the Contractor. Use of the material will not be allowed until the material is prequalified by further tests or otherwise accepted by the Designer.

14.2.2 Crushed Stone

Prior to pipe installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the ¾-Inch Crushed Stone to be used for pipe bedding (e.g., sedimentation basin underdrain, or if RCP is used) meets the requirements of the Specifications. Instructions for this are provided in Section 8.2 of this QAM.

14.2.3 Granular Fill

Prior to pipe installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the Granular Fill to be used for pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 8.2 of this QAM.

14.2.4 Geotextile

Prior to pipe installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the geotextile(s) to be used around the crushed stone pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 11.2 of this QAM.

14.2.5 Trench Backfill

Prior to pipe installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the trench backfill material(s) to be placed over the site drainage pipe meets the requirements of the Specifications. Instructions for this are provided in Section 8.2 of this QAM.

14.3 Material Conformance Testing

14.3.1 Drainage Pipe

CQA conformance testing of the pipe and fittings will not be required unless requested by the Designer. If deemed necessary by the Designer, the test requirements will be determined at that time by the Designer.

14.3.2 Crushed Stone

Prior to pipe installation, the QAC will verify that the conformance test results for the ¾-Inch Crushed Stone to be used for pipe bedding (e.g., sedimentation basin underdrain, or if RCP is used) meets the requirements of the Specifications. Instructions for this are provided in Section 8.3 of this QAM.

14.3.3 Granular Fill

Prior to pipe installation, the QAC will verify that the conformance test results for the Granular Fill to be used for pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 8.3 of this QAM.

14.3.4 Geotextile

Prior to pipe installation, the QAC will verify that conformance test results for the geotextile(s) to be used around the crushed stone pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 11.3 of this QAM.

14.3.5 Trench Backfill

Prior to pipe installation, the QAC will verify that conformance test results for the trench backfill material(s) to be placed over the drainage pipe meets the requirements of the Specifications. Instructions for this are provided in Section 8.3 of this QAM.

14.4 Field Evaluation/Monitoring of Construction Techniques

The QAC will verify that the pipe and fittings are stored on clean level ground, free of conditions, which could damage the pipe. Where necessary, due to muddy or sloping ground conditions, the pipe will be required to be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

During construction, the QAC will verify compliance with the following:

- handling of the pipe is conducted in such a manner that the pipe is not damaged;

- ropes, fabric, or rubber-protected slings and straps are used when handling the pipe;
- pipe or fittings are not dropped onto rocky or unprepared ground or into trenches or dragged over sharp objects;
- the subgrade surface is firm and free of debris;
- crushed stone (pipe bedding material) is placed in accordance with the Drawings and the Specifications;
- pipe segments are not brought into position until preceding lengths have been bedded and secured in their final position;
- the pipe segments are properly joined using the appropriate components as required on the Drawings and Specifications;
- joints are stable and in secure condition prior to and after backfilling;
- where applicable, anti-seep collar(s) are properly installed;
- blocking is not used under pipe unless pre-approved by the Designer; and
- placement of backfill over the pipe is conducted in lifts meeting the requirements of the Specifications, and in a manner that will not damage the pipe.

14.5 Deficiencies, Problems, and Repairs

The QAC will report any deficiencies and noncompliances in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the QAC and Project Manager.

The Contractor will correct the deficiency to the satisfaction of the QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

15. MANHOLES AND CATCH BASINS

15.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to installation of storm-water catch basins (CBs) and leachate-transfer manholes (MHs). Items in this section include pre-cast concrete catch basins, HDPE or pre-cast concrete manholes, and, to some degree, related materials such as fittings, accessories, bedding materials, and backfill. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

15.2 Pre-Construction Qualifying of Material Sources

15.2.1 Manholes and Catch Basins

Prior to construction, the Contractor will provide the QAC with the quality control information and certifications from the MH and CB manufacturers as set forth in Section 02570 of the Specifications.

The QAC will examine all the MH and CB manufacturers' certifications to verify that the property values listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor for all the MHs and CBs used at the site. The QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the MHs or CBs.

15.2.2 Crushed Stone

Prior to MH or CB installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the ¾-Inch Crushed Stone to be used for bedding meets the requirements of the Specifications. Instructions for this are provided in Section 8.2 of this QAM.

15.2.3 Geotextile

Prior to MH or CB installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the geotextile(s) to be used around the crushed stone bedding meets the requirements of the Specifications. Instructions for this are provided in Section 11.2 of this QAM.

15.2.4 Backfill

Prior to MH or CB installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the backfill material(s) to be placed around the MHs and CBs meets the requirements of the Specifications. Instructions for this are provided in Section 8.2 of this QAM.

15.3 Material Conformance Testing

15.3.1 Manholes and Catch Basins

CQA conformance testing of the MHs and CBs will not be required unless requested by the Designer. If deemed necessary by the Designer, the test requirements will be determined at that time by the Designer.

15.3.2 Crushed Stone

Prior to MH or CB installation, the QAC will verify that the conformance test results for the ¾-Inch Crushed Stone to be used for bedding meets the requirements of the Specifications. Instructions for this are provided in Section 8.3 of this QAM.

15.3.3 Geotextile

Prior to MH or CB installation, the QAC will verify that conformance test results for the geotextile(s) to be used around the crushed stone bedding meets the requirements of the Specifications. Instructions for this are provided in Section 11.3 of this QAM.

15.3.4 Backfill

Prior to MH or CB installation, the QAC will verify that conformance test results for the backfill material(s) to be placed around the MHs and CBs meets the requirements of the Specifications. Instructions for this are provided in Section 8.3 of this QAM.

15.4 Field Evaluation/Monitoring of Construction Techniques

The QAC will verify that the MHs and CBs are stored on clean level ground, free of conditions, which could damage the structures. Where necessary, due to muddy or sloping ground conditions, the pipe will be required to be stored on wooden sleepers, spaced suitably as not to allow stresses to be produced in the structures at the point of contact with the sleepers.

During construction, the QAC will verify compliance with the following:

- handling of the MHs and CBs is conducted in such a manner that the structures are not damaged;
- ropes, fabric, or rubber-protected slings and straps are used when handling the MHs or CBs;
- MHs or CBs are not dropped onto rocky or unprepared ground or into trenches or dragged over sharp objects;
- the subgrade surface is firm and free of debris;
- crushed stone (bedding material) is placed in accordance with the Drawings and the Specifications;
- MH and CB riser segments are not brought into position until preceding segments have been bedded and secured in their final position;
- the MH or CB segments is properly joined using the appropriate components as required on the Drawings and Specifications;
- joints are stable and in secure condition prior to and after backfilling; and
- placement of backfill around the MH and CB structures is conducted in lifts meeting the requirements of the Specifications, and in a manner that will not damage the structures.

15.5 Deficiencies, Problems, and Repairs

The QAC will report any deficiencies and noncompliances in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the QAC and Project Manager.

The Contractor will correct the deficiency to the satisfaction of the QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

16. HDPE PIPING

16.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to installation of high density polyethylene (HDPE) piping for the leachate collection system (LCS) and underdrain collection system. Items in this section include the HDPE pipe and, to some degree, associated materials such as crushed stone, geotextile, pipe bedding, and trench backfill. The following CQA activities are discussed in this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

16.2 Pre-construction Qualifying of Material Sources

16.2.1 HDPE Pipe

Pipes must be prequalified as described below. Prior to the shipment of the HDPE pipes and fittings, the Contractor will be required to provide the QAC with the quality control information and certifications from the pipe manufacturer as set forth in Section 02780 of the Specifications.

The QAC will examine the HDPE pipe manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the Specifications and that proper and complete documentation has been provided by the Contractor for all HDPE pipe, fittings, and pipe-accessories used at the site. The QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the pipe.

The QAC will verify that the following information is printed at frequent intervals on, or otherwise clearly provided for the HDPE pipe used on the project:

- name and/or trademark of the pipe Manufacturer;
- nominal pipe size, wall thickness, and SDR;
- manufacturing standard reference (e.g., ASTM D 2513); and

- a production code from which the date and place of manufacture can be determined.

If, during pre-construction qualifying, any of the HDPE piping fails to meet the Specifications, the QAC will notify the Contractor. Use of the material will not be allowed until the material is prequalified by further tests or otherwise accepted by the Designer.

16.2.2 Crushed Stone

Prior to pipe installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the 1½-Inch Crushed Stone to be used around the LCS collection and underdrain collection pipes meets the requirements of the Specifications. Instructions for this are provided in Section 8.2 of this QAM.

16.2.3 Granular Fill

Prior to pipe installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the Granular Fill to be used for HDPE pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 8.2 of this QAM.

16.2.4 Geotextile

Prior to pipe installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the geotextile(s) to be used around the crushed stone for the LCS and underdrain collection system meets the requirements of the Specifications. Instructions for this are provided in Section 11.2 of this QAM.

16.2.5 Trench Backfill

Prior to pipe installation, the QAC will verify that pre-qualifying test results submitted by the Contractor for the trench backfill material(s) to be placed over the HDPE leachate/underdrain transfer pipe meets the requirements of the Specifications. Instructions for this are provided in Section 8.2 of this QAM.

16.3 Material Conformance Testing

16.3.1 HDPE Pipes

Material conformance testing of the HDPE pipes will not be required unless aspects of the pre-qualifying information are deficient or suspect, or if requested by the Designer. If deemed necessary by the Designer, the QAC will remove a minimum 3-ft (1-m) section of pipe and deliver it to the Geosynthetics QAL for testing to evaluate whether the pipe meets the required properties of the Specifications. The conformance test requirements will be determined at that time by the Designer.

16.3.2 Crushed Stone

Prior to pipe installation, the QAC will verify that the conformance test results for the 1½-Inch Crushed Stone to be used around the LCS and underdrain collection pipes meets the requirements of the Specifications. Instructions for this are provided in Section 8.3 of this QAM.

16.3.3 Granular Fill

Prior to pipe installation, the QAC will verify that the conformance test results for the Granular Fill to be used for HDPE pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 8.3 of this QAM.

16.3.4 Geotextile

Prior to pipe installation, the QAC will verify that conformance test results for the geotextile(s) to be used around the crushed stone for the LCS and underdrain collection pipes meets the requirements of the Specifications. Instructions for this are provided in Section 11.3 of this QAM.

16.3.5 Trench Backfill

Prior to pipe installation, the QAC will verify that conformance test results for the trench backfill material(s) to be placed over the HDPE leachate/underdrain transfer pipe meets the requirements of the Specifications. Instructions for this are provided in Section 8.3 of this QAM.

16.4 Field Evaluation/Monitoring of Construction Techniques

The QAC will verify that the pipe and fittings are stored on clean level ground, free of conditions which could damage the pipe; and where necessary (e.g., due to muddy or sloping ground conditions) the pipe is stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

During construction, the QAC will verify compliance with the following:

- the perforated pipe has the proper amount and spacing of perforations and that the perforations are oriented properly after the pipe is installed;
- handling of the pipe is conducted in such a manner that the pipe is not damaged;
- ropes, fabric, or rubber-protected slings and straps are used when handling pipe;
- pipe or fittings are not dropped onto rocky or unprepared ground or into trenches or dragged over sharp objects;
- the subgrade surface is firm and free of debris;
- crushed stone is carefully placed under and around the pipe in accordance with the Drawings and the Specifications;
- pipe segments are not brought into position until preceding lengths have been bedded and secured in its final position;
- pipe sections are properly joined using procedures recommended by the Manufacturer and/or allowed for in the Specifications;
- joints are stable and in secure condition prior to and after backfilling;
- blocking is not used under pipe unless pre-approved by the Designer; and
- placement of backfill over the pipe is conducted in lifts meeting the requirements of the Specifications and in a manner that will not damage the pipe.

16.5 <u>Field Testing of Work Products</u>

The QAC will verify that the Contractor has performed the applicable pre-testing procedures (e.g. flushing the carrier pipes, bracing the pipe, etc.) set forth in Specification Section 01669 prior to initiating any hydrostatic or low-pressure air testing of the HDPE pipes during installation.

The QAC will monitor the Contractor's activities during installation for hydrostatic pressure testing of the HDPE carrier (inner) pipe for all forcemain piping. The QAC will confirm that the Contractor follows the procedures set forth in Specification Section 01669 for hydrostatic pressure testing. The QAC will either record the test results or will observe the Contractor recording the results and review the results upon submittal by the Contractor.

The QAC will monitor the Contractor's activities during installation for low-pressure air testing of the: (i) HDPE containment (outer) pipe for all forcemain piping; and (ii) HDPE carrier (inner) pipe and HDPE containment (outer) pipe for all gravity drain piping. The QAC will confirm that the Contractor follows the procedures set forth in Specification Section 01669 for low-pressure air testing. The QAC will either record the test results or will observe the Contractor recording the results and review the results upon submittal by the Contractor.

16.6 Deficiencies, Problems, and Repairs

The QAC will report any deficiencies or noncompliance in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the QAC and Project Manager.

The Contractor will correct the deficiency to the satisfaction of the QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

17. TOPSOIL AND SEEDING

17.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to establishing permanent vegetation in the designated areas. Items in this section include Topsoil, fertilizer, seed, mulch, erosion control mat, and related materials such as lime, and soil binders. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

17.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Contractor will provide the QAC with the quality control information and certifications for the Topsoil, fertilizer, lime, grass seed, cellulose fiber mulch (if hydroseeding method will be used), hay or straw mulch, soil binder (if used), and erosion control mat and mulch-anchoring net, as set forth in Section 02800 of the Specifications. For the materials that do not have quantitative property requirements, the Contractor must submit written certification from the supplier(s) that the material(s) meet the qualitative descriptions set forth in the Specifications.

The QAC will examine all the suppliers' certifications to verify that the properties listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor or supplier for the materials used at the site. The QAC will report any deviations from the above requirements to the Contractor and/or Project Manager prior to approving installation of any given material.

17.3 Material Conformance Testing

CQA conformance testing of the Topsoil, seed, or related materials will not be required unless requested by the Designer. If deemed necessary by the Designer, the conformance test requirements will be determined at that time by the Designer.

The QAC will observe the materials as they are delivered to the site, and review labels and product documentation to ensure that the material documentation is consistent with the pre-qualifying documentation previously submitted by the Contractor.

17.4 Field Evaluation/Monitoring of Construction Techniques

The QAC will verify that the Topsoil, as it is stockpiled or delivered to the site appears to be consistent with the requirements set forth in the Specifications, and that the oversized pieces and deleterious materials are removed and stockpiled. If screening operations are used by the Contractor, the QAC will verify that the screen sizes are sufficient to remove oversized particles and deleterious materials.

During construction, the QAC will verify compliance with Part 3 of Specification Section 02800, including the following:

- the subgrade area to receive Topsoil has been raked or otherwise loosened, and surficial debris has been removed;
- the specified minimum thickness of the Topsoil is achieved after being placed and rolled; thickness measurements will be performed by the QAC by excavating or hand-augering shallow test holes at a frequency of at least 2 measurements per acre;
- lime, fertilizer, seed, and mulch are applied at the rates set forth in Specification Section 02800; and
- soil binder (tackifier) and mulch-anchoring netting are installed in areas steeper than 15% where hay or straw mulch is used.

The QAC or Project Manager will observe the areas seeded after 8 weeks to assess provisional acceptance of the work. Provisional acceptance shall be as defined in Specification Section 02800. The QAC or Project Manager will observe the areas seeded after the 1-year guarantee period to assess final acceptance of the work.

17.5 Deficiencies, Problems, and Repairs

The QAC will report any deficiencies and noncompliances in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the QAC and Project Manager.

The Contractor will correct the deficiency to the satisfaction of the QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

18. CLEANUP AND SITE RESTORATION

18.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to cleanup and site restoration. The following CQA activities are discussed in the remainder of this section:

- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

18.2 Field Evaluation/Monitoring of Construction Techniques

The QAC will observe the Contractor's work activities and will verify that, during construction, the Contractor keeps the site in as clean and neat a condition as possible. This includes the project area, haul roads, borrow areas, and the entrance area to the Crossroads facility.

The QAC will verify that stockpiles are located as shown on the Drawings or as approved by the Project Manager and that the Contractor regularly removes and disposes of refuse resulting from the construction activities.

18.3 Deficiencies, Problems, and Repairs

The QAC will report any deficiencies and noncompliances in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the QAC and Project Manager. The Contractor will correct the deficiency to the satisfaction of the QAC or as directed by the Project Manager.

19. DOCUMENTATION AND CQA FINAL REPORT

19.1 Introduction

An effective CQA plan consists of implementing the activities set forth in this QAM, and providing documentation assuring the Owner that the construction was performed in accordance with the Drawings and Specifications.

CQA personnel (i.e., the QAC) will provide the Owner with signed descriptive remarks, data sheets, and logs to verify that the CQA activities have been carried out. CQA personnel will maintain at the site a complete file of the project Drawings, Specifications, and QAM, as well as daily reports, testing logs, and other pertinent forms and documents. Blank forms to be used for CQA documentation will be prepared prior to construction and kept electronically by the CQA personnel and/or in a file at the site so that they may be readily printed or photocopied as needed during the project.

19.2 Daily Recordkeeping

19.2.1 Overview

Daily records will be completed in the field, documenting the Contractor's and/or Geosynthetic Installer's activities, as well as CQA activities. The forms to be completed that pertain to each of these categories of records are discussed below. The discussion includes the person(s) responsible for completing each form, and form submittal timeframes.

19.2.2 Project Administration Records

Most project administration records are completed daily by select CQA personnel and submitted weekly to the CQA Site Manager and/or CQA Engineer-of-Record. These forms are briefly described below.

Daily Field Report

The Daily Field Reports will be prepared by select CQA personnel. The Daily Field Reports will summarize the Contractor's and/or Geosynthetic Installer's activities conducted that day as well as the CQA activities performed. Other information should include the following:

- date, project name, location, and other identification;
- a narrative of the events and activities, including meetings and observations which occurred during a given day;
- weather conditions;
- names of personnel participating in important discussions;
- relevant subject matters or issues;
- activities planned and performed;
- constraints or suggestions;
- scheduling information; and
- the signature of the CQA personnel who authored the report.

Daily Weather Log

Ambient temperatures, precipitation, and general weather conditions will be recorded on the Daily Weather Log or in the DFRs by CQA personnel at various times during the day during geomembrane deployment and seaming. This log will be available for review at the site and will be issued as part of the Final Report.

Personnel Log

The Personnel Log will be used by CQA personnel to document dates when key personnel are on-site. This log will provide a summary of on-site involvement of personnel for the Contractor, Geosynthetic Installer, CQA Surveyor, and CQA personnel during the project. It is not intended as an absolute log to record the exact times when each individual is at the site; rather it is to summarize when key individuals (supervisors, foremen, managers, directors, etc.) work or visit the site. This log will be available for review at the site and will be issued as part of the Final Report. Alternatively this information may be recorded the CQA personnel DFRs.

19.2.3 Soils CQA Records

Records kept for all aspects of the construction will be completed by the QAC. The information will be recorded as testing done in the field or as results are received from the Soil QAL. The records will be available for review on site, and copies will be issued as part of the Final Report. The relevant forms that will be needed during the project are listed below:

- Soil Sample Log;
- Laboratory Test Summary Log; and
- Summary of Field Density Test;

19.2.4 Geosynthetic Field CQA Records

Records kept for geosynthetic-related activities (e.g., GCL, geomembrane, drainage geocomposite/geonet, geotextile) will be kept by the QAC. The information will be recorded as shipments are received, testing is done in the field, or as results are received from the laboratory. The records will be available for review on site and copies will be issued as part of the Final Report. The relevant forms that will be needed during the project are listed below:

- Material Inventory Logs;
- Geosynthetic Installer's Subgrade Acceptance Certifications;
- Panel Placement Logs;
- Trial Seam Logs;
- Production Seam Logs;
- Nondestructive Test Logs;
- Destructive Test Logs;
- Repair Summary Logs; and
- Seam and Panel Repair Locations Logs.

19.3 Survey Records

CQA personnel will be responsible for receiving, reviewing, and record keeping of survey information from: (i) the Contractor's as-built documentation and (ii) the CQA Surveyor's documentation. Interim submittals will be reviewed by the CQA personnel as described in Section 2 of this QAM and copies of edits and comments will be kept on file during construction.

The CQA Surveyors Record Drawings will be included in the Final Report. The Record Drawings will include:

- Plan sheets depicting the key layers of the liner or final cover system;
- Panel layout drawing(s) showing the locations of geomembrane seams, destructive-test samples, and major repairs; and
- Detail sheets showing the configuration of the details of construction, clearly indicating any modifications that were made from the Drawings issued before construction as part of the Contract Documents.

The Contractor's As-Built Drawings will be kept on file and will be included as an appendix to the Final Report only to the extent required to bring additional clarity or information to the Record Drawings.

19.4 Photographic Documentation

CQA personnel will be responsible for photographing the construction progress on a frequent basis. Photographic documentation will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will be stored electronically in chronological order. These photographs will be available for review at any time by the Project Manager, Designer, or other parties upon the request of the Project Manager. Selected photographs will be reproduced as part of the Final Report.

19.5 Clarifications/Changes to Drawings, Specifications, or QAM

Clarifications and minor changes to the Drawings, Specifications, and/or QAM may be necessary during construction. In such cases, the CQA personnel will notify the Project

Manager, who will in turn notify the Designer, and if necessary, the appropriate regulatory personnel. In most cases, the CQA personnel will be required to submit written information describing the proposed change and rationale for the request. This is typically administered using a Request for Clarification (RFC) or a Request for Information (RFI) form. The Project Manager will submit back to the CQA personnel all correspondence to and from the Designer (and, when necessary, regulatory personnel) regarding each RFC or RFI, providing the requested clarifying information, and/or indicating acceptance or rejection of proposed changes.

A log of all RFCs and RFIs will be kept by the CQA personnel and copies will be kept on file at the site. Copies of all RFCs and RFIs will be included as an appendix to the Final Report and will be incorporated into the Record Drawings as previously described in Section 19.3 of the QAM.

19.6 Weekly Field Summaries/Weekly Meeting Minutes

At the end of each week during construction or after the weekly progress meeting, the CQA Site Manager will prepare a Weekly Field Summary report/Weekly Meeting Minutes (report). The report will briefly describe the Contractor and/or Geosynthetic Installer's progress during the week and will summarize planned activities for the upcoming two weeks. Field sketches may be prepared for review prior to the weekly progress meeting to provide a visible illustration of progress in the major work areas. The report will include a summary of CQA conformance testing for the materials used during each week and a summary of the field testing and relevant work products for each week. The report will also include a section designated to activities and monitoring of site erosion and sediment controls. The report will also address: submittals and actions taken, punch list items (as applicable), significant problems and how they were resolved, change order (i.e., RFC and RFI) status, and construction stability monitoring results (if applicable). Daily Field Reports can be attached to the report if requested by MEDEP personnel.

19.7 CQA Final Report

Upon completion of the work, the QAC will submit a CQA Final Report to the Project Manager. This report will certify that the work has been performed in compliance with the Drawings, Specifications, and the QAM except as amended via the RFIs, and that the summary document provides the necessary supporting information. The geosynthetic CQA documentation will either be integrated into the Final Report or will be included as stand-alone report in an appendix to the Final Report.

At a minimum, the CQA Final Report will include: (a) an overview of the construction work; (b) the parties involved with the project; (c) weekly field summaries of the construction activities and meeting minutes; (d) observation logs; (e) tabulations of all testing results; (f) a tabulation of changes (RFCs and RFIs) to the Drawings, Specifications, or QAM; (g) photographic documentation; (h) subgrade acceptance forms; (i) manufacturer's quality control certificates; (j) the Record Drawings; and (g) a summary statement sealed and signed by a Professional Engineer registered in the State of Maine (i.e., the CQA Engineer-of-Record) that the facility was constructed in accordance with the Drawings, Specifications, and QAM, as amended by any RFIs.

19.8 Storage of Records

All reports and records will be stored by CQA personnel using standard electronic and/or hard copy filing methods, which will allow for easy access to CQA personnel and the Project Manager.

APPENDIX VI(b)
Quality Assurance Manual
– Final Closure Construction

Prepared for:

Waste Management Disposal Services of Maine, Inc.
357 Mercer Road
Norridgewock, Maine 04957

QUALITY ASSURANCE MANUAL FINAL CLOSURE CONSTRUCTION

CROSSROADS LANDFILL NORRIDGEWOCK, MAINE

Prepared by:

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289 Great Road Suite 202
Acton, Massachusetts 01720

Project Number: BE0232C

September 2019

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1. INTRODUCTION

1.1 Purpose of QAM

This Quality Assurance Manual (QAM) establishes the quality-assurance monitoring and documentation activities that will be implemented during the construction of the final closure system and related facilities (erosion control structures, access roads, etc.) for landfill units at Waste Management Disposal Services of Maine's (WMDSM) Crossroads Landfill Facility in Norridgewock, Maine. The purpose of the QAM is to provide specific procedures that will be followed by Construction Quality Assurance (CQA) personnel in order to assure the Owner that the construction was performed in accordance with the Drawings and Specifications.

The organization of this QAM is generally parallel to the organization of the sections presented in Division 02 of the Specifications. Much of the information presented in the QAM was extracted from Waste Management, Inc.'s *Quality Assurance Guidance Document for the Installation of Lining Systems*, dated June 1996.

1.2 Construction Quality Assurance and Construction Quality Control

This QAM is a site-specific document which addresses the following: (i) CQA personnel responsibilities and authorities; (ii) monitoring and testing activities that will be performed during construction; and (iii) CQA documentation requirements. In the context of this document, Construction Quality Assurance and Construction Quality Control are defined as follows:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA personnel to assure conformity of the construction with the requirements of the Drawings, Specifications, and QAM. CQA is provided by a party independent from production and installation (i.e., independent of the Contractor or Geosynthetics Installer).
- Construction Quality Control (CQC) refers to those actions taken by the Contractor, Manufacturers, or Suppliers, including their designated representatives, to ensure that the materials and the workmanship meet the requirements of the Drawings, Specifications, QAM and all components of the Contract Documents.

1.3 Project Personnel

1.3.1 Organization of Personnel

The project organization chart depicting the key roles and lines of communication for construction at the Crossroads Landfill is provided in Figure 1. Definitions for these terms are provided in Section 01100 of the Specifications. Project Manager refers to the Owner's Representative and shall apply equally to the term Construction Manager. The duties and responsibilities of the CQA individuals identified in Figure 1 are described below.

1.3.2 CQA Engineer-of-Record

The CQA Engineer-of-Record will serve as the certifying engineer for construction of the work. He will review all clarifications and changes, which may affect the design and will serve as technical reviewer of the CQA Final Report. He will also be directly accessible to the Project Manager, Designer, and CQA personnel for technical direction during construction. The CQA

Engineer-of-Record must provide clear documentation demonstrating construction experience on at least 5 previous landfill projects, and must be a licensed Professional Engineer (Civil) in the State of Maine.

1.3.3 CQA Site Manager

The CQA Site Manager will interact on a frequent basis with all project personnel, and will have authority over CQA personnel. He must provide clear documentation demonstrating on-site field work experience on at least 5 previous landfill projects, and/or an appropriate level of NICET certification. The responsibilities and duties of the CQA Site Manager include the following:

- be familiar with the basic concepts used to develop the Drawings and Specifications;
- evaluate conformance of materials and construction with the requirements of the Drawings and Specifications;
- be familiar with other site-specific documentation, including the Contractor's bid;
- attend the meetings described in Section 1.5 of this QAM;
- assist the Project Manager in preparing documentation for Requests for Information (RFI) or other clarifications to the Drawings and/or Specifications;
- administer the CQA program (i.e., assign and manage CQA personnel, review field reports, and provide review of CQA related issues);
- review as-built survey information submitted by the Contractor;
- coordinate and review the CQA Surveyor's work products;
- prepare the Weekly Field Summaries; and
- prepare the CQA Final Report.

1.3.4 Soils Quality Assurance Laboratory (Soil QAL)

The Soil QAL will have experience in the physical testing of soils and concrete, and be familiar with, and properly-equipped to perform the geotechnical testing required by the QAM.

1.3.5 Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL)

The Geosynthetic QAL will have experience in testing the types of geosynthetics to be used on the project, and be familiar with, and properly equipped to perform the testing required by the QAM. The Geosynthetic QAL will be certified by the Geosynthetic Accreditation Institute’s - Laboratory Accreditation Program (GAI-LAP).

1.3.6 Construction Quality Assurance Technician(s)

CQA personnel will be responsible for on-site CQA activities. The general duties of CQA personnel will include the following:

- be familiar with the CQA requirements for the project;
- perform daily CQA activities;
- attend CQA-related meetings discussed in Section 1.5 of this CQA Plan;
- verify the calibration and condition of on-site CQA equipment;

- assign locations for testing and sampling;
- coordinate collection and shipping of laboratory test samples;
- review and report results of laboratory testing and Manufacturer and Contractor testing;
- review and assist the CQA Site Manager or Project Manager in approving the Contractor's submittals;
- prepare CQA daily field reports that include descriptions of the construction progress and any relevant observations;
- provide daily field reports and logs to the CQA Site Manager for review;
- report any unresolved deviations from the Drawings and Specifications to the CQA Site Manager; and
- assist in preparing the CQA final report.

Relative to earthwork construction, the duties of CQA personnel will include the following:

- check stockpile or borrow sources periodically for variability of the soils, and verify that conformance testing is carried out;
- field-test soil moisture content and monitor moisture conditioning activities by the Contractor;
- field-test soil density and monitor earthwork activities;
- collect soil samples for laboratory conformance testing;
- examine soil surfaces for signs of excessive wetting, desiccation, or other defects prior to placement of overlying materials;
- monitor scarification between lifts and before recompaction or proof rolling that is required to repair deteriorated areas; and
- establish, with the Project Manager, additional test requirements beyond those in the Specifications and/or QAM, when necessary.

Relative to the geosynthetics, the. CQA personnel will:

- review Manufacturer and Contractor certifications and documentation and make appropriate recommendations to the Geosynthetic Installer;
- review the Geosynthetic Installer’s personnel qualifications for conformance with those pre-approved for work on site;
- monitor material delivery when possible to document if materials are damaged prior to or during unloading;
- monitor on-site transport and storage;
- coordinate conformance testing to verify material properties;
- obtain samples for laboratory conformance testing;

- monitor placement operations; and
- monitor repair operations.

In addition to these duties, CQA personnel will take note of on-site activities that could result in damage to the soils, geosynthetics, or other components of the project. Observations so noted will be reported as soon as possible to the Contractor and when necessary to the Project Manager.

1.3.7 Construction Quality Assurance Surveyor

A CQA Surveyor will provide survey data to verify as-built documentation of the Contractor's work. Responsibilities of the CQA Surveyor are presented in Section 2 of the QAM.

1.4 Applicable References

Organizations whose standards are referenced in the QAM and the Specifications are as follows:

- AASHTO - American Association of State Highway and Transportation Officials;
- ASTM -American Society for Testing and Materials;
- GSI - Geosynthetic Institute;
- MEDOT - Maine Department of Transportation;
- OSHA - Occupational Safety and Health Administration; and
- MEDEP SWMR - Maine Department of Environmental Protection Solid Waste Management Rules.

Any reference to standards of any society, institute, association, or governmental agency will pertain to the edition in effect as of the date of this QAM, unless stated otherwise.

1.5 Site and Project Meetings

1.5.1 Pre-Construction Meeting

Prior to initiating construction activities at the site, select requirements set forth in the Contract Documents for the project will be addressed in a pre-construction meeting. At a minimum, the meeting will be attended by the Contractor, CQA Site Manager, Designer, and the Project Manager.

The purpose of this meeting is to begin planning for coordination of tasks, to present the schedule and sequence of work, to discuss anticipated problems which might cause difficulties and delays in construction, and present the procedures for clarifications and field changes to the Drawings or Specifications.

The pre-construction meeting should include discussion of the following activities:

- review the responsibilities of each party;
- confirm the lines of authority and communication;
- communicate to all parties any relevant documents;
- review critical design details of the project;

- address any appropriate modifications to the QAM;
- address any appropriate modifications to the Drawings or Specifications so that the fulfillment of design specifications or performance standards can be achieved;
- establish an understanding by the parties of the QAM and QA and QC procedures;
- establish work area security and safety protocol in accordance with the Owner's and the Contractor's health and safety plans;
- describe soil borrow source locations;
- establish soil stockpiling locations;
- confirm the methods for documenting and reporting, and for distributing documents and reports;
- confirm acceptance and approval process for task completion prior to schedule sequence advancement; and
- establish procedures for processing applications for payment.

Items discussed during the pre-construction meeting will be documented by a person designated at the beginning of the meeting, and minutes will be transmitted to all parties within one week of the meeting.

1.5.2 Progress Meetings

A weekly progress meeting (via teleconference or at the site) will be held each week during construction between select CQA personnel, the Contractor, and the Project Manager. The Engineer-of-Record and Designer will participate in the weekly meetings when appropriate. Current progress, planned activities for the upcoming week, and any new business or revisions to the work will be discussed at this meeting. The Project Manager will document in the meeting minutes any problems, decisions, or questions arising at this meeting. Any matters requiring action which are raised in this meeting will be reported to the appropriate parties. Minutes of weekly progress meetings will be distributed to each party present at the meeting and other designated parties.

Daily progress meetings will be held between the CQA Site Manager and the Contractor prior to the start of work, during the day, and/or following the completion of work at the end of the day. The purpose of these meetings will be to review the previous day's activities, review the upcoming day's activities and identify any needs or potential construction problems. Major items discussed during these meetings will be documented in the CQA personnel's daily field reports.

1.5.3 Problem or Work Deficiency Meetings

Special meetings will be held by the Project Manager when and if problems or deficiencies are present or judged likely to occur. At a minimum, these meetings will be attended by the Contractor, the Project Manager, and select CQA personnel. The purpose of these meetings will be to define and resolve the problem or work deficiency as follows:

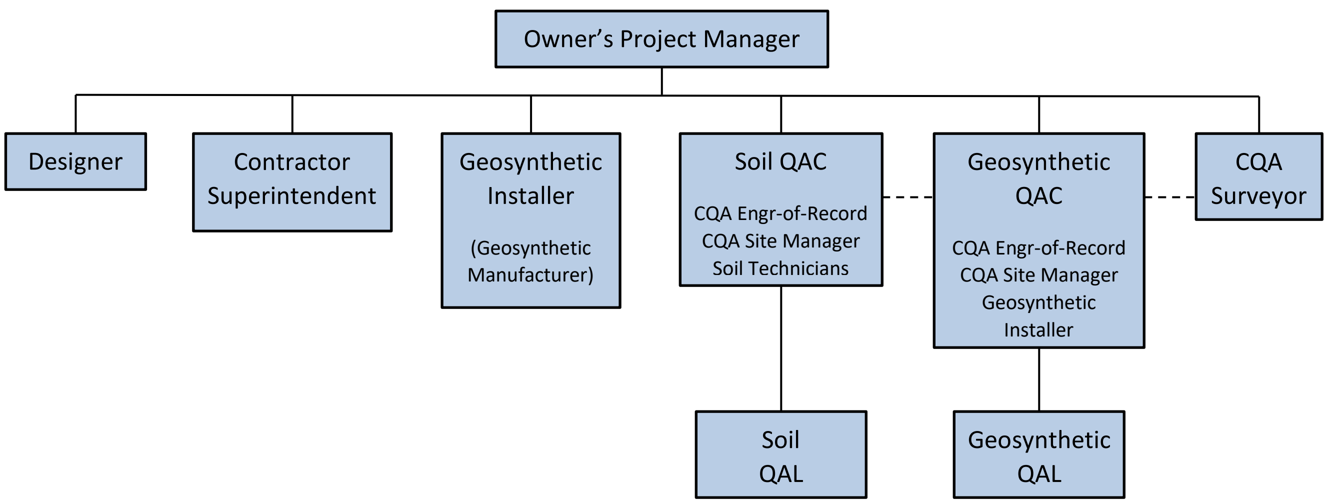
- define and discuss the problem or deficiency;

- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

Items discussed during these meetings will be documented by the Project Manager, and if deemed necessary, minutes will be transmitted to affected parties.

FIGURE 1

LINES OF COMMUNICATION
WMDSM - CROSSROADS LANDFILL



2. CQA SURVEYING

2.1 Introduction

CQA Surveying of lines and grades will be conducted on an ongoing basis during construction to independently verify the work of the Contractor. The responsibilities of the Contractor's Surveyor are described in Section 01160 of the Specifications. The CQA Surveyor will use existing control monuments at the site and the control monuments established by the Contractor's Surveyor during construction. The Soil QAC will coordinate the CQA Surveyor's field work for all aspects of the work except for the geosynthetic components of the liner system or final cover system, which will be coordinated by the Geosynthetic QAC.

2.2 Surveying Personnel

CQA Surveying will be performed under the direct supervision of a registered Land Surveyor licensed in the State of Maine, who may also be the senior surveyor on site. The survey crew will consist of the senior surveyor and as many surveying assistants as required to satisfactorily perform and complete the work. Personnel will be experienced in all aspects of surveying, including detailed, accurate documentation, and generation of Record Drawings.

2.3 Precision and Accuracy

The survey instruments used by the CQA Surveyor will be sufficiently precise and accurate to meet the needs of the project as defined in the Specifications. Survey instruments will be capable of reading to a precision of 0.01 ft and with a setting accuracy of 10 seconds. Calibration certificates for survey instruments will be submitted on request to the Soil QAC prior to the initiating CQA surveying activities at the site.

2.4 Scope of CQA Surveying

The scope of CQA surveying will include, but not necessarily be limited to:

- verifying the horizontal and vertical coordinates of selected construction control points;
- verifying layer thickness, especially of soil components of the final cover system;
- providing record information regarding the horizontal alignment and vertical profile of site piping placed during the construction;
- providing detailed record information of the locations of geomembrane seams, destructive tests, and major repairs;
- providing sufficient survey information of interim conditions such that, if requested by the Project Manager, material quantities can be calculated; and
- providing Record Drawings, including plan sheets of the important final cover system components and geomembrane panel layout drawings.

It will be the responsibility of the CQA personnel and the CQA Surveyor to coordinate the CQA surveying work such that areas are promptly surveyed, interim results are reviewed, and approval is granted for the Contractor to proceed with subsequent work in the areas. The Soil QAC will report any nonconformance or inconsistencies to the Contractor promptly to minimize delays in the construction.

2.5 Documentation

Original field CQA survey notes will be retained by the senior CQA Surveyor. A copy of these notes will be given to the Soil QAC or Geosynthetic QAC by fax at the end of each day or surveying task, as requested by the CQA personnel. The CQA Surveyor will be required to produce interim verification documentation (e.g. partial "draft" record drawing) as the job progresses, at the request of the CQA personnel.

3. INSTRUMENTATION

3.1 Overview

This section of the QAM addresses the CQA program to be implemented by the Soil QAC with regard to protection and installation (if any) of site instrumentation. Items in this section include piezometers, monitor wells, slope inclinometers, Shape Accelerometer Arrays (SAA's), and settlement plates. If new instrumentation is called for in the Construction Drawings, supply and installation of the site instrumentation will most likely be performed by a Specialty Contractor/Consultant (separate from the Construction Contractor) with experience in hydrogeologic and/ geotechnical instrumentation. Likewise, certification of the installation will be provided by a specialty hydrogeologic or geotechnical consultant that may be separate from the Soil QAC.

The purpose of this section is to describe the general CQA activities related to on-site instrumentation for which the Soil QAC will be responsible. Detailed information regarding monitoring/certification of the actual instrumentation is not addressed herein. The following CQA activities are discussed in the remainder of this section:

- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

3.2 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will assist the Project Manager in coordinating installation activities for the site instrumentation, as requested, and will inform the Contractor of existing or proposed instrumentation activities as they might affect (or be affected by) construction activities.

The Soil QAC will observe the locations of existing and proposed instrumentation, and will verify that, prior to initiating work in these areas, the Contractor has installed all necessary measures to adequately mark and protect the instrumentation, as set forth in Section 02100 of the Specifications. The Soil QAC will routinely verify that the Contractor maintains the markers and protective measures.

3.3 Deficiencies, Problems, and Repairs

The Soil QAC will report any deficiencies and noncompliances in the instrumentation markings and/or protective measures to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the Soil QAC and Project Manager. The Contractor will promptly correct the deficiency to the satisfaction of the Soil QAC, or as directed by the Project Manager.

4. TEMPORARY EROSION CONTROL

4.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to temporary erosion and sediment controls. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

4.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Contractor will be required to provide the Soil QAC with the quality control information and certification from the supplier(s) of temporary seed, mulches or matting, and silt fence as set forth in Section 02120 of the Specifications.

The Soil QAC will examine all of the suppliers' certifications to verify that the property values listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor for the temporary erosion and sedimentation materials that will be used at the site. The Soil QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the materials.

4.3 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will observe the Contractor's work activities and will verify that, prior to initiating work in any given area, temporary erosion and sediment controls, as set forth in Section 02120 of the Specifications and the Erosion and Sedimentation Control Plan (ESCP) have been installed. The Soil QAC will routinely verify that the Contractor keeps the site free from excessive sediment and in as neat a condition as possible. This includes the project area, haul roads, borrow areas, stockpile areas, and the entrance area to the Crossroads facility.

The Soil QAC will perform weekly inspections of the Contractor's temporary erosion and sediment controls, and will perform an inspection of the controls within one working day of any rain event exceeding ½ inch. The Contractor may accompany the Soil QAC during these inspections, or may perform independent inspections as set forth in the Specifications and ESCP. The Soil QAC will be responsible for reviewing the Contractor's erosion control inspection checklist forms within one working day of the Contractor submitting the forms.

The Soil QAC will verify that stockpiles are located as shown on the Drawings or as approved by the Project Manager, and that the Contractor has installed and is frequently maintaining all erosion and sedimentation control measures around these areas, as set forth in the Specifications and ESCP.

4.4 Deficiencies, Problems, and Repairs

The Soil QAC will report any deficiencies and noncompliances in the erosion and sedimentation controls to the Contractor. The extent of the deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the Soil QAC and Project Manager. The Contractor will promptly correct any deficiency to the satisfaction of the Soil QAC, or as directed by the Project Manager.

5. CLEARING, GRUBBING, AND STRIPPING

5.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to clearing, grubbing, and stripping. The following CQA activities are addressed in this section:

- field evaluation/monitoring of construction techniques; and
- deficiencies and problems.

5.2 Field Evaluation/Monitoring of Construction Techniques

Formal testing for clearing, grubbing, and stripping is not required. However, the Soil QAC will perform the following monitoring activities for clearing, grubbing, stripping, and stockpiling of on-site soils:

- verifying that trees and cleared vegetation are disposed of in proper areas;
- verifying that minimal disturbance to areas surrounding the limits of work occurs during clearing and grubbing activities;
- monitoring the location and configuration of stockpile areas and verify the separation of adjacent stockpiles of different materials; and
- documenting that proper erosion controls are implemented and maintained around the areas to be cleared, grubbed, or stripped, and around soil stockpiles.

5.3 Deficiencies and Problems

Deficiencies, problems, or other non-conformances with the Construction Documents will be documented and reported by the Soil QAC to the Contractor and the Project Manager.

6. EXCAVATION AND STORAGE OF SILT CLAY

6.1 Overview

This section of the QAM addresses the CQA program to be implemented by the Soil QAC with regard to excavation and storage of silt clay. The following CQA activities are discussed in the remainder of this section:

- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

6.2 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will become familiar with the locations from which the Contractor will excavate silt clay materials, as set forth on the Drawings. The Soil QAC will routinely verify that the Contractor follows the requirements set forth in Section 02140 of the Specifications when excavating, transporting, and stockpiling silt clay materials. Specifically, the Soil QAC will work closely with the Contractor prior to or during excavation to evaluate the condition of the silt clay (e.g., moisture content) in an effort to facilitate use of the material to the extent practicable. The Soil QAC will also verify that the Contractor takes all precautions necessary to avoid mixing the silt clay with other materials that the silt clay is stockpiled in the area(s) designated on the Drawings, or as directed by the Project Manager, and that unsuitable material is not used.

6.3 Deficiencies, Problems, and Repairs

The Soil QAC will report any deficiencies and noncompliances in the silt clay excavation activities to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the Soil QAC and Project Manager. The Contractor will correct any deficiency to the satisfaction of the Soil QAC, or as directed by the Project Manager.

7. EARTHWORK

7.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to general earthwork. General earthwork consists of placement and compaction of all soil, stone, or gravel components of the work, with the exception of Topsoil (which is covered in Section 15 of the QAM). The following CQA activities are discussed in this section:

- Pre-construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

7.2 Pre-construction Qualifying of Material Sources

Prior to construction with any given soil, stone, or gravel material, the Soil QAC will receive test results from the Contractor for a sample of each material taken from the proposed source. The Soil QAC will review the test results to ensure that each material meets the requirements set forth in the Specifications. Results of the pre-construction qualifying tests may be counted toward the conformance testing frequency requirements, provided the results meet the specified material properties. The Soil QAC may also request that the Contractor provide a sample of each material for additional testing, if further pre-construction qualification testing by the Soil QAC is warranted.

If, a pre-construction qualifying sample fails to meet the requirements of the Specifications, the Soil QAC will notify the Contractor. Use of the material will not be allowed until the material is prequalified by further tests. Additional tests, if necessary, will be performed by the Soil QAC at the request of the Project Manager at the contractors' expense.

7.3 Material Conformance Testing

During construction, a conformance testing program will be implemented by the Soil QAC to verify that the physical properties of the earthwork materials meet the specified material properties. The Soil QAC will obtain soil samples for conformance testing from the borrow source, on-site stockpiles, or from trucks as they unload material in the work area. The laboratory test methods and frequencies required for conformance testing are given in the following tables:

- Table 7-1a: Sedimentation Basin Filter Sand
- Table 7-2a: Protective Layer
- Table 7-3a: Intermediate Cover
- Table 7-4a: Silt Clay Borrow
- Table 7-5a: Granular Common Borrow
- Table 7-6a: Cohesive Common Borrow
- Table 7-7a: Structural Fill

- Table 7-8a: Granular Fill
- Table 7-9a: ¾-Inch Crushed Stone
- Table 7-10a: 1½-Inch Crushed Stone
- Table 7-11a: Surface Course
- Table 7-12a: Riprap

If a sample fails a conformance test, the Soil QAC will notify the Contractor and use of the material represented by that sample will not be allowed. Additional tests will be performed by the Soil QAC as directed by the Project Manager, or the Contractor will use material from a different source.

7.4 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will monitor and document the earthwork activities. Monitoring the construction work for the earthwork materials will include the following:

- monitoring the thickness of lifts as loosely placed and after being compacted;
- documenting the type of construction equipment and methods used to place and compact the material;
- observing the action of the compaction and heavy hauling equipment on the construction surface (i.e., penetration, pumping, cracking, etc.) to detect inadequate compaction;
- verifying that proper equipment and methods are used to place soil or stone over geosynthetic components of the liner system or final cover system, and that wrinkles or excess tensile stresses to underlying geosynthetics are minimized; and
- verify that only low-ground pressure equipment traverses over lined areas unless an approved thickness of protective soil is first placed.

7.5 Field Testing of Work Products

7.5.1 Routine Field Testing

Field testing (primarily density and moisture content testing) of placed/compacted earthwork materials will be performed by the Soil QAC during construction to evaluate the Contractor's work product with respect to the requirements of the Specifications. The test methods and frequencies for CQA field testing are given in Tables 7-1b through 7-13b for the various materials, as previously listed in Section 7.3 of this QAM. Sampling and test locations will be selected by the Soil QAC.

Moisture/density testing will be performed primarily using a nuclear gauge (in accordance with ASTM D6938). The Soil QAC will perform several Oven Moisture content tests (ASTM D2216) on Silt Clay Borrow at the outset of construction to evaluate requirements for moisture offsets for the nuclear gauge and during construction at a minimum frequency of one oven moisture test per nine (9) nuclear moisture/density tests.

The Soil QAC will be responsible for submitting enough samples to the Soil QAL to meet the minimum testing frequency for Standard or Modified Proctor compaction testing for each soil as set forth in Tables 7-1a through 7-12a. The Soil QAC will also have the Soil QAL perform additional compaction tests as necessary to evaluate variability in material, and will perform Proctor check-points as frequently as needed to verify that the correct Proctor curve is being referenced.

It is also the responsibility of the Soil QAC to monitor placement and compaction of soil in the geosynthetics anchor trench. The Soil QAC will verify that the backfilling techniques do not damage the geosynthetics in or near the anchor trench. Moisture and density testing of the backfill should be performed by the Soil QAC at a frequency of once every 50 linear feet measured along the anchor trench.

7.5.2 Special Testing

A special testing frequency will be used at the discretion of the Soil QAC when initial testing or visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the compactor rollers slip during compaction operations;
- the lift thickness is greater than specified;
- the material is at highly variable moisture content;
- dirt-clogged rollers are used to compact the material;
- the materials properties are highly variable;
- the degree of compaction is doubtful; or
- as directed by the Designer or Project Manager.

During construction, the frequency of testing may also be increased in the following situations:

- adverse weather conditions;
- breakdown of equipment;
- at the start and finish of grading;
- if the material initially fails to meet compaction requirements; or
- the work area is reduced.

7.6 Deficiencies, Problems, and Repairs

If a deficiency or noncompliance is discovered, the Soil QAC will promptly evaluate the extent and nature of the defect. The extent of the deficient area will be evaluated by additional tests, observations, a review of records, or other means deemed appropriate (e.g., proof rolling by the Contractor).

After defining the extent and nature of a defect, the Soil QAC will notify the Contractor, and at times, the Project Manager, to schedule appropriate retests after the work deficiency is corrected.

If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Soil QAC will develop and present to the Project Manager or Designer suggested alternative solutions for approval. All retests recommended by the Soil QAC must verify that the deficiency has been corrected before additional work is performed by the Contractor in the area of the deficiency.

TABLE 7-1a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR SEDIMENTATION BASIN FILTER SAND

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING[1]**
Particle-Size Analysis [2]	ASTM D422	1 per 2,500 yd^3

Notes:
1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 7-1b

FIELD TESTING REQUIREMENTS FOR SEDIMENTATION BASIN FILTER SAND

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING**
Layer Thickness	Grade Markers or Test Holes	2 per acre

TABLE 7-2a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR PROTECTIVE LAYER

TEST	METHOD	MINIMUM FREQUENCY OF TESTING(1)
Particle Size Analysis (2)	ASTM D422	1 per 5,000 yd^3
Hydraulic Conductivity	ASTM D5084 or ASTM D2434, as applicable	1 per source

Notes:
1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 7-2b

FIELD TESTING REQUIREMENTS FOR PROTECTIVE LAYER

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
Layer Thickness	Grade Markers(1) or Test Holes	2 per acre

Notes:
1. Verification of layer thicknesses for final cover construction using grade markers and surveying can be questionable due to consolidation of the waste and corresponding settlement of the layer surface. Test holes are therefore the preferred method to measure and verify thickness of compacted soil layers.

TABLE 7-3a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR INTERMEDIATE COVER

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING[(1)]**
Particle Size Analysis [(2)]	ASTM D422	1 per 2,500 yd^3
Moisture Content	ASTM D2216	1 per 2,500 yd^3
Remolded Permeability [(3)]	ASTM D2434	1 per 5,000 yd^3
Standard Proctor Compaction	ASTM D698	1 per source

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.
3. Remolded permeability to be performed on sample compacted to at least 88% of its Standard Proctor maximum dry density (i.e., light compactive effort).

TABLE 7-3b
FIELD TESTING REQUIREMENTS FOR INTERMEDIATE COVER

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING**
Layer Thickness	Test Holes	5 per acre per lift

TABLE 7-4a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR SILT CLAY BORROW

TEST	METHOD	MINIMUM FREQUENCY OF TESTING(1)
Particle Size Analysis (2)	ASTM D422	1 per 2,500 yd^3
Moisture Content	ASTM D2216	1 per 2,500 yd^3
Atterberg Limits	ASTM D4318	1 per 2,500 yd^3
Standard Proctor Compaction	ASTM D698	1 per 5,000 yd^3

Notes:
1. All tests on this table are to be performed a minimum of once per source.
2. Particle-size analysis includes hydrometer.

TABLE 7-4b

FIELD TESTING REQUIREMENTS FOR SILT CLAY BORROW

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
In-Place Density	ASTM D6938	5 per acre per lift
In-Place Moisture	ASTM D6938	5 per acre per lift
Oven Moisture	ASTM D2216	1 per 9 nuclear tests
Post-Compaction Thickness	Grade Markers(1) or Test Holes	2 per acre per lift

Notes:
1. Verification of layer thicknesses for final cover construction using grade markers and surveying can be questionable due to consolidation of the waste and corresponding settlement of the layer surface. Test holes are therefore the preferred method to measure and verify thickness of compacted soil layers.

TABLE 7-5a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GRANULAR COMMON BORROW

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING[(1)]**
Particle Size Analysis [(2)]	ASTM D422	1 per 5,000 yd^3
Modified Proctor Compaction	ASTM D1557	1 per 5,000 yd^3

Notes:
1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 7-5b

FIELD TESTING REQUIREMENTS FOR GRANULAR COMMON BORROW

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING**
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 7-6a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR COHESIVE COMMON BORROW

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING[(1)]**
Particle Size Analysis [(2)]	ASTM D422	1 per 5,000 yd^3
Standard Proctor Compaction	ASTM D698	1 per 5,000 yd^3

Notes:
1. All tests on this table are to be performed a minimum of once per source.
2. Particle-size analysis includes hydrometer.

TABLE 7-6b

FIELD TESTING REQUIREMENTS FOR COHESIVE COMMON BORROW

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING**
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 7-7a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR STRUCTURAL FILL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING[1]
Particle Size Analysis [2]	ASTM D422	1 per 2,500 yd^3
Modified Proctor Compaction	ASTM D1557	1 per 5,000 yd^3

Notes:
1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle-Size Analysis is not required.

TABLE 7-7b

FIELD TESTING REQUIREMENTS FOR STRUCTURAL FILL

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 7-8a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GRANULAR FILL

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING(1)**
Particle Size Analysis (2)	ASTM D422	1 per 5,000 yd^3
Modified Proctor Compaction	ASTM D1557	1 per 5,000 yd^3

Notes:
1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 7-8b

FIELD TESTING REQUIREMENTS FOR GRANULAR FILL

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING(1)**
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 7-9a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR 3/4 - INCH CRUSHED STONE

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING(1)**
Particle Size Analysis (2)	ASTM D422	1 per 2,500 yd^3

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 7-9b

FIELD TESTING REQUIREMENTS FOR 3/4 - INCH CRUSHED STONE

(NOT APPLICABLE)

TABLE 7-10a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR 1 1/2 - INCH CRUSHED STONE

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING(1)**
Particle Size Analysis (2)	ASTM D422	1 per 2,500 yd^3
Carbonate Content	ASTM D4373	1 per source

Notes:
1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 7-10b

FIELD TESTING REQUIREMENTS FOR 1/2 - INCH CRUSHED STONE

(NOT APPLICABLE)

TABLE 7-11a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR SURFACE COURSE

TEST	METHOD	MINIMUM FREQUENCY OF TESTING(1)
Particle Size Analysis (2)	ASTM D422	1 per source
Modified Proctor Compaction	ASTM D1557	1 per source

Notes:

1. All tests on this table are to be performed a minimum of once per source.
2. Hydrometer component of Particle Size Analysis is not required.

TABLE 7-11b

FIELD TESTING REQUIREMENTS FOR SURFACE COURSE

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
In-Place Density	ASTM D6938	1 per 1,000 yd^3
In-Place Moisture	ASTM D6938	1 per 1,000 yd^3

TABLE 7-12a

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR RIPRAP

TEST	**METHOD**	**MINIMUM FREQUENCY OF TESTING[(1)]**
Particle Size Analysis	Visual Inspection	1 per 1,000 yd^3

Notes:
1. All tests on this table are to be performed a minimum of once per source.

TABLE 7-12b

FIELD TESTING REQUIREMENTS FOR RIPRAP

(NOT APPLICABLE)

8. GEOMEMEMBRANE

8.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to the polyethylene (PE) geomembrane component of the liner system or final cover system. The geomembrane will be supplied by the Owner and installed by the Geosynthetics Installer, under direct contract with the Owner (WMDSM). The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

8.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Owner or the Geosynthetic Installer will provide the Geosynthetic QAC with the quality control information and certifications from the geomembrane manufacturer as set forth in Section 02400 of the Specifications.

The Geosynthetic QAC will examine all geomembrane manufacturers' certifications to verify that the property values listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Owner or Geosynthetic Installer for all geomembrane used at the site. The Geosynthetic QAC will report any deviations from the above requirements to the Owner or Geosynthetic Installer prior to approving deployment of the geomembrane.

Additionally, if a plant visit is requested by the Project Manager, the Geosynthetic QAC or personnel from the Geosynthetic QAL will visit the geomembrane manufacturer's plant for the purpose of verifying that manufacturing quality control procedures are in conformance with the Specifications. The plant visit must be performed during the manufacturing of the geomembrane rolls for the project. While at the plant, the Geosynthetic QAC will review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures, as follows:

- verify that the measurements of properties by the geomembrane manufacturer are properly documented and test methods used are acceptable;
- spot inspect the rolls and verify that they are free of holes, blisters, or any sign of defects or contamination by foreign matter;
- review packaging and transportation procedures to verify that these procedures are not damaging the geomembrane;
- verify that all rolls are properly labeled; and

- verify that extrusion rods and/or beads manufactured for the field seaming of the geomembrane are derived from the same base resin type as the geomembrane.

The Geosynthetic QAC will document their plant visit and upon completion of the visit, forward the documentation to the Project Manager.

In addition to the above pre-qualification evaluation process, the Geosynthetic QAC should be aware that a direct shear testing program may be developed and performed under the direction of the Designer for new products and or liner-component interfaces. This program may or may not include the geomembrane; therefore, the Geosynthetic QAC should inquire of the Project Manager and/or Designer regarding this at the outset of the project. If applicable, the results of any such program shall be approved by the Designer as a part of the initial pre-qualification process.

8.3 Material Conformance Testing

Conformance sampling of the geomembrane may be performed by the Geosynthetic QAC or personnel from the Geosynthetic QAL at the manufacturing plant, or by the Geosynthetic QAC upon delivery of the rolls to the site, as requested by the Project Manager. The Geosynthetic QAC will obtain samples and forward them to the Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL) for testing to evaluate whether the material meets the requirements of the Specifications and the geomembrane manufacturer's list of certified properties.

Conformance samples will be taken by the Geosynthetic QAC unless otherwise specified, samples will be 2-ft long by the roll width following the removal of one full wrap from the roll. The Geosynthetic QAC will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- Geosynthetic QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the geomembrane are given in Table 8-1.

All conformance test results will be reviewed by the Geosynthetic QAC before approving deployment of the geomembrane. Any nonconformance of the material's physical properties will be promptly reported to the Project Manager. The following procedure will apply whenever a geomembrane sample fails a conformance test conducted by the Geosynthetics QAL:

- The Geosynthetic Installer will be required to replace all of the rolls of geomembrane within the batch from which the nonconforming sample was obtained.
- Alternatively, if the geomembrane manufacturer, and the Project Manager both agree, the Geosynthetic QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two

samples must pass the conformance tests in Table 8-1. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geomembrane on site and a sample from every roll that is subsequently delivered from the same geomembrane manufacturer must be conformance tested by the Geosynthetic QAL.

During conformance testing, the Geosynthetic QAC will also verify that the geomembrane manufacturer has identified all rolls of geomembrane with the following information:

- name of manufacturer;
- product identification;
- thickness;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The Geosynthetic QAC will record the above information for each roll delivered to the site using a Material Inventory Log form for the geomembrane.

In addition to the conformance testing described above, the geomembrane must be tested in accordance with the *Interface and Internal Shear Resistance Testing Program Work Plan* and validated by project specific cover system stability analysis.

8.4 <u>Field Evaluation/Monitoring of Construction Techniques</u>

8.4.1 Proposed Panel Layout

Prior to construction, the Geosynthetic QAC will review the proposed panel layout plan submitted by the Geosynthetic Installer. The purpose of the review will be to become familiar with the proposed orientation of the panels, the general installation sequencing, the quantities of materials needed for the job, and to assess whether the proposed installation will be in accordance with the Specifications. The Geosynthetic QAC will make written review comments, sign the proposed panel layout plan indicating that the review has taken place, and return it to the Project Manager.

8.4.2 Transportation, Handling, and Storage

During unloading and storage, the Contractor and/or the Geosynthetic Installer will be required to keep the geomembrane off the ground and protect the geomembrane from precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

The Geosynthetic QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Project Manager. Any damaged rolls will be rejected by the Geosynthetic QAC and the Project Manager, and will be required to be repaired or replaced by the Owner or party responsible for damage.

8.4.3 Field Panel Identification

The Geosynthetic QAC will ensure that each field panel is given an identification number. This identification number will be agreed upon by the Geosynthetic QAC and Geosynthetic Installer, and will allow for the geomembrane roll numbers to be traceable to the field panel identification numbers.

The Geosynthetic QAC will document the relationship between roll numbers, factory panels, and field panel identification numbers. The field panel identification numbers will be used for all quality assurance/quality control records.

8.4.4 Field Panel Placement

The Geosynthetic QAC will monitor field panel placement and verify that field panels are installed in general accordance with the overall panel orientation indicated on the Geosynthetics Installer's proposed panel layout plan. CQA personnel will record the field panel identification number, manufacturers roll number, location, date of installation, and dimensions of each field panel. The Geosynthetic QAC will label each panel in the field with its panel identification number using a semi-permanent marker (e.g., paint stick). To avoid confusion, the Geosynthetic QAC will use a different color marker than used by the Geosynthetic Installer.

Prior to deployment, the Geosynthetic QAC will observe the work area, and will verify that subgrade surfaces have been fully approved by the Soil QAC. It is the responsibility of the Geosynthetic QAC to provide subgrade acceptance forms to the Geosynthetic Installer and verify that they have been signed prior to deployment.

The Geosynthetic QAC will monitor geomembrane deployment and verify compliance with the following:

- ambient temperatures are within the limits required by the Specifications, and wind is not excessive;
- deployment vehicles or other equipment do not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
- the prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement, without excessive moisture (e.g., dew, ponding, etc.);
- the anchor trench is of the proper dimensions and in suitable condition, without loose or wet soils underlying the geomembrane;
- personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;
- the method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- the method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);

- adequate temporary loading and/or anchoring (e.g., sand bags, tires) have been placed to prevent uplift by wind; and
- direct contact with the geomembrane is minimized in areas where excessive traffic may be expected (e.g., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials).

The Geosynthetic QAC will observe the geomembrane panels, after placement and prior to seaming, for damage, and will advise the Geosynthetic Installer if any panels, or portions of panels, are rejected or needed to be repaired. Damaged panels or portions of damaged panels, which have been rejected, will be marked and their removal from the work area will be recorded by the Geosynthetic QAC.

The Soil QAC will be responsible for monitoring placement and compaction of soil backfill in anchor trenches. The Soil QAC will verify that the backfilling techniques do not damage the geosynthetics, and will perform moisture and density testing in accordance with the procedures set forth in Section 7.5 of the QAM.

8.4.5 Field Panel Seaming

8.4.5.1 Panel Layout

The Geosynthetic QAC will review and become familiar with the proposed panel layout plan previously submitted by the Geosynthetic Installer. In general, seams should be oriented parallel to the line of maximum slope (i.e., oriented up and down, not across, the slope). In corners and odd-shaped geometric locations, the number of seams should be minimized. Horizontal seams where the cover geomembrane is welded to the liner geomembrane are allowed within 5 ft of the toe of slope. No other horizontal seams should be closer than 5 ft from the toe of slopes, or areas of potential stress concentrations, unless otherwise authorized by the Designer. A seam numbering system compatible with the field panel identification numbering system will be established by the Geosynthetic QAC prior to any seaming.

8.4.5.2 Seaming Equipment and Products

Extrusion Fillet Process

The Geosynthetic QAC will perform the following activities during the extrusion fillet welding process:

- verify and document that the extrusion-welding apparatus is permanently marked with an identification number;
- verify that the extrusion-welding apparatus is equipped with gauges giving the temperature in the apparatus and at the nozzle;
- verify that the extrudate is comprised of the same resin as the geomembrane sheeting;
- monitor extrudate temperatures, ambient temperatures, and geomembrane sheet temperatures at appropriate intervals;
- verify that a suitable number of spare operable seaming apparatus are maintained on site;

- verify that the extruder is purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel;
- verify that the proper amount of geomembrane grinding has been performed and that over-grinding has not occurred;
- confirm that the electric generator is placed on a smooth base such that no damage occurs to the geomembrane; and
- confirm that a smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

Fusion Process

The Geosynthetic QAC will perform the following activities during the fusion welding process:

- verify and document that the fusion-welding apparatus is a self-propelled device and that it is permanently marked with an identification number;
- verify that the fusion-welding apparatus is equipped with gauges giving the applicable temperatures and welding speed;
- verify that a suitable number of spare operable seaming apparatus are maintained on site;
- confirm that the electric generator is placed on a smooth protective base such that no damage occurs to the geomembrane;
- confirm that, for cross seams, the edge of the cross seam is ground to a smooth protective incline (top and bottom) prior to welding;
- verify that a smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage; and
- verify that a movable protective layer is used, as necessary, directly below each overlap of geomembrane that is to be seamed to prevent build-up of moisture between the sheets.

8.4.5.3 Seam Preparation

The Geosynthetic QAC will monitor that:

- weather conditions for seaming are within the limits required by the Specifications, unless approved otherwise by the Geosynthetic QAC and the Designer;
- prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;
- if seam overlap grinding is required, the process is completed according to the Geomembrane Manufacturer's instructions and/or the Specifications, whichever is the more stringent, prior to the seaming operation, and in a way that does not damage the geomembrane;
- the grind depth shall not exceed 10 percent of the geomembrane thickness;
- grinding marks do not appear beyond the extrudate after it is placed; and
- seams are aligned with the fewest possible number of wrinkles and “fish mouths”.

8.4.5.4 Overlapping and Temporary Bonding

The Geosynthetic QAC will monitor that:

- the panels of geomembrane have a finished overlap of a minimum of 3 inches for extrusion welding and 5 inches for fusion welding, and sufficient overlap has been provided to allow peel tests to be performed on the seam;
- no solvent or adhesive is used; and
- the procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus is controlled such that the geomembrane is not damaged.

8.4.5.5 Seaming in Critical Areas

The Geosynthetic QAC will be familiar with the locations of all appurtenances, geomembrane penetrations (e.g. risers for leachate collection cleanout pipes or gas vents) and critical areas (e.g. sumps, tie-in seams with previous phases, etc.) identified on the Drawings. The Geosynthetic QAC will closely monitor seaming techniques in these locations and will verify that:

- connection of the geomembrane to appurtenances have been made in accordance with the details set forth in the Drawings and Specifications;
- the Geosynthetic Installer uses extreme care while welding around appurtenances since neither destructive nor nondestructive testing may be possible in these areas;
- rigorous visual inspection of all welds in these locations is performed by both the Geosynthetic Installer and the Geosynthetic QAC.

8.5 <u>Field Testing of Work Product</u>

8.5.1 Trial Seams

Trial seam testing will be performed by the Geosynthetic Installer. The Geosynthetic QAC will observe and document the Geosynthetic Installer's trial seam testing procedures and verify they are in accordance with the Specifications. CQA personnel will document identification numbers of trial seam samples and record the results. Each sample will also be marked with the date, time, machine temperature(s) and setting(s), number of seaming unit, (parent material test yield strength) PMTYS results, and name of seaming technician.

8.5.2 Nondestructive Seam Testing

Nondestructive field seam testing will be performed by the Geosynthetic Installer to check the continuity of seams. During the Geosynthetic Installer's nondestructive testing of field seams, the Geosynthetic QAC will confirm that seams are tested over their full length using either the vacuum test or the air pressure test. The Geosynthetic QAC personnel will verify that nondestructive testing has been performed on all of the seams, and document the results.

Any required seam repairs identified as a result of failed nondestructive seam testing will be made by the Geosynthetics Installer in accordance with the Specifications. The Geosynthetic QAC will:

- observe the repair procedures;
- observe the retesting procedures; and
- document the results.

8.5.3 Destructive Testing

8.5.3.1 Location and Frequency

The Geosynthetic QAC will select all destructive seam test sample locations in order to accomplish the sampling and testing frequencies set forth in the Specifications. Sample locations will be established by the Geosynthetic QAC according to the guidelines given below.

- Test locations will be determined during seaming at the discretion of the Geosynthetic QAC. In general, the locations should be selected to provide good spatial coverage of the tests, and to meet the minimum destructive test frequency set forth in the Specifications. Selection of additional test locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential indication of deficient welding.
- The Geosynthetic Installer will not be informed in advance of the locations where the seam samples will be taken.

8.5.3.2 Sampling Procedures

The Geosynthetics Installer will cut the destructive samples at the locations designated by the Geosynthetic QAC, under observation of the Geosynthetic QAC when possible. The Geosynthetic QAC will mark each sample accordingly and record the sample location on the standardized Seam and Panel Repair Location Log. The Geosynthetic QAC will confirm that the requirements of the Specifications are followed with respect to initial field testing, sample size, and distribution of portions.

The Geosynthetic QAC will monitor that holes in the geomembrane resulting from destructive seam test sampling are promptly repaired by the Geosynthetic Installer in accordance with repair procedures described in the Specifications. The Geosynthetic QAC will document that the continuity of the new seams in the repaired area have been nondestructively tested.

8.5.3.3 Field Destructive Testing

The Geosynthetic QAC will monitor that test strips are tested for peel adhesion and shear in the field by the Geosynthetic Installer, using a gauged tensiometer in accordance with the Specifications. The Geosynthetic QAC will document using the appropriate standardized field forms: the date, number of seaming unit, seaming technician identification, destructive sample number, PMTYS results, and pass or fail description. If the field tests meet the Specification requirements, then the Geosynthetic QAC will coordinate shipping of the samples to the Geosynthetic QAL for formal destructive testing.

8.5.3.4 Laboratory Destructive Testing

Destructive test samples will be tested by the Geosynthetics QAL in accordance with the testing procedures given in the Specifications. The Geosynthetic QAL should provide test results no more than 24 hours after they receive the samples. The Geosynthetic QAC will promptly review the test results and report the results to the Geosynthetic Installer, including notification of approval, or any inconsistencies or nonconformances.

8.5.3.5 Procedures for Destructive Test Failure

The Geosynthetic QAC will document that the procedures set forth in the Specifications are implemented whenever a sample fails a destructive test, whether that test was conducted in the field or by the Geosynthetics QAL. The Geosynthetics QAC will monitor that the Geosynthetic Installer follows a logical and rigorous procedure for tracking the extent of the seam represented by the failing destructive test (e.g., a tie-in seam or a seam made by the apparatus and/or operator used in the failing seam).

All failed seams must be bounded by two locations from which samples passing laboratory destructive tests have been taken or the entire seam is reconstructed and retested. In cases exceeding 150 ft of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing. Repairs will be made in accordance with the Specifications. The Geosynthetic QAC will document the actions taken in conjunction with destructive test failures.

8.6 <u>Defects and Repairs</u>

8.6.1 Inspection for Defects

All seams and non-seam areas of the geomembrane will be examined by the Geosynthetics QAC for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane should be clean at the time of examination.

8.6.2 Repair Procedures

The Geosynthetics QAC will monitor the Geosynthetic Installer’s repair activities for portions of the geomembrane where destructive test samples were obtained, or areas exhibiting a flaw or failing test results. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Geosynthetic Installer and the Geosynthetics QAC.

In addition, the following conditions will be monitored by the Geosynthetics QAC:

- surfaces of the geomembrane which are to be repaired are abraded no more than one hour prior to the repair;
- all surfaces are clean and dry at the time of the repair;
- all seaming equipment used in repairing procedures has been pre-approved;
- the repair procedures, materials, and techniques have been pre-approved in advance of the specific repair;

- patches or caps extend at least 6 in. beyond the edge of the defect, and all corners of patches are rounded; and
- all tee seams are extrusion welded a minimum of 4 inches beyond the intersection in all directions.

The Geosynthetic QAC will observe all repair areas and verify that the repairs were completed in accordance with the Specifications.

8.6.3 Verification of Repairs

The Geosynthetic QAC will number and log each repair, and document that the repair areas have been non-destructively tested using approved methods. Repairs, which pass the non-destructive test, will be taken as an indication of an adequate repair. Large caps may be of sufficient extent to require destructive test sampling, at the discretion of the Geosynthetic QAC, or as required in the Specifications. The Geosynthetic QAC will observe non-destructive testing of repairs and will record the number of each repair, date, and test outcome.

TABLE 8-1

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GEOMEMBRANE

TEST	METHOD	MINIMUM FREQUENCY OF TESTING
Density	ASTM D1505/D792	1 per 100,000 ft^2
Thickness	ASTM D5994	1 per 100,000 ft^2
Tensile Strength at Yield	ASTM D6693	1 per 100,000 ft^2
Tensile Strength at Break	ASTM D6693	1 per 100,000 ft^2
Elongation at Yield	ASTM D6693	1 per 100,000 ft^2
Elongation at Break	ASTM D6693	1 per 100,000 ft^2
Puncture Resistance	ASTM D4833	1 per 100,000 ft^2
Carbon Black Content	ASTM D1603 or D4218	1 per 100,000 ft^2
Carbon Dispersion	ASTM D5596	1 per 100,000 ft^2

Notes:

1. Test shall be performed at a frequency of one per lot or at listed frequency, whichever is greater. A lot shall be as defined by ASTM D 4354, unless defined otherwise by the Geosynthetic QAC.
2. In addition to the conformance testing described above, the geomembrane must be tested in accordance with the *Interface and Internal Shear Resistance Testing Program Work Plan* and validated by project specific cover system stability analysis.

9. GEOTEXTILES

9.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to geotextile components of the cover system, which are defined as any geotextile located within the lined footprint. For geotextiles that are located outside the lined footprint, manufacturer's literature that demonstrates the geotextile meets or exceeds the specified properties will be adequate for "preconstruction qualifying of material sources," and no "material conformance testing" will be required. This section does not pertain to the heat-bonded geotextile component of drainage geocomposite materials, which is covered in Section 10 of the QAM. The following CQA activities are discussed in this section:

- Pre-construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

9.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Contractor and/or Geosynthetic Installer will be required to provide the Geosynthetic QAC with the quality control information and certification from the geotextile manufacturer(s) as set forth in Section 02510 of the Specifications. For Owner-supplied geotextiles, the Owner will be required to provide the Geosynthetics QAC with the quality control information and certification from the geotextile manufacturer(s) as set forth in Section 02510 of the Specifications.

The Geosynthetic QAC will examine all geotextile manufacturers' certifications to verify that the property values listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor and/or Geosynthetic Installer for all geotextile used at the site. The Geosynthetic QAC will also verify that the manufacturer of all nonwoven geotextiles provides certification that the geotextile is continuously inspected for the presence of needles using a metal detector. The Geosynthetic QAC will report any deviations from the above requirements to the Contractor and/or Geosynthetic Installer prior to approving installation of the geotextile.

9.3 Material Conformance Testing

Conformance sampling of the geotextile(s) will be performed by the Geosynthetic QAC upon delivery of rolls to the site, unless otherwise directed by the Project Manager. The Geosynthetic QAC will obtain samples and forward them to the Geosynthetic QAL for testing to evaluate whether the material meets the requirements of the Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the Geosynthetic QAC and unless otherwise specified, samples will be 2-ft long by the roll width. The Geosynthetic QAC will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- Geosynthetic QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the geotextiles are given in Table 9-1.

All conformance test results will be reviewed by the Geosynthetic QAC before installation of the geotextile. Any nonconformance of the material's physical properties will be promptly reported to the Contractor and/or Geosynthetic Installer. The following procedure will apply whenever a geotextile sample fails a conformance test conducted by the Geosynthetic QAL:

- The Owner/Contractor will be required to replace all of the rolls of geotextile within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Contractor and/or Geosynthetic Installer, geotextile manufacturer, and the Project Manager all agree, the Geosynthetic QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geotextile on site and a sample from every roll that is subsequently delivered from the same geotextile manufacturer must be conformance tested by the Geosynthetics QAL.

During conformance testing, the Geosynthetic QAC will also verify that the geotextile manufacturer has identified all rolls of geotextile with the following information:

- name of Manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The Geosynthetic QAC will record all of the above information for each roll delivered to the site using a Material Inventory Log form for the geotextile.

9.4 Field Evaluation/Monitoring of Construction Techniques

During shipment and storage, the Contractor and/or the Geosynthetic Installer will be required to keep the geotextile off the ground and protect the geotextile from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Specifications require that the geotextile rolls be shipped and stored in opaque and watertight wrappings.

The Geosynthetic QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Contractor and/or the Geosynthetic Installer. Any damaged rolls will be rejected by the Geosynthetic QAC and Project Manager, and will be required to be repaired or replaced by the Contractor, or Geosynthetic Installer.

The Contractor and/or the Geosynthetic Installer will be required to handle all geotextile in such a manner as to ensure the geotextile is not damaged. The Geosynthetic QAC will verify compliance with the following:

- immediately prior to geotextile placement, the subgrade is free of sharp protrusions or other obstructions that could potentially damage the geotextile;
- in the presence of wind, the geotextile is weighted with sandbags (or equivalent ballast weight approved by the Geosynthetic QAC), and that sandbags remain until replaced with an overlying layer;
- efforts are made to minimize the presence of wrinkles in the geotextile, and if necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles;
- a visual examination of the geotextile is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and
- the geotextile is not left exposed for longer that the maximum allowable period (as set forth in the Specifications) after placement unless a longer exposure period is approved by the Designer.

The Geosynthetic QAC will verify that, where required in the Specifications, geotextiles are continuously sewn, the geotextiles are overlapped per specification section 02510 prior to seaming, and that sewing is performed using polymeric thread and stitching type, as required in the Specifications.

The Geosynthetic QAC and/or the Soil QAC will verify that the Contractor places all soil and aggregate materials on top of geotextiles such that:

- the geotextile and underlying materials are not damaged;
- wrinkles are minimized; and
- excess tensile stresses are not produced in the geotextile.

9.5 Deficiencies, Problems, and Repairs

CQA personnel will report to the Contractor and/or the Geosynthetic Installer any unresolved deficiencies in the subgrade prior to geotextile placement, and will not approve of geotextile deployment until the subgrade deficiencies are resolved to the satisfaction of the Geosynthetic QAC and in accordance with the Specifications.

The Geosynthetic QAC will verify that any holes or tears in the geotextile are repaired in accordance with the Specifications, and that care is taken to remove any soil or other material, which may have penetrated the torn geotextile.

The Geosynthetic QAC will document deficiencies or noncompliance with the specified requirements and report them to the Contractor and/or Geosynthetic Installer. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the Geosynthetic QAC.

The Contractor will correct the deficiency to the satisfaction of the Geosynthetic QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Geosynthetic QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the Geosynthetic QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor and/or Geosynthetic Installer in the area of the deficiency.

TABLE 9-1
MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GEOTEXTILES

TEST	METHOD	MINIMUM FREQUENCY OF TESTING(1)
Mass Per Unit Area	ASTM D5261	1 per 100,000 ft^2
Apparent Opening Size (O_{95})	ASTM D4751	1 per 100,000 ft^2
Grab Strength	ASTM D4632	1 per 100,000 ft^2
Trapezoidal Tear Strength	ASTM D4533	1 per 100,000 ft^2
Puncture Strength	ASTM D6241	1 per 100,000 ft^2

Note:
1. All tests on this table are to be performed a minimum of once per source for each type of geotextile used on the project.

10. DRAINAGE GEOCOMPOSITE/GEONET

10.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to the geocomposite drainage layer component of the liner system or final cover system. The geocomposite will be supplied by the Owner and installed by the Geosynthetic Installer, under direct contract with the Owner (WMDSM). The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

10.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Owner will provide the Geosynthetic QAC with the quality control information and certifications from the double-sided and singled-sided geocomposite manufacturer as set forth in Section 02520 of the Specifications.

The Geosynthetic QAC will examine all geocomposite manufacturer's certifications to verify that the property values listed on the manufacturer's certifications meet or exceed the Specifications and that proper and complete documentation has been provided by the Owner for all geocomposite used at the site. The Geosynthetic QAC will also verify that the manufacturer of the nonwoven geotextile component(s) of the geocomposite provides certification that the geotextile is continuously inspected for the presence of needles using a metal detector. The Geosynthetic QAC will report any deviations from the above requirements to the Project Manager prior to approving installation of the geocomposite.

To complete the pre-qualification process of proposed single-sided geocomposite product, the hydraulic transmissivity of a specimen of the material will be evaluated by the Geosynthetic QAL using the hydraulic-transmissivity test conditions set forth in Article 2.03A of Specification 02520. Likewise, to complete the pre-qualification process of proposed double-sided geocomposite product, the hydraulic transmissivity of a specimen of the material will be evaluated by the Geosynthetic QAL using the hydraulic-transmissivity test conditions set forth in Article 2.04A of Specification 02520.

In addition to the above pre-qualification evaluation process, the Geosynthetic QAC should be aware that a direct shear testing program may be developed and performed under the direction of the Designer for new products and or liner-component interfacesIf applicable, the results of any such program shall be approved by the Designer as a part of the initial pre-qualification process.

10.3 Material Conformance Testing

Conformance sampling of the geocomposite may be performed by the Geosynthetic QAC or personnel from the Geosynthetic QAL at the manufacturing plant, or by the Geosynthetic QAC upon delivery of rolls to the site, as requested by the Project Manager. The Geosynthetic QAC will obtain samples and forward them to the Geosynthetic QAL for testing to evaluate whether the material meets the requirements of the Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the Geosynthetic QAC, unless otherwise specified, samples will be 2-ft long by the full roll width. The Geosynthetic QAC will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled;
- project number;
- lot/batch number and roll number;
- conformance sample number; and
- Geosynthetic QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the geocomposite are given in Table 10-1.

All conformance test results will be reviewed by the Geosynthetic QAC before installation of the geocomposite. Any nonconformance of the material’s physical properties will be promptly reported to the Project Manager. The following procedure will apply whenever a geocomposite sample fails a conformance test conducted by the Geosynthetic QAL:

- The Owner or Geocomposite Supplier will be required to replace all of the rolls of geocomposite within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Geosynthetic Installer, geocomposite manufacturer and the Project Manager all agree, the Geosynthetic QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geocomposite on site and a sample from every roll that is subsequently delivered from the same geocomposite manufacturer must be conformance tested by the Geosynthetics QAL.

During conformance testing, the Geosynthetic QAC will also verify that the geocomposite manufacturer has identified all rolls of geocomposite with the following information:

- name of Manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The Geosynthetic QAC will record all of the above information for each roll delivered to the site using a Material Inventory Log form for the geocomposite.

10.4 Field Evaluation/Monitoring of Construction Techniques

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the geocomposite off the ground and protect the geocomposite from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Specifications require that the geocomposite rolls be shipped and stored in opaque and watertight wrappings.

The Geosynthetic QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Geosynthetic Installer. Any damaged rolls will be rejected by the Geosynthetic QAC and the Project Manager, and required to be repaired or replaced by the Owner or Geocomposite Supplier.

The Geosynthetic Installer will be required to handle and deploy all geocomposite in such a manner as to ensure the geocomposite is not damaged. The Geosynthetic QAC will verify compliance with the following:

- immediately prior to geocomposite placement, the underlying geomembrane surface is free of moisture or obstructions that could potentially damage the geocomposite;
- in the presence of wind, the geocomposite is weighted with sandbags (or equivalent ballast weight approved by the Geosynthetic QAC), and that sandbags remain until replaced with the overlying protective cover soil layer;
- efforts are made to minimize the presence of wrinkles in the geocomposite, and if necessary, the geocomposite is positioned by hand after being unrolled to minimize wrinkles;
- care is taken by the Geosynthetic Installer not to entrap stones, soil, dust, or moisture that could damage or cause clogging to the geocomposite;
- a visual examination of the geocomposite is carried out over the entire surface, after installation, to verify that no areas of burn-through of the geotextile component are observed;
- a visual examination of the geocomposite is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present; and

- the geocomposite is not left exposed for longer than the maximum allowable period (as set forth in the Specifications) after placement unless a longer exposure period is approved by the Designer.

The Geosynthetic QAC will verify that the components of the geocomposite (i.e., geotextile-geonet-geotextile) are sewn, joined, and/or overlapped to like-components in adjacent geocomposite panels, as required in the Specifications.

The Geosynthetic QAC and/or the Soil QAC will verify that the Contractor and/or Geosynthetics Installer places soil or geosynthetic materials on top of geocomposites such that:

- the geocomposite and underlying materials are not damaged;
- wrinkles are minimized; and
- excess tensile stresses are not produced in the geocomposite.

10.5 Deficiencies, Problems, and Repairs

The Geosynthetic QAC will report to the Geosynthetic Installer any unresolved deficiencies in the underlying geomembrane prior to geocomposite placement, and will not approve of geocomposite deployment until the geomembrane deficiencies are resolved to the satisfaction of the Geosynthetic QAC and in accordance with the Specifications.

The Geosynthetic QAC will verify that any holes or tears in the geocomposite are repaired in accordance with the Specifications, and that care is taken by the Contractor to remove any soil or other material, which may have penetrated the torn geocomposite.

The Geosynthetic QAC will document deficiencies or noncompliance with the specified requirements and report them to the Geosynthetic Installer. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the Geosynthetic QAC.

The Geosynthetic Installer will correct the deficiency to the satisfaction of the Geosynthetic QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Geosynthetic QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the Geosynthetic QAC must verify that the deficiency has been corrected before any additional work is performed by the Geosynthetics Installer in the area of the deficiency.

TABLE 10-1

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR DRAINAGE GEOCOMPOSITE/GEONET

TEST	METHOD	MINIMUM FREQUENCY OF TESTING(1)
Geotextile Component(s)		
Mass per Unit Area	ASTM D5261	1 per 100,000 ft^2
10.5.1.1.1.1 Geonet Component		
Polymer Specific Gravity	ASTM D1505	1 per 100,000 ft^2
Thickness	ASTM D5199	1 per 100,000 ft^2
Geocomposite		
Transmissivity	ASTM D4716(2,3,4)	1 per 200,000 ft^2

Notes:

1. Testing shall be performed at a frequency of one per lot or at listed frequency, whichever is greater, for each type of geocomposite used for the work. A lot shall be as defined by ASTM 4354, unless defined otherwise by the Geosynthetic QAC.
2. Pre-qualifying transmissivity tests on double-sided and single-sided geocomposite shall be performed using the conditions set forth in Section 10.2 of this QAM.
3. Conformance tests shall be performed with the geocomposite using the test conditions set forth in Section 10.2 of this QAM. The transmissivity shall meet or exceed the transmissivity measured during the prequalifying test.
4. Frequency of test per each gradient specified in Technical Specification Section 02520 Part 2.04.A.

11. GEOSYNTHETIC CLAY LINER

11.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to the geosynthetic clay liner (GCL) component of the liner system or final cover system. The GCL will be supplied and installed by the Geosynthetic Installer, under direct contract with the Owner (WMDSM). The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

11.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the supplier of the GCL will provide the Geosynthetic QAC with the quality control information and certifications from the GCL manufacturer as set forth in the Section 02530 of the Specifications.

The Geosynthetic QAC will examine all GCL manufacturers' certifications to verify that the property values listed on the manufacturer's certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the supplier of the GCL to be used at the site.

In addition to the above pre-qualification evaluation process, the Geosynthetic QAC should be aware that a direct shear testing program may be developed and performed under the direction of the Designer for new products and or liner-component interfaces. If applicable, the results of any such program shall be approved by the Designer as a part of the initial pre-qualification process.

11.3 Material Conformance Testing

Conformance sampling of the GCL may be performed by the Geosynthetic QAC or personnel from the Geosynthetic QAL at the manufacturing plant, or by the Geosynthetic QAC upon delivery of rolls to the site, as requested by the Project Manager. The Geosynthetic QAC will obtain samples and forward them to the Geosynthetic QAL for testing to evaluate whether the material meets the requirements of the Specifications and the manufacturer's list of certified properties.

Conformance samples will be taken by the Geosynthetic QAC, unless otherwise specified, samples will be 2-ft long by the full roll width. The Geosynthetic QAC will mark the machine direction on the samples with an arrow and affix a label, tag, or otherwise mark each sample with the following information:

- date sampled
- project number;
- lot/batch number and roll number;

- conformance sample number; and
- Geosynthetic QAC personnel identification.

The laboratory test methods and frequencies required for CQA conformance testing of the GCL are given in Table 11-1.

All conformance test results will be reviewed by the Geosynthetic QAC before installation of the GCL. Any nonconformance of the material's physical properties will be promptly reported to the Project Manager. The following procedure will apply whenever a GCL sample fails a conformance test conducted by the Geosynthetic QAL:

- The Owner or GCL Supplier will be required to replace all of the rolls of GCL within the batch from which the sample that is not in conformance with the specifications was obtained.
- Alternatively, if the Geosynthetic Installer, GCL manufacturer and the Project Manager all agree, the Geosynthetic QAC will obtain additional conformance samples from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the conformance tests specified above. If either of these samples fails to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics QAL. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of GCL on site and a sample from every roll that is subsequently delivered from the same GCL manufacturer must be conformance tested by the Geosynthetics QAL.

During conformance testing, the Geosynthetic QAC will also verify that the GCL manufacturer has identified all rolls of GCL with the following information:

- name of Manufacturer;
- product identification;
- lot number;
- batch number;
- roll number; and
- roll dimensions.

The Geosynthetic QAC will record all of the above information for each roll delivered to the site using a Material Inventory Log form for the GCL.

11.4 Field Evaluation/Monitoring of Construction Techniques

During unloading and storage, the Contractor and/or the Geosynthetics Installer will be required to keep the GCL off the ground and protect the GCL from direct sunlight, precipitation or other inundation, excessive heat or cold, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. To that effect, the Specifications require that the GCL rolls be shipped and stored in opaque and watertight wrappings.

The Geosynthetic QAC will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Project Manager. Any damaged rolls will be rejected by the Geosynthetic QAC and the Project Manager, and required to be repaired or replaced by the Owner or GCL Supplier.

The Geosynthetic Installer will be required to handle and deploy all GCL in such a manner as to ensure the GCL is not damaged. Prior to GCL deployment directly on silt-clay, the Geosynthetic QAC will observe the area, and will confirm that the soil subgrade surface has been fully approved by the Soil QAC. During installation, the Geosynthetic QAC will verify compliance with the following:

- immediately prior to GCL placement, the underlying silt-clay subgrade, geotextile, or geocomposite surface is free of moisture or obstructions that could potentially damage the GCL;
- the GCL is installed with the correct orientation (i.e., with the correct side up);
- efforts are made to keep the GCL placed to minimize the presence of wrinkles in the GCL, and if necessary, the GCL is positioned by hand after being unrolled to minimize wrinkles;
- excessive amounts of bentonite do not ravel out along the edges of the GCL;
- care is taken by the Geosynthetic Installer not to entrap stones, soil, dust, or moisture that could damage the GCL;
- in the presence of wind, the GCL is weighted with sandbags (or equivalent ballast weight approved by the Geosynthetic QAC), and that sandbags remain until replaced with the overlying geomembrane;
- a visual examination of the GCL is carried out over the entire surface, after installation, to verify that no potentially harmful foreign objects, such as needles or tools, are present;
- prior to geomembrane deployment, the Geosynthetic QAC grants approval for the GCL to be covered;
- no more GCL is deployed during each day than can be covered by the end of the day with seamed geomembrane; and
- the GCL is not left exposed for longer than the maximum allowable period (as set forth in the Specifications) after placement unless a longer exposure period is approved by the Designer.

The Geosynthetic QAC will verify that the GCL panels are overlapped and that seams are recommended by the GCL manufacturer and as required in the Specifications. The Geosynthetic QAC will also confirm that the Designer is made aware of any end-to-end GCL seams on slopes, and that any special overlapping or connecting methods required by the Designer are implemented by the Geosynthetic Installer.

The Geosynthetic QAC will verify that the Geosynthetics Installer places the geomembrane on top of the GCL such that:

- the GCL and underlying materials are not damaged;
- wrinkles are minimized;
- excess tensile stresses are not produced in the GCL; and
- the geomembrane extends at least 2 ft beyond the underlying GCL, and the leading edge of the geomembrane has adequately ballast to avoid wind uplift and reduce the likelihood of surface water running under the geomembrane and hydrating the GCL.

The Geosynthetic QAC will confirm that cover soils are placed over the geosynthetics within the maximum allowable period (as set forth in the Specifications) after deployment to provided confining pressure and reduce potential for unconfined swelling and/or lateral movement of the GCL unless a longer period is approved by the Designer.

11.5 Deficiencies, Problems, and Repairs

The Geosynthetic QAC will report to the Geosynthetic Installer any unresolved deficiencies in the underlying soil or geosynthetic subgrade surface prior to GCL placement, and will not approve of GCL deployment until the deficiencies are resolved to the satisfaction of the Geosynthetic QAC and in accordance with the Specifications.

The Geosynthetic QAC will verify that any holes or tears in the GCL are repaired in accordance with the Specifications, and that care is taken by the Contractor and/or Geosynthetic Installer to remove any soil or other material, which may have penetrated the torn GCL.

The Geosynthetic QAC will document deficiencies or noncompliance with the specified requirements and report them to the Geosynthetic Installer. The extent of deficiencies will be evaluated by observations, a review of records, or other means deemed appropriate by the Geosynthetic QAC.

The Geosynthetic Installer will correct the deficiency to the satisfaction of the Geosynthetic QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Geosynthetic QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the Geosynthetic QAC must verify that the deficiency has been corrected before any additional work is performed by the Geosynthetics Installer in the area of the deficiency.

TABLE 11-1

MATERIAL CONFORMANCE TESTING REQUIREMENTS FOR GEOSYNTHETIC CLAY LINER (GCL)

TEST	METHOD	MINIMUM FREQUENCY OF TESTING(1)
Mass per Unit Area	ASTM D5993	1 per 100,000 ft^2
Thickness	ASTM D5199	1 per 100,000 ft^2
Grab Strength	ASTM D4632	1 per 100,000 ft^2
Puncture Resistance	ASTM D4833	1 per 100,000 ft^2
Peel	ASTM D6496	1 per 100,000 ft^2
Index Flux	ASTM D5887	1 per 250,000 ft^2

Notes:

1. Testing shall be performed at a frequency of one per lot or at the listed frequency, whichever is greater. A lot shall be as defined by ASTM D 4354, unless defined otherwise by the Geosynthetic QAC.

12. SITE PIPING

12.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to installation of site (storm-water drainage) piping. Items in this section include reinforced concrete pipe (RCP), polyethylene (PE) drain pipe, flexible PE underdrain pipe, and product-specific pipe (such as ADS pipe products). Also included to some degree in the section are related materials such as pipe fittings, pipe bedding, and trench backfill. The following CQA activities are discussed in this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

12.2 Pre-Construction Qualifying of Material Sources

12.2.1 Drainage Pipe

Prior to shipment of the pipe and fittings, the Contractor or Pipe Supplier will be required to provide the Soil QAC with the quality control information and certifications from the pipe manufacturer as set forth in Section 02560 of the Specifications.

The Soil QAC will examine all of the pipe manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the project specifications, and that proper and complete documentation has been provided by the Contractor for all drainage pipe, fittings, and other pipe-accessories used at the site. The Soil QAC will report any deviations from the above requirements to the Project Manager prior to approving installation of the pipe.

The Soil QAC will verify that the following information is printed at frequent intervals on, or otherwise clearly provided for the drainage pipe used on the project:

- name and/or trademark of the pipe Manufacturer;
- nominal pipe size;
- manufacturing standard reference (e.g., AASHTO M170, ASTM F405, etc.); and
- a production code from which the date and place of manufacture can be determined.

If, during pre-construction qualifying, any of the piping fails to meet the Specifications, the Soil QAC will notify the Project Manager. Use of the material will not be allowed until the material is prequalified by further tests or otherwise accepted by the Designer.

12.2.2 Crushed Stone

Prior to pipe installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the ¾-Inch Crushed Stone to be used for pipe bedding (e.g., sedimentation basin underdrain, or if RCP is used) meets the requirements of the Specifications. Instructions for this are provided in Section 7.2 of this QAM.

12.2.3 Granular Fill

Prior to pipe installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the Granular Fill to be used for pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 7.2 of this QAM.

12.2.4 Geotextile

Prior to pipe installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the geotextile(s) to be used around the crushed stone pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 9.2 of this QAM.

12.2.5 Trench Backfill

Prior to pipe installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the trench backfill material(s) to be placed over the site drainage pipe meets the requirements of the Specifications. Instructions for this are provided in Section 7.2 of this QAM.

12.3 Material Conformance Testing

12.3.1 Drainage Pipe

CQA conformance testing of the pipe and fittings will not be required unless requested by the Designer. If deemed necessary by the Designer, the test requirements will be determined at that time by the Designer.

12.3.2 Crushed Stone

Prior to pipe installation, the Soil QAC will verify that the conformance test results for the ¾-Inch Crushed Stone to be used for pipe bedding (e.g., sedimentation basin underdrain, or if RCP is used) meets the requirements of the Specifications. Instructions for this are provided in Section 7.3 of this QAM.

12.3.3 Granular Fill

Prior to pipe installation, the Soil QAC will verify that the conformance test results for the Granular Fill to be used for pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 7.3 of this QAM.

12.3.4 Geotextile

Prior to pipe installation, the Soil QAC will verify that conformance test results for the geotextile(s) to be used around the crushed stone pipe bedding meets the requirements of the Specifications. Instructions for this are provided in Section 9.3 of this QAM.

12.3.5 Trench Backfill

Prior to pipe installation, the Soil QAC will verify that conformance test results for the trench backfill material(s) to be placed over the drainage pipe meets the requirements of the Specifications. Instructions for this are provided in Section 7.3 of this QAM.

12.4 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will verify that the pipe and fittings are stored on clean level ground, free of conditions, which could damage the pipe. Where necessary, due to muddy or sloping ground conditions, the pipe will be required to be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

During construction, the Soil QAC will verify compliance with the following:

- handling of the pipe is conducted in such a manner that the pipe is not damaged;
- ropes, fabric, or rubber-protected slings and straps are used when handling the pipe;
- pipe or fittings are not dropped onto rocky or unprepared ground or into trenches or dragged over sharp objects;
- the subgrade surface is firm and free of debris;
- crushed stone (pipe bedding material) is placed in accordance with the Drawings and the Specifications;
- pipe segments are not brought into position until preceding lengths have been bedded and secured in their final position;
- the pipe segments are properly joined using the appropriate components as required on the Drawings and Specifications;
- joints are stable and in secure condition prior to and after backfilling;
- where applicable, anti-seep collar(s) are properly installed;
- blocking is not used under pipe unless pre-approved by the Designer; and
- placement of backfill over the pipe is conducted in lifts meeting the requirements of the Specifications, and in a manner that will not damage the pipe.

12.5 Deficiencies, Problems, and Repairs

The Soil QAC will report any deficiencies and noncompliances in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the Soil QAC and Project Manager.

The Contractor will correct the deficiency to the satisfaction of the Soil QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Soil QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the Soil QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

13. MANHOLES AND CATCH BASINS

13.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to installation of storm-water catch basins (CBs) and associated manholes (MHs). Items in this section include pre-cast concrete catch basins, HDPE or pre-cast concrete manholes, and, to some degree, related materials such as fittings, accessories, bedding materials, and backfill. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

13.2 Pre-Construction Qualifying of Material Sources

13.2.1 Manholes and Catch Basins

Prior to construction, the Contractor will provide the Soil QAC with the quality control information and certifications from the MH and CB manufacturers as set forth in Section 02530 of the Specifications.

The Soil QAC will examine all the MH and CB manufacturers' certifications to verify that the property values listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor for all the MHs and CBs used at the site. The Soil QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the MHs or CBs.

13.2.2 Crushed Stone

Prior to MH or CB installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the ¾-Inch Crushed Stone to be used for bedding meets the requirements of the Specifications. Instructions for this are provided in Section 7.2 of this QAM.

13.2.3 Geotextile

Prior to MH or CB installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the geotextile(s) to be used around the crushed stone bedding meets the requirements of the Specifications. Instructions for this are provided in Section 9.2 of this QAM.

13.2.4 Backfill

Prior to MH or CB installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the backfill material(s) to be placed around the MHs and CBs meets the requirements of the Specifications. Instructions for this are provided in Section 7.2 of this QAM.

13.3 Material Conformance Testing

13.3.1 Manholes and Catch Basins

CQA conformance testing of the MHs and CBs will not be required unless requested by the Designer. If deemed necessary by the Designer, the test requirements will be determined at that time by the Designer.

13.3.2 Crushed Stone

Prior to MH or CB installation, the Soil QAC will verify that the conformance test results for the ¾-Inch Crushed Stone to be used for bedding meets the requirements of the Specifications. Instructions for this are provided in Section 7.3 of this QAM.

13.3.3 Geotextile

Prior to MH or CB installation, the Soil QAC will verify that conformance test results for the geotextile(s) to be used around the crushed stone bedding meets the requirements of the Specifications. Instructions for this are provided in Section 9.3 of this QAM.

13.3.4 Backfill

Prior to MH or CB installation, the Soil QAC will verify that conformance test results for the backfill material(s) to be placed around the MHs and CBs meets the requirements of the Specifications. Instructions for this are provided in Section 7.3 of this QAM.

13.4 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will verify that the MHs and CBs are stored on clean level ground, free of conditions, which could damage the structures. Where necessary, due to muddy or sloping ground conditions, the pipe will be required to be stored on wooden sleepers, spaced suitably as not to allow stresses to be produced in the structures at the point of contact with the sleepers.

During construction, the Soil QAC will verify compliance with the following:

- handling of the MHs and CBs is conducted in such a manner that the structures are not damaged;
- ropes, fabric, or rubber-protected slings and straps are used when handling the MHs or CBs;
- MHs or CBs are not dropped onto rocky or unprepared ground or into trenches or dragged over sharp objects;
- the subgrade surface is firm and free of debris;
- crushed stone (bedding material) is placed in accordance with the Drawings and the Specifications;
- MH and CB riser segments are not brought into position until preceding segments have been bedded and secured in their final position;
- the MH or CB segments is properly joined using the appropriate components as required on the Drawings and Specifications;

- joints are stable and in secure condition prior to and after backfilling; and
- placement of backfill around the MH and CB structures is conducted in lifts meeting the requirements of the Specifications, and in a manner that will not damage the structures.

13.5 Deficiencies, Problems, and Repairs

The Soil QAC will report any deficiencies and noncompliances in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the Soil QAC and Project Manager.

The Contractor will correct the deficiency to the satisfaction of the Soil QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Soil QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the Soil QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

14. HDPE PIPING

14.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to installation of high density polyethylene (HDPE) piping for the leachate collection system (LCS) headers, for leachate transfer piping outside of the landfill units, and leachate recirculation system piping. Items in this section include the HDPE pipe and, to some degree, associated materials such as crushed stone, geotextile, pipe bedding, and trench backfill. The following CQA activities are discussed in this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques;
- Field Testing of Work Products; and
- Deficiencies, Problems, and Repairs.

14.2 Pre-construction Qualifying of Material Sources

14.2.1 HDPE Pipe

The LCS will include 8-in. diameter perforated and solid-wall HDPE collection pipes. The HDPE leachate transfer piping outside of the landfill unit will consist of dual-containment (double-wall) gravity pipe or forcemain. The inside "carrier pipe" will be 8-inch diameter solid-wall HDPE, and the outside "secondary containment pipe" will be 14-inch solid-wall HDPE.

The pipes must be prequalified as described below. Prior to the shipment of the HDPE pipes and fittings the Contractor will be required to provide the Soil QAC with the quality control information and certifications from the pipe manufacturer as set forth in Section 02780 of the Specifications.

The Soil QAC will examine all of the HDPE pipe manufacturer's certifications to verify that the property values listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor for all HDPE pipe, fittings, and pipe-accessories used at the site. The Soil QAC will report any deviations from the above requirements to the Contractor prior to approving installation of the pipe.

The Soil QAC will verify that the following information is printed at frequent intervals on, or otherwise clearly provided for the HDPE pipe used on the project:

- name and/or trademark of the pipe Manufacturer;
- nominal pipe size, wall thickness, and SDR;
- manufacturing standard reference (e.g., ASTM D 2513); and
- a production code from which the date and place of manufacture can be determined.

If, during pre-construction qualifying, any of the HDPE piping fails to meet the Specifications, the Soil QAC will notify the Contractor. Use of the material will not be allowed until the material is prequalified by further tests or otherwise accepted by the Designer.

14.2.2 Crushed Stone

Prior to pipe installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the 1½-Inch Crushed Stone to be used around the LCS collection headers and riser pipes, in the sump and around the perforated HDPE leachate distribution pipes meets the requirements of the Specifications. Instructions for this are provided in Section 7.2 of this QAM.

14.2.3 Granular Fill

Prior to pipe installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the Granular Fill to be used for HDPE pipe bedding (e.g., leachate transfer gravity or forcemain, leachate recirculation riser and header piping) meets the requirements of the Specifications. Instructions for this are provided in Section 7.2 of this QAM.

14.2.4 Geotextile

Prior to pipe installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the geotextile(s) to be used around the crushed stone for the LCS collection headers, in the LCS sump, and above the leachate recirculation trench for separation between waste and trench bedding material meets the requirements of the Specifications. Instructions for this are provided in Section 9.2 of this QAM.

14.2.5 Trench Backfill

Prior to pipe installation, the Soil QAC will verify that pre-qualifying test results submitted by the Contractor for the trench backfill material(s) to be placed over the HDPE leachate transfer pipe meets the requirements of the Specifications. Instructions for this are provided in Section 7.2 of this QAM.

14.3 Material Conformance Testing

14.3.1 HDPE Pipes

Material conformance testing of the HDPE pipes will not be required unless aspects of the pre-qualifying information are deficient or suspect, or if requested by the Designer. If deemed necessary by the Designer, the Soil QAC will remove a minimum 3-ft (1-m) section of pipe and deliver it to the Geosynthetics QAL for testing to evaluate whether the pipe meets the required properties of the Specifications. The conformance test requirements will be determined at that time by the Designer.

14.3.2 Crushed Stone

Prior to pipe installation, the Soil QAC will verify that the conformance test results for the 1½-Inch Crushed Stone to be used around the LCS collection headers and perforated leachate distribution pipes meets the requirements of the Specifications. Instructions for this are provided in Section 7.3 of this QAM.

14.3.3 Granular Fill

Prior to pipe installation, the Soil QAC will verify that the conformance test results for the Granular Fill to be used for HDPE pipe bedding (e.g., leachate transfer gravity or forcemain piping and leachate recirculation header and riser) meets the requirements of the Specifications. Instructions for this are provided in Section 7.3 of this QAM.

14.3.4 Geotextile

Prior to pipe installation, the Soil QAC will verify that conformance test results for the geotextile(s) to be used above the leachate recirculation trench for separation between waste and trench bedding material, around the crushed stone for the LCS collection headers, and in the LCS sump meets the requirements of the Specifications. Instructions for this are provided in Section 9.3 of this QAM.

14.3.5 Trench Backfill

Prior to pipe installation, the Soil QAC will verify that conformance test results for the trench backfill material(s) to be placed over the HDPE leachate transfer pipe meets the requirements of the Specifications. Instructions for this are provided in Section 7.3 of this QAM.

14.4 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will verify that the pipe and fittings are stored on clean level ground, free of conditions which could damage the pipe; and where necessary (e.g., due to muddy or sloping ground conditions) the pipe is stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

During construction, the Soil QAC will verify compliance with the following:

- the perforated pipe has the proper amount and spacing of perforations, and that the perforations are oriented properly after the pipe is installed;
- handling of the pipe is conducted in such a manner that the pipe is not damaged;
- ropes, fabric, or rubber-protected slings and straps are used when handling pipe;
- pipe or fittings are not dropped onto rocky or unprepared ground or into trenches or dragged over sharp objects;
- the subgrade surface is firm and free of debris;
- crushed stone for the LCS and leachate recirculation system is carefully placed under and around the pipe in accordance with the Drawings and the Specifications;
- pipe segments are not brought into position until preceding lengths have been bedded and secured in its final position;
- pipe sections are properly joined using procedures recommended by the Manufacturer and/or allowed for in the Specifications;
- joints are stable and in secure condition prior to and after backfilling;
- blocking is not used under pipe unless pre-approved by the Designer; and
- placement of backfill over the pipe is conducted in lifts meeting the requirements of the Specifications, and in a manner that will not damage the pipe.

14.5 Deficiencies, Problems, and Repairs

The Soil QAC will report any deficiencies or noncompliance in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the Soil QAC and Project Manager.

The Contractor will correct the deficiency to the satisfaction of the Soil QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Soil QAC will develop and present to Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the Soil QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

15. TOPSOIL AND SEEDING

15.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to establishing permanent vegetation in the designated areas. Items in this section include topsoil, fertilizer, seed, mulch, erosion control mat, and related materials such as lime, and soil binders. The following CQA activities are discussed in the remainder of this section:

- Pre-Construction Qualifying of Material Sources;
- Material Conformance Testing;
- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

15.2 Pre-Construction Qualifying of Material Sources

Prior to construction, the Contractor or Owner (i.e., the Topsoil Supplier) will provide the Soil QAC with the quality control information and certifications for the topsoil, fertilizer, lime, grass seed, cellulose fiber mulch (if hydroseeding method will be used), hay or straw mulch, soil binder (if used), and erosion control mat and mulch-anchoring net, as set forth in Section 02800 of the Specifications. For the materials that do not have quantitative property requirements, the Contractor must submit written certification from the supplier(s) that the material(s) meet the qualitative descriptions set forth in the Specifications.

The Soil QAC will examine all the suppliers' certifications to verify that the properties listed on the certifications meet or exceed the Specifications, and that proper and complete documentation has been provided by the Contractor or supplier for the materials used at the site. The Soil QAC will report any deviations from the above requirements to the Contractor and/or Project Manager prior to approving installation of any given material.

15.3 Material Conformance Testing

CQA conformance testing of the topsoil, seed, or related materials will not be required unless requested by the Designer. If deemed necessary by the Designer, the conformance test requirements will be determined at that time by the Designer.

The Soil QAC will observe the materials as they are delivered to the site, and review labels and product documentation to ensure that the material documentation is consistent with the pre-qualifying documentation previously submitted by the Contractor.

15.4 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will verify that the topsoil, as it is stockpiled or delivered to the site appears to be consistent with the requirements set forth in the Specifications, and that the oversized pieces and deleterious materials are removed and stockpiled. If screening operations are used by the Contractor, the Soil QAC will verify that the screen sizes are sufficient to remove oversized particles and deleterious materials.

During construction, the Soil QAC will verify compliance with Part 3 of Specification Section 02800, including the following:

- the subgrade area to receive topsoil has been raked or otherwise loosened, and surficial debris has been removed;
- the specified minimum thickness of the topsoil is achieved after being placed and rolled; thickness measurements will be performed by the Soil QAC by excavating or hand-augering shallow test holes at a frequency of at least 2 measurements per acre;
- lime, fertilizer, seed, and mulch are applied at the rates set forth in Article 3.01, and in the order set forth in Article 3.02 of Specification Section 02800; and
- soil binder (tackifier) and mulch-anchoring netting are installed in areas steeper than 15% where hay or straw mulch is used.

The Soil QAC or Project Manager will observe the areas seeded after 8 weeks to assess provisional acceptance of the work. Provisional acceptance shall be as defined in Article 3.03 of Specification Section 02800. The Soil QAC or Project Manager will observe the areas seeded after the 1-year guarantee period to assess final acceptance of the work.

15.5 Deficiencies, Problems, and Repairs

The Soil QAC will report any deficiencies and noncompliances in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the Soil QAC and Project Manager.

The Contractor will correct the deficiency to the satisfaction of the Soil QAC. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the Soil QAC will develop and present to the Designer and Project Manager suggested alternative solutions for approval. All retests or subsequent re-evaluations recommended by the Soil QAC must verify that the deficiency has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

16. CLEANUP AND SITE RESTORATION

16.1 Overview

This section of the QAM addresses the CQA program to be implemented with regard to cleanup and site restoration. The following CQA activities are discussed in the remainder of this section:

- Field Evaluation/Monitoring of Construction Techniques; and
- Deficiencies, Problems, and Repairs.

16.2 Field Evaluation/Monitoring of Construction Techniques

The Soil QAC will observe the Contractor's work activities and will verify that, during construction, the Contractor keeps the site in as clean and neat a condition as possible. This includes the project area, haul roads, borrow areas, and the entrance area to the Crossroads facility.

The Soil QAC will verify that stockpiles are located as shown on the Drawings or as approved by the Project Manager, and that the Contractor regularly removes and disposes of refuse resulting from the construction activities.

16.3 Deficiencies, Problems, and Repairs

The Soil QAC will report any deficiencies and noncompliances in the construction to the Contractor. The extent of deficiencies will be evaluated by observations, review of records, or other means deemed appropriate by the Soil QAC and Project Manager. The Contractor will correct the deficiency to the satisfaction of the Soil QAC, or as directed by the Project Manager.

17. DOCUMENTATION AND CQA FINAL REPORT

17.1 Introduction

An effective CQA plan consists of implementing the activities set forth in this QAM, and providing documentation assuring the Owner that the construction was performed in accordance with the Drawings and Specifications.

CQA personnel (i.e., the Soil QAC or Geosynthetic QAC, as applicable) will provide the Owner with signed descriptive remarks, data sheets, and logs to verify that the CQA activities have been carried out. CQA personnel will maintain at the site a complete file of the project Drawings, Specifications, and QAM, as well as daily reports, testing logs, and other pertinent forms and documents. Blank forms to be used for CQA documentation will be prepared prior to construction and kept electronically by the CQA personnel and/or in a file at the site so that they may be readily printed or photocopied as needed during the project.

17.2 Daily Recordkeeping

17.2.1 Overview

Daily records will be completed in the field, documenting the Contractor's and/or Geosynthetic Installer's activities, as well as CQA activities. The forms to be completed that pertain to each of these categories of records are discussed below. The discussion includes the person(s) responsible for completing each form, and form submittal timeframes.

17.2.2 Project Administration Records

Most project administration records are completed daily by select CQA personnel and submitted weekly to the CQA Site Manager and/or CQA Engineer-of-Record. These forms are briefly described below.

Daily Field Report

The Daily Field Report (DFR)will be prepared by select CQA personnel. The Daily Field Report will summarize the Contractor's (or Geosynthetic Installer's) activities conducted that day as well as the CQA activities performed. Other information should include the following:

- date, project name, location, and other identification;
- a narrative of the events and activities, including meetings and observations which occurred during a given day;
- weather conditions;
- names of personnel participating in important discussions;
- relevant subject matters or issues;
- activities planned and performed;
- constraints or suggestions;
- scheduling information; and
- the signature of the CQA personnel who authored the report.

Daily Weather Log

Ambient temperatures, precipitation, and general weather conditions will be recorded on the DFR by CQA personnel. Additional ambient temperatures, precipitation, and general weather conditions may be provided at various times during the day during geomembrane deployment and seaming.

Personnel Log

The Personnel Log will be used by CQA personnel to document dates when key personnel are on-site. This log will provide a summary of on-site involvement of personnel for the Contractor, Geosynthetic Installer, CQA Surveyor and CQA personnel during the project. It is not intended as an absolute log to record the exact times when each individual is at the site; rather it is to summarize when key individuals (supervisors, foremen, managers, directors, etc.) work or visit the site. This log will be included in the DFR and will be issued as part of the Final Report.

17.2.3 Soils CQA Records

Records kept for all aspects of the construction except the geosynthetic liner components will be completed by the Soil QAC. The information will be recorded as testing is done in the field or as results are received from the Soil QAL. The records will be available for review on site, and copies will be issued as part of the Final Report. The relevant forms that will be needed during the project are listed below:

- Soil Sample Log;
- Laboratory Test Summary Log; and
- Summary of Field Density Test.

17.2.4 Geosynthetic Field CQA Records

Records kept for geosynthetic-related activities (e.g., GCL, geomembrane, drainage geocomposite/geonet, geotextile) will be kept by the Geosynthetic QAC. The information will be recorded as shipments are received; testing is done in the field, or as results are received from the laboratory. The records will be available for review on site, and copies will be issued as part of the Final Report. The relevant forms that will be needed during the project are listed below:

- Material Inventory Logs;
- Geosynthetic Installer's Subgrade Acceptance Certifications;
- Panel Placement Logs;
- Trial Seam Logs;
- Production Seam Logs;
- Nondestructive Test Logs;
- Destructive Test Logs;
- Repair Summary Logs; and
- Seam and Panel Repair Locations Logs.

17.3 Survey Records

CQA personnel will be responsible for receiving, reviewing, and record keeping of survey information from: (i) the Contractor's as-built documentation, and (ii) the CQA Surveyor's documentation. Interim submittals will be reviewed by the CQA personnel as described in Section 2 of the QAM, and copies of edits and comments will be kept on file during construction.

The CQA Surveyors Record Drawings will be included in the Final Report. The Record Drawings will include:

- Plan sheets depicting the key layers of the liner or final cover system;
- Panel layout drawing(s) showing the locations of geomembrane seams, destructive-test samples, and major repairs; and
- Detail sheets showing the configuration of the details of construction, clearly indicating any modifications that were made from the Drawings issued before construction as part of the Contract Documents.

The Contractor's As-Built Drawings will be kept on file, and will be included as an appendix to the Final Report only to the extent required to bring additional clarity or information to the Record Drawings.

17.4 Photographic Documentation

CQA personnel will be responsible for photographing the construction progress on a frequent basis. Photographic documentation will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will be stored electronically in chronological order. These photographs will be available for review at any time by the Project Manager or Designer and other parties upon the request of the Project Manager. Selected photographs will be reproduced as part of the Final Report and will be included in the DFR.

17.5 Clarifications/Changes to Drawings, Specifications, or QAM

Clarifications and minor changes to the Drawings, Specifications, and/or QAM may be necessary during construction. In such cases, the CQA personnel will notify the Project Manager, who will in turn notify the Designer, and if necessary, the appropriate regulatory personnel. In most cases, the CQA personnel will be required to submit written information describing the proposed change and rationale for the request. This is typically administered using a Request for Clarification (RFC) or a Request for Information (RFI) form. The Project Manager will submit back to the CQA personnel all correspondence to and from the Designer (and, when necessary, regulatory personnel) regarding each RFC or RFI, providing the requested clarifying information, and/or indicating acceptance or rejection of proposed changes.

A log of all RFCs and RFIs will be kept by the CQA personnel, and copies will be kept on file at the site. Copies of all RFCs and RFIs will be included as an appendix to the Final Report, and will be incorporated into the Record Drawings as described in Section 17.7 of the QAM.

17.6 Weekly Field Summaries/Weekly Meeting Minutes

At the end of each week during construction or after the weekly progress meeting, the CQA Site Manager will prepare a Weekly Field Summary report/Weekly Meeting Minutes (report). The report will briefly describe the Contractor and/or Geosynthetic Installer's progress during the week and will summarize planned activities for the upcoming two weeks. Field sketches will be prepared for review prior to the weekly progress meeting to provide a visible illustration of progress in the major work areas. The report will include a summary of CQA conformance testing for the materials used during each week, and a summary of the field testing and relevant work products for each week. The report will also include a section designated to activities and monitoring of site erosion and sediment controls. The report will also address: submittals and actions taken, punch list items (as applicable), significant problems and how they were resolved, change order (i.e., RFC/RFI) status, and construction stability monitoring results (if applicable). Daily Field Reports can be attached to the report if requested by MEDEP personnel.

17.7 CQA Final Report

Upon completion of the work, the Soil QAC will submit a CQA Final Report to the Project Manager. This report will certify that the work has been performed in compliance with the Drawings, Specifications, and the QAM except as amended via the RFCs/RFIs, and that the summary document provides the necessary supporting information. The Geosynthetic QAC's documentation will either be integrated into the Final Report, or will be included as stand-alone report in an appendix to the Final Report.

At a minimum, the CQA Final Report will include: (a) an overview of the construction work; (b) the parties involved with the project; (c) weekly field summaries of the construction activities and meeting minutes; (d) observation logs; (e) tabulations of all testing results; (f) a tabulation of changes (RFIs) to the Drawings, Specifications, or QAM; (g) photographic documentation; (h) subgrade acceptance forms; (i) manufacturer's quality control certificates; (j) the Record

Drawings; and (g) a summary statement sealed and signed by a Professional Engineer registered in the State of Maine (i.e., the CQA Engineer-of-Record) that the facility was constructed in accordance with the Drawings, Specifications, and QAM, as amended by any RFIs.

17.8 Storage of Records

All reports and records will be stored by CQA personnel using standard electronic and/or hard-copy filing methods, which will allow for easy access to CQA personnel and the Project Manager.

APPENDIX VI(c)

Technical Specifications – Cell Construction

LANDFILL CELL CONSTRUCTION
WMDSM – CROSSROADS LANDFILL NORRIDGEWOCK, MAINE
TECHNICAL SPECIFICATIONS
TABLE OF CONTENTS

NOTES:

1. The earthwork specification has been modified to include a maximum allowable hydraulic conductivity of $1\text{x}10^{-5}$ cm/sec for silty clay used to backfill under the liner system.
2. The minimum allowable interface shear strength requirements for the liner system, as established in the veneer stability calculation package, will be incorporated into the project specifications prior to construction of the liner systems.

SECTION 01100

DEFINITION OF TERMS

PART 1 - GENERAL

1.01 SCOPE

A. The scope of this section is to provide definitions of the relevant terms used in these Specifications.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 DOCUMENTS

A. Contract Documents: refers to the entire package of information issued to and used by the Contractor to enter into and perform the Work. The Contract Documents include, but are not necessarily limited to:

1. Drawings
2. Specifications
3. Quality Assurance Manual (QAM)
4. Erosion and Sedimentation Control Plan
5. Contractor Agreement(s)
6. Miscellaneous Information issued to the Contractor during the bidding process
7. Meeting Minutes
8. Addendums, Change Orders, Request for Clarifications and Request for Information

B. Technical Specifications: refers to Division 01 through Division 16 of the Specifications to be used by the Contractor for the work. The term Technical Specifications shall apply equally to the term Specifications.

C. Construction Drawings: refers to the set of drawings to be used by the Contractor for the work. The term Construction Drawings shall apply equally to the terms Drawings, and Plans. Shop Drawings refers to drawings prepared by the Contractor (e.g. Manholes, Pump Stations, Cast-in-Place Concrete, etc.) and submitted to the Design for review/approval. Once approved, the terms Construction Drawing, Drawings, and Plans become inclusive of the Shop Drawings.

D. Quality Assurance Manual (QAM): refers to the document titled *Quality Assurance Manual for the Crossroads Landfill* and referenced in the project Quality Assurance Plan included in these specifications as an appendix, and used by the Quality Assurance Consultant (QAC) to ensure appropriate levels of quality assurance monitoring and testing are achieved during the work. The term Quality Assurance Manual shall apply equally to the term QAM.

E. As-Built Drawings: refers to drawings produced by the Contractor and submitted to the Project Manager, or QAC to check the accuracy of construction layout, layer thicknesses, tolerances, and other aspects of the work.

F. Record Drawings: refers to the drawings produced by the QAC and/or Construction Quality Assurance (CQA) Surveyor in partial fulfillment for certification that the work was completed in accordance with the Contract Documents.

1.04 PARTIES

A. Owner: refers to Waste Management Disposal Services of Maine, Inc. The term Owner shall apply equally to the terms WMDSM, Waste Management, Inc., and Waste Management.

B. Project Manager: refers to the official representative of the Owner for the work. The term Project Manager shall apply equally to the terms Construction Manager, and Owner's Representative. Responsibilities of the Project Manager include, but are not necessarily limited to:

1. Coordinating communications.
2. Chairing meetings and recording minutes.
3. Monitoring schedules.
4. Liaison with Maine Department of Environmental Protection (DEP).
5. Reviewing and/or distributing submittals.
6. Administration of Requests for Information and Field Clarifications.
7. Administration of contracts, change orders, addenda, and pay requisites.

C. Contractor: refers to the firm responsible for performing all aspects of the work, except as designated for the Geosynthetics Installer, or specialty contractors commissioned directly by the Owner. The term Contractor shall apply equally to the terms Earthwork Contractor, and General Contractor. Responsibilities of the Contractor include, but are not necessarily limited to:

1. Supplying all non-geosynthetic materials as set forth in the Contract Documents.
2. Constructing all non-geosynthetic aspects of the work, except as noted in the Contract Documents.
3. Supplying and installing all site piping, including the geotextile filter, crushed stone, and HDPE pipe components of the underdrain system, leachate collection system (LCS), forcemain or gravity leachate transfer piping, and all stormwater drainage piping.

D. Geosynthetic Installer: refers to the firm responsible for installing the geosynthetic components of the liner system. The term Geosynthetic Installer shall apply equally to the term Installer. Responsibilities of the Geosynthetic Installer include, but are not necessarily limited to installing all geosynthetic components of the liner system, except for the geotextile separator below the Underdrain Collection Sand, the geotextile component of the LCS collection piping system; and the geotextile component of surface water management features (riprap lined perimeter swale, plunge pool, etc).

E. Designer: refers to the firm responsible for preparing the design, including the Drawings, Specifications, and QAM, and other select components of the Contract Documents. The term Designer shall apply equally to the term Engineer. Responsibilities of the Designer include, but are not necessarily limited to:

1. Attending meetings as requested by the Project Manager.
2. Addressing all Requests for Information and proposed Field Clarification Requests that arise during the work.
3. Approving in writing any changes to the Drawings, Specifications, or QAM implemented during the work.
4. Providing interpretation of the (intent of the) Drawings and Specifications as needed.

F. Quality Assurance Consultant: refers to the firm responsible for observing, monitoring, and documenting the quality assurance activities for the Contractor's work. The term Quality Assurance Consultant shall apply equally to the term QAC, and as a general term for CQA Technician and CQA Engineer-of-Record. The QAC shall be a firm independent from the Owner, Contractor, Geosynthetics Installer, and manufacturers of materials for this project. Responsibilities of the QAC include, but are not necessarily limited to:

1. Administering requirements set forth in the QAM.
2. Attending meetings as requested by the Project Manager.
3. Preparing the Certification Report and Record Drawings for the work.
4. Certifying construction of the work.
5. Coordinating activities of the Soil Quality Assurance Laboratory (Soil QAL), Geosynthetic QAL, and CQA Surveyor for the work.

G. CQA Surveyor: refers to the firm responsible for verifying the as-built information submitted by the Contractor and providing the QAC with the information required to prepare Record Drawings. The term CQA Surveyor shall apply equally to the term Record Surveyor. Responsibilities of the CQA Surveyor do not include layout of any aspects of the work which are the responsibility of the Contractor.

PART 2 - PRODUCTS

Not Applicable**.**

PART 3 - EXECUTION

Not Applicable.

[END OF SECTION]

SECTION 01160

SURVEY CONTROL

PART 1 - GENERAL

1.01 LINES, GRADES AND LEVELS

A. The Owner will provide a survey base line and/or bench marks for construction purposes, as shown on the Drawings. The Contractor shall safeguard all survey points and bench marks. Should any of these points be disturbed or destroyed, the replacement cost will be borne by the Contractor. The Contractor will be held entirely responsible for rectifying Work improperly constructed and any associated liabilities or costs to the Owner resulting from failure to maintain and protect established survey points and bench marks.

B. The Contractor shall be responsible for the layout of all lines, grades, and levels necessary for the proper construction of the Work called for by the Drawings and Specifications. Survey control shall include, but not be limited to: accomplishing proper cuts and fills, appropriate slopes in drainage swales and pipes, and placing specified layer thicknesses for liner system or cover system materials. Any work deficiencies and any associated liabilities or costs to the Owner caused by improper survey layout, including lost productivity of the QAC, shall be rectified at the Contractor's expense.

C. The Contractor shall employ competent and experienced personnel to provide the surveying functions. These personnel shall be directed by a Maine Licensed Land Surveyor.

D. The Contractor shall provide partially-complete or finalized as-built survey information at any stage of the work to the Project Manager, QAC within 24 hours of being requested. These interim submittals may be in the form of as-built drawings as described in Section 01550 or may be in the form of tabulated coordinates of verified construction control points, as requested by the QAC. This information may be used to verify proper layout and layer thicknesses as the work progresses, to calculate material quantities, and to perform other activities deemed necessary by the Project Manager to check the Contractor's work.

E. The Contractor's surveyor will follow the tolerances consistent with boundary surveys. If, during any stage of the Work, the Contractor's survey work is deemed inaccurate or otherwise unacceptable to the Project Manager, the Owner shall have the authority to provide and direct all survey layout for the Work at the Contractor's expense. Survey units shall be US Survey Feet.

PART 2 - MATERIALS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

[END OF SECTION]

SECTION 01200

PROJECT COORDINATION AND MEETINGS

PART 1 - GENERAL

1.01 PRECONSTRUCTION CONFERENCES

A. The Contractor shall not commence work until a preconstruction conference has been held at which representatives of the Contractor, Designer, QAC, Owner and MEDEP are present (unless waived by Maine DEP). This preconstruction conference will be arranged by the Project Manager and is intended to establish lines of communication between the parties involved. The time and place of the preconstruction conference will be arranged by the Project Manager and all parties will be notified approximately two weeks in advance. Personnel from Maine DEP will be notified at least 7 days in advance of the preconstruction conference.

1.02 PROGRESS MEETINGS

A. The Contractor shall make physical arrangements for progress meetings to be held weekly at a minimum or as requested by the Project Manager. The meetings will be held to review the work progress, to make necessary adjustments to schedules, to discuss submittals, changes, substitutions, and other items affecting the work. The Project Manager will preside at meetings and will be responsible for preparing meeting minutes as deemed appropriate.

B. Attendance at the progress meetings will include the Project Manager, QAC, major subcontractors, and suppliers as appropriate to discuss agenda topics for each meeting. Personnel from Maine DEP will be notified in advance about the progress meeting schedule and will have the option to attend. The Designer will be invited to attend as deemed appropriate by the Project Manager.

1.03 JOB SITE ADMINISTRATION

A. The Contractor shall keep a competent and authorized supervisory representative at each work location during all working hours who shall act as the agent of the Contractor.

B. The Contractor’s supervisory representative shall be a competent, English-speaking superintendent capable of reading and thoroughly understanding the Drawings and Specifications, with full authority to fulfill the Contractor's duties and responsibilities on the job. If in the opinion of the Project Manager the supervisory representative or any of his successors proves incompetent, not conscientious, or not industrious, then the Contractor shall replace him upon written request by the Project Manager.

C. The Contractor shall only employ competent workers on the job. Whenever the Project Manager notifies the Contractor in writing that, in their opinion, any workers on the job, whether employed by the Contractor or any subcontractors, is incompetent, unfaithful, disorderly, or otherwise unsatisfactory, such workers shall be discharged from the contract work and shall not be employed on it, except with the written consent of the Project Manager.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

[END OF SECTION]

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 PROCEDURES

A. The Contractor shall deliver an electronic version of necessary submittals to the Project Manager. Hard copies of submittals shall be provided by the Contractor upon request. Each item shall be transmitted on a form acceptable to the Project Manager. The form shall identify the Project, Contractor, Subcontractor, Major Supplier, pertinent Drawing sheet and detail number, applicable standards (such as ASTM or Federal Specification numbers), and Specification Section and Paragraph numbers, as appropriate. Any and all deviations from the Contract Documents shall be identified.

B. Within 14 days after execution of the Contract and prior to mobilization to the site, the Contractor shall submit to the Project Manager a Proposed Work Plan indicating the methods the Contractor proposes to complete the work. The plan shall include, but not necessarily be limited to, a description of the Contractor's proposed sequence of construction; access to and from borrow areas and the landfill; methods of filling, compaction and moisture control; traffic control at intersections of haul roads and access roads; erosion and sedimentation control; dust control; preparation and restoration of borrow areas; and mulching and hydroseeding. The handling and transporting of asbestos waste shall be presented in a Contingency Asbestos Waste Handling Plan, along with Construction Health and Safety/Contingency Plan, as required by Section 02190 of these specifications.

C. Within 14 days after execution of the Contract the Contractor shall submit a Wick Drain Installation Plan as described in Section 02170 of these specifications.

D. Within 14 days after execution of the Contract Agreement, the Contractor shall submit to the Project Manager an estimated progress schedule indicating the starting and completion dates for the various stages of the work. The Contractor shall submit revised schedules reflecting changes subsequent to the previous submittal with each Application for Payment.

E. The Contractor shall comply with the progress schedule for submittals related to the progress of the Work. Following the Project Manager's review of each submittal, the Contractor shall revise and resubmit the submittal, if required, identifying changes made since the previous submittal.

1.02 CONSTRUCTION PROGRESS SCHEDULES

A. The Contractor shall submit a horizontal bar chart (Gantt chart) with separate bars for each major operation, identifying the first work day of each week. The bar chart shall show the complete sequence of construction activity, identify the work of separate stages, the projected percentage of completion for each item of Work at the time of each Application for Progress Payment, submittal dates for shop drawings, product data, and samples, and product delivery dates, including those furnished by the Owner (if any). The bar chart shall also distinguish between critical-path and noncritical-path activities.

1.03 PRODUCT DATA

A. Contractor shall submit copies of product data sheets as required in the Specifications. The Contractor shall mark each copy of product data sheets to identify applicable products, models, options and other data. The Contractor shall submit the number of copies he requires, plus four copies to the Project Manager.

1.04 MANUFACTURER'S INSTRUCTIONS

A. Where required in individual Specification Sections, the Contractor shall submit the manufacturer's printed instructions for delivery, storage, assembly, installation, adjusting, and finishing, in quantities specified for the product data.

1.05 SAMPLES

A. Prior to installation, the Contractor shall submit samples to illustrate the functional characteristics of the product, as required in these Specifications. The Contractor shall submit the number of samples to the party set forth in the respective Specification Section or as directed by the Project Manager.

1.06 SUBMITTAL SCHEDULE

A. The Contractor shall complete all of the submittal items as required in any section of the Specifications, QAM, or Contract Documents not later than the specified number of calendar days. Associated shipping, work, and use of materials by Contractor shall not begin until the Project Manager's review of each respective submittal is complete, and further resubmission is not required. The Contractor shall plan all the work activities to allow the Project Manager at least seven days to review the submittal after initial delivery. Review of submittals should not cause a delay in the work. Each resubmittal shall be identified with the number of the original submittal followed by consecutive numbers starting with “01” for the first resubmittal, “02” for second, etc.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

[END OF SECTION]

SECTION 01400

QUALITY CONTROL

PART 1 - GENERAL

1.01 GENERAL QUALITY CONTROL

A. The Contractor shall maintain quality control over the suppliers, manufacturers, products, services, site conditions, and workmanship to produce work of specified quality.

B. The Contractor shall comply with industry standards except when more restrictive tolerances on the Drawings, Specifications, or QAM indicate more rigid standards or more precise workmanship are required.

1.02 CONTRACTOR'S OBLIGATIONS

A. The Contractor shall comply with instructions in full detail, including each step in sequence. If instructions conflict with any Contract Document, the Contractor and/or Construction Manager shall submit a Request for Clarification (RFC) to the Designer. If an interpretation of the design is considered, a Request for Information (RFI) will be submitted to the Designer and MEDEP before proceeding.

B. Where required in the Specifications, or as requested by the Designer and/or Project Manager, the Contractor shall submit the manufacturer's certificates verifying that products meet or exceed the specified requirements.

1.03 INSPECTION AND TESTING

A. The Owner will employ and pay for services of a QAC to perform construction quality assurance. These services will be performed in accordance with the requirements of the QAM to establish whether the Work is in accordance with the Drawings and Specifications. Reports of the results of all QAC testing and construction observation shall be maintained on site, be submitted to the Project Manager on request, and shall give observations and results of tests, indicating compliance or non-compliance with specified standards and with the Contract Documents.

B. The Contractor shall cooperate fully with the QAC, and furnish tools, samples of materials, and assistance, as requested by the QAC.

C. The Contractor shall allow the QAC ample time and opportunity for testing materials used in the work. The Contractor and Project Manager shall advise the QAC promptly upon placing orders for materials so that arrangements may be made, if desired, for inspection before shipment from the place of manufacture. The Contractor shall at all times furnish the QAC and his representatives, facilities including labor, and allow proper time for inspecting and testing materials and workmanship. The Contractor must anticipate that possible delays may be caused to the execution of this work due to the necessity of materials being inspected and accepted for use. The Contractor shall furnish, at their own expense, all samples of materials required by the Specifications or QAM.

D. The Work shall, at all times, be subject to the observation of the Project Manager, QAC, and/or Designer. Observation or non-observation by the Project Manager, QAC, and/or Designer shall in no way relieve the Contractor from his contractual obligation to furnish work and material as required, and properly complete the Work in accordance with these Contract Documents. If the Project Manager and/or QAC considers that the Work is not being properly accomplished, they may condemn or reject all or any part of the work and any materials or equipment incorporated in it. If any material, equipment, or work is condemned or rejected, the Contractor shall bear all expenses for removal and proper replacement of such material, equipment or work required to be provided by these Contract Documents. The expense of replacing any work done by others which is adversely affected by removal and proper replacement of improper work done by the Contractor shall be solely borne by the Contractor.

1.04 SUBSTANDARD WORK OR MATERIALS

A. Any defective or substandard work or materials furnished by the Contractor that is discovered before the final acceptance of the work, as established by the Certificate of Substantial Completion, or during the subsequent guarantee period, shall be removed immediately even though it had not been previously noticed and may have even been recommended for payment. Any equipment or materials condemned or rejected shall be tagged as such and shall be immediately removed from the site. Satisfactory work or materials shall be substituted for that rejected.

B. The Designer and/or QAC may order tests on substandard or damaged work, equipment, or materials to determine the required functional capability for possible acceptance, if there is not other reason for rejection. The cost of such tests shall be solely borne by the Contractor and the nature, extent and supervision of the tests will be as determined by the Designer and/or QAC. If the results of the tests indicate that the required functional capability of the work, equipment or material was not impaired, consistent with the final general appearance of same, the work, equipment or materials may be deemed acceptable. If the results of such tests reveal that the required functional capability of the questionable work or materials has been impaired, then such work or materials shall be deemed substandard and shall be replaced. The Contractor may elect to replace the substandard work, or material in lieu of performing the tests.

PART 2 - PRODUCTS

Not Applicable.

PART 3 – EXECUTION

Not Applicable.

[END OF SECTION]

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 CONSTRUCTION FACILITIES

A. The Contractor shall provide and pay for a weather-tight field office equipped with sturdy furniture, drawing rack and drawing display table. Clean space shall be provided for Project meetings, with table and chairs to accommodate six to eight persons. A separate private office with desk, chair, plan table, two-drawer filing cabinet, internet, and telephone will be provided by the Owner for the use of the QAC.

B. The Contractor shall maintain paved site roads, unpaved facility roads, and temporary roads that serve the work areas during construction. The Contractor shall restore all site roads that served work areas to their original condition.

C. The Contractor shall maintain areas outside the limits of work free of mud, dirt, waste materials, debris, and rubbish which are a direct result of work performed by the Contractor.

D. The Contractor shall conduct vehicle maintenance only in an area approved by the Project Manager. The Contractor shall promptly clean-up and notify the Project Manager of any spills or leakage of fluids from construction vehicles or refueling trucks.

E. The Contractor shall stage materials only in areas of the site indicated on the Drawings or pre-approved by the Project Manager.

1.02 TEMPORARY UTILITIES

A. The Owner will provide access to utilities on site including power and telephone service. The Contractor shall be responsible for connection to power and telephone service per applicable codes. The Owner will pay for electricity. The Contractor is responsible for all other utilities.

B. The Contractor shall be responsible to provide water to be used for construction activities such as dust control, hydroseeding, and water which may be necessary to facilitate compaction. This water will be available from on-site sources designated by the Owner.

C. The Contractor shall provide adequate temporary sanitary facilities for use by Contractor and QAC personnel.

1.03 TEMPORARY CONTROLS

A. The Contractor shall maintain excavations free of water, protect the site from puddling or running water, and furnish and install all required temporary erosion control measures to comply fully with the Contract Documents, including Section 02120 of these Specifications, the project Erosion and Sedimentation Control Plan, and the Maine Department of Environmental Protection's requirements.

B. The Contractor shall protect installed work, provide special protection where specified in individual specification sections, and provide temporary and removable protection for installed products.

1.04 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. The Contractor shall remove appropriate temporary above-grade or buried utilities, equipment, facilities, and materials prior to Final Completion inspection. The Contractor shall restore existing and permanent facilities used during construction to original or better condition, unless specifically approved by the Owner.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

[END OF SECTION]

SECTION 01550

PROJECT AS-BUILT DOCUMENTS

PART 1 - GENERAL

1.01 MAINTENANCE OF AS-BUILT DOCUMENTS AND SAMPLES

A. The Contractor shall maintain at the Site for the Owner's permanent records one complete set of As-Built Documents which include a copy of the Drawings, Specifications, Addenda, Change Orders, Owner Field Orders, Shop Drawings, Quality Control Field Reports, Product Data, and Samples. The Drawings are to be used as the basis for all As-Built Drawings by the Contractor.

B. The As-Built Documents shall be stored in the Contractor's field office apart from other field documents used by the Contractor for construction purposes. The Contractor shall maintain the As-Built Documents in clean, dry, legible condition and in good order. The As-Built Documents shall be made available at all times for inspection by the Project Manager, QAC, and Designer.

1.02 MARKING

A. The Contractor shall mark all changes on the As-Built Drawings upon construction of each item of work. The Contractor shall record information concurrently with construction progress and shall not cover any work until the required information has been recorded on the As-Built Drawings.

B. During construction, the Contractor shall submit to the QAC as-built plan sheets, based on the Contractor's survey documentation. The plan sheets shall show the work in progress and shall provide the as-built coordinates and/or elevations for/at all construction layout points shown on the Drawings. The Contractor shall submit interim plan sheets to the QAC whenever requested during construction, within 24 hours of being requested. Generation and submittal of up to 12 interim as-built plan sheets shall be included in the Contractor's price to conduct the work and shall be submitted at no additional cost to the Owner.

C. Contractor shall submit the As-Built Documents including a set of plans marked "As-Built Drawings" to the Project Manager upon substantial completion of the Work. The As-Built Documents shall include a tabulation of all as-built coordinates of and/or elevations at each layout point shown on the Drawings.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

[END OF SECTION]

SECTION 01669

TESTING PIPING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Requirements for hydrostatic and air pressure testing of new piping and structures.
2. Requirements for hydrostatic testing of existing gravity drain and proposed connecting piping as set forth on the Drawings.
3. Other Sections reference this Section for detailed testing requirements.

1.02 QUALITY ASSURANCE

A. Pipe lines shall be pressure tested in presence of the QAC. The Contractor shall provide minimum seven days notice to the QAC before performing test.

B. The Contractor shall provide necessary piping connections between section of line being tested and nearest available source of water or air supply, together with test pressure equipment, meters, pressure gauge, and other equipment, materials, and facilities necessary to make specified tests.

C. The Contractor shall provide bulkheads, flanges, valves, bracing, blocking, or other temporary isolating devices required.

D. The Contractor shall remove temporary isolating devices after tests are complete.

1.03 SUBMITTALS

A. The Contractor shall submit all manufacturer's written procedures for testing to the Project Manager at least ten days prior to initiating test activities. The procedures will provide details of the pressure gauge to be used.

B. The Contractor shall submit test reports for each piping system tested to the Project Manager within 24 hours after conducting the tests.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall implement the following general procedures when conducting pipe pressure tests, unless approved otherwise by the Designer.

1. Testing shall be performed after the pipe has been placed in its final position (e.g., in trenches or in the leachate vaults, etc.), but prior to placing backfill materials. The Contractor is encouraged to perform similar tests prior to placement (e.g., after fusion welding) as a quality control measure. Tests conducted prior to pipe placement, however, will not be regarded by the QAC as final or a substitute for in-place testing.
2. Safety: Pressure test in accordance with all applicable OSHA requirements and provide adequate safety equipment to all personnel and implement appropriate procedures to avoid injury or damage.
3. Cost: The cost of testing procedures including personnel, equipment, and materials shall be responsibility of Contractor.
4. Contractor shall correct and retest leaks or defects at no additional cost to the Owner.
5. Allow a minimum 24 hours drying time for solvent weld joints before performing tests.
6. Remove any valves (including solenoid and check valves in the leachate vaults), flow meters, and instruments from within the test sections, and reconnect pipes with temporary fittings. All pipes shall be flushed with clean water until pipe section to be tested is clean and free of dirt, sand, pipe shavings, Teflon tape, or other foreign material. Allow sufficient time for pipe temperature to equilibrate with ambient temperature.
7. Isolate sections of pipe system having different test pressures.
8. Plug pipe outlets with test plugs, blind flanges or other devices suitable for the test pressure. All segments shall be braced securely to prevent blowouts. Verify test pressures do not exceed any component of the pipe system.
9. Restrain all expansion joints.
10. Pressurizing equipment shall include regulator(s) set to avoid over-pressurizing and damaging otherwise acceptable line.
11. Add water slowly to test section. Purge all trapped air. Vent high spots as needed. Inspect connections and re-tighten or otherwise correct any visible leaks.
12. Remove temporary sectionalizing device after tests are complete.
13. Reinstall valves, flow meters and instruments.

3.02 HYDROSTATIC PRESSURE TEST

A. The Contractor shall perform hydrostatic pressure testing on:

   1. All PVC piping and hoses inside the leachate vaults.
   2. All HDPE forcemain carrier pipes.

B. The Contractor shall implement the following procedure when conducting hydrostatic pressure testing, unless approved otherwise by the Designer.

   1. All testing shall meet the requirements set forth in Article 3.01.A.
   2. Initial Expansion Period: Pressurize test section to required test pressure. Add makeup water as needed to maintain test pressure for a 3-hour period.
   3. Test Period: Reduce pressure 10 psig below pressure during the expansion period. Monitor pressure for 1 additional hour. Record pressure at end of the 1-hour period.
   4. Acceptance:
      a. Test shall be accepted if pressure drop over the 1-hour test period is less than 5 percent of the pressure at the beginning of the test period.
      b. All visible leaks shall be repaired regardless of test results. Section shall be retested if correcting leaks requires disassembly.
   5. If pressure test is not accepted, correct leaks or defects in the pipe, and retest at the cost solely borne by the Contractor.
   6. In no case exceed maximum allowable pressure for any pipeline component, including valves, fittings, and instruments.
   7. Test Pressures:
      a. Leachate vault piping - 80 psig
      b. HDPE forcemain carrier pipes - 40 psig

3.03 LOW PRESSURE AIR TEST

A. The Contractor shall perform a low-pressure air test on all gravity drain carrier pipe, and on gravity drain and forcemain containment pipes.

B. The Contractor shall implement the following procedure when conducting low-pressure air testing, unless approved otherwise by the Designer.

   1. All testing shall meet the requirements set forth in Article 3.01.A.
   2. Set safety valve at 5.0 psig. Test proper operation prior to pressurizing pipe.
   3. Add air to the pipeline until internal pressure is 4.0 psig.
   4. Maintain 4.0 psig in the pipeline for at least 2 minutes to allow air temperature to stabilize. Add or bleed off air as required.
   5. Disconnect air supply. Allow pressure to decrease to 3.5 psig. Close off all air valves.

6. Measure time required for air pressure to drop to 2.5 psig. Compare with test time in the table below.

Pipe Diameter	Test Time (T)		Minimum Distance Between Manholes (L)	K Value
(Inches)	**Minutes**	**Seconds**	**(feet)**	**(sec/foot)**
8	3	46	320	0.704
10	4	43	260	1.10
12	5	40	215	1.58
14	7	5	170	2.16
18	8	30	145	3.56
21	9	55	125	4.85
24	11	20	105	6.34

If the minimum distance between manholes requirement cannot be met, test time in the above table shall be T = KL, where T = time in seconds, L= distance between manholes in feet, K = appropriate value from the above table.

C. Acceptance:

1. The low-pressure air test will be accepted if the measured time is greater than the test time in the above table, for the corresponding pipe diameter.
2. If the test is not accepted, the Contractor shall correct leaks and defects, and re-test at the cost solely borne by the Contractor.

3.04 TEST REPORT

A. The Contractor shall prepare and submit to the Project Manager a test report for each piping system tested within two days after completing all tests and retests. The following information shall be included in test report.

1. Date of test.
2. Description and identification of piping system tested.
3. Type of test performed.
4. Test pressure.
5. Type and location of leaks detected.
6. Corrective action taken to repair leaks.
7. Results of retesting.

[END OF SECTION]

SECTION 01670

SYSTEMS DEMONSTRATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Before Substantial Completion is considered for the entire Work, the Contractor shall demonstrate and/or test specific items of equipment and systems in operation. System start-up shall be performed in accordance with the applicable Operations and Maintenance manuals, and spare parts shall be provided for, but not necessarily limited to the following, if newly installed:

1. Geotechnical Instrumentation.
2. Miscellaneous Electrical Items, including heaters, lights, receptacles, and fans, if any.

B. Coordination: The Contractor shall:

1. Designate a representative of the Contractor to be responsible for start-up of systems. The representative shall coordinate the work with the Project Manager or designated Owner's representative for the leachate logic system.
2. Submit a schedule of systems demonstrations for review by the Project Manager ten days prior to system tests and demonstrations.
3. Notify the Project Manager at least five working days before tests and system operation demonstrations are to begin so arrangements to witness testing and demonstration can be made.
4. Reschedule canceled tests and demonstrations of system operations five working days in advance.

1.02 SUBMITTALS

A. The Contractor shall submit all operation and maintenance (O&M) data to the Project Manager prior to Contract Closeout.

B. The Contractor shall submit the following reports to the Project Manager:

1. Preliminary testing of components and systems.
   a. Prepare and submit a report within five working days of completion of preliminary tests on activities included in preliminary testing of components and systems as required by this Section.

   b. At a minimum, the report shall describe findings of inspections; revisions, modifications or replacement of equipment; calibrations; test results; dates and names of persons involved and observing inspections, testing, and other activities pertaining to start-up of components and systems; and statement regarding operational condition of components and systems.
2. Start-Up of Completed System.

a. Prepare and submit a report within five working days of completion of start-up and demonstration. Report shall describe start-up and operational conditions; names of persons involved and observing operation; and statement regarding system ability to meet operational criteria.

1.03 INSTALLATION AND START-UP

A. Manufacturers Services

1. Where required herein and/or in individual Specification Sections, the Contractor shall make arrangements with each equipment supplier or manufacturer to furnish the services of a factory-trained service engineer who is specifically trained on the type of equipment being furnished.
2. The service engineer shall be for the sole purpose and use of the Project Manager and Designer to assist the Contractor during installation and start-up of all equipment and systems furnished by that supplier or manufacturer. The service engineer shall verify that the equipment has been installed properly and serviced so to be acceptable to the equipment manufacturer and in order that it will provide safe and efficient operation.
3. Should a minimum amount of time be specified for this service, it shall be exclusive of travel time and of correction of defects, testing, and training.

B. Correction of Defects

1. The Contractor shall provide sufficient service to place the equipment or systems into satisfactory operation. All time and materials needed to correct defective equipment shall be provided at no additional cost to the Owner.

C. Preparation for Testing

1. Prior to testing, the Contractor shall require each supplier to certify that the equipment is ready for operation. The Contractor shall then furnish the labor, tools, equipment, power, and clean water necessary to perform the field tests to determine that the supplied equipment including controls and alarms meets hydraulic, electric, mechanical, and performance requirements.

1.04 TRAINING

A. Wherever required herein or in individual Specification Sections, the Contractor shall have each equipment supplier or manufacturer furnish the services of a fully qualified field service engineer to provide operator training to the Owner in the complete operation and maintenance of all equipment furnished by that supplier or manufacturer.

B. The minimum length of time specified for this service shall be exclusive of travel time and shall follow and be exclusive of installation and start-up, correction of defects, and testing. This training will be scheduled by the Contractor in conjunction with and approved by the Project Manager.

C. The items addressed by the training session shall include, but not be limited to, system description, system operation, system disassembly and reassembly, lubrication, routine maintenance, corrective maintenance, use of Operation and Maintenance Manual, system troubleshooting and ordering of spare parts.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 PRELIMINARY TESTING OF SYSTEM COMPONENTS

A. Process, mechanical, instrumentation, and electrical equipment components, including related piping and control systems, shall be subjected to individual inspection and preliminary testing by Contractor and certified by Contractor to be ready for process operations before components and systems are put into systems operation demonstration.

B. Preliminary inspection and tests shall be made to determine if equipment is properly assembled, aligned, adjusted, calibrated, wired, and/or connected. Changes, adjustments or replacements of equipment due to errors or omissions on part of Contractor, or otherwise necessary to comply with requirements of Contract Documents shall be done without additional cost to the Owner.

3.02 START-UP OF COMPLETED SYSTEM

A. General

1. The Contractor is responsible for testing each individual piece of equipment and all combinations of equipment, as they may operate one in conjunction with another. Equipment shall be tested as necessary for proper operation in the presence of the Owner, and at no additional cost to the Owner.
2. The Contractor shall give the Owner five working days notice of scheduled pre-start up and final performance test dates. All testing and related costs and fees shall be borne by the Contractor.

B. Performance Tests

1. Full tests shall be made at each site after all specified equipment has been installed.
2. Instrumentation
   a. Tests on instrumentation equipment furnished shall be conducted. Equipment shall be capable of monitoring, indicating, and/or recording the applicable process variable.
   b. The Contractor shall furnish calibrated meters and necessary instruments, labor, and equipment to make these required tests under the direction of the Owner in order to test the units and determine their efficiency.

3. Equipment to Meet Requirements
   a. It shall be the responsibility of the Contractor to make all the necessary and/or required changes and/or replacements and re-tests to make the units meet the specified operation and efficiency requirements.

3.03 SPARE PARTS

A. Spare parts shall be furnished by the Contractor for all equipment as specified herein or in their applicable Sections. Spare parts shall be individually protected and be packaged in a suitable container for long term storage with the contents therein properly identified for each specification section by the manufacturer. Delivery and storage of spare parts shall be coordinated with the Project Manager.

3.04 SPECIAL TOOLS

A. Any special tools which may be necessary for the adjustment, operation, and maintenance of any equipment shall be furnished by the Contractor with the respective equipment.

3.05 LUBRICATION

A. All equipment specified shall be furnished by the Contractor with all the required lubricants by the applicable manufacturer of that piece of equipment and shall be installed by the Contractor.

B. All equipment shall have a full charge of the proper lubricant at the time of Owner acceptance.

[END OF SECTION]

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 CLOSEOUT PROCEDURES

A. The Contractor shall comply with the procedures in the Standard General Conditions of the Construction Agreement for issuance of the Certificate of Substantial Completion.

B. The Contractor shall submit a written certification that the Contract Documents have been reviewed and that the Work is complete in accordance with the Contract Documents and ready for inspection.

C. The Contractor shall submit a statement of accounting giving the total adjusted Contract Sum, previous payments, and the sum remaining due.

1.02 FINAL CLEANING

A. The Contractor shall perform the final cleanup prior to final site inspection by the Project Manager. Final cleanup shall consist of removal of temporary construction; removal of waste and rubbish resulting from the Contractor’s work or the work of subcontractors/subconsultants managed by the Contractor; removal of surplus materials belonging to the Contractor and/or subcontractors/subconsultants; re-staging of surplus material belonging to the Owner and resulting from Contractor and subcontractor/subconsultant activities; and removal of the Contractor's construction facilities from the Project and from the site. Removal of temporary construction shall include temporary erosion control measures, as approved by the Project Manager. Final cleanup shall also include final grading and seeding of borrow, laydown, and stockpile areas, as called for in the Specifications, Drawings, and/or Maine Best Management Practices (BMPs).

1.03 SYSTEMS START-UP AND DEMONSTRATIONS

A. The Contractor shall perform all system start-up, testing, and training, and deliver all Operations and Maintenance information and spare parts as required by the Specifications prior to final payment application.

1.04 WARRANTIES

A. Prior to the final application for payment, the Contractor shall submit applicable warranty documents from subcontractors, suppliers, and manufacturers. For items of work delayed materially beyond the date of substantial completion, the Contractor shall provide an updated submittal within ten days after acceptance, listing the date of acceptance as the start of the warranty period.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

[END OF SECTION]

SECTION 02100

INSTRUMENTATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. It is of paramount importance on this Site that the Contractor protects all instrumentation from damage. Instrumentation consists of settlement plates, horizontal and vertical slope inclinometers, Shape Acceleration Arrays (SAAs), standpipe and vibrating wire piezometers, instrumentation signal cables, water quality monitoring wells, and/or other devices used to monitor surficial or subsurface properties displacements and pressures at the Site. Due to the nature of the Site and proposed construction, instrumentation may be located within or close to the limits of work. The Contractor shall verify the location and adequately mark and protect all instrumentation within 25 feet beyond the limits of work prior to beginning site work activities. Such protective measures may consist of, but are not limited to, the temporary placement of boulders, barriers, or manhole segments around the installations. Caution markings shall be clearly visible from construction equipment.

B. Should any existing instruments be decommissioned as part of the Contractor’s work. the Contractor shall retain an Owner-designated subconsultant to complete the required work.

1.02 APPLICABLE SECTIONS

A. Section 02120 - Temporary Erosion Control

B. Section 02130 - Clearing, Grubbing, and Stripping

C. Section 02140 - Excavation and Storage of Silt Clay

D. Section 02170 - Wick Drain and Underdrain

E. Section 02200 - Earthwork

F. Section 02240 - Soil Barrier Layer

G. Section 02560 - Stormwater Piping

H. Section 02780 - HDPE Piping

I. Section 02800 - Topsoil Placement and Hydroseeding

1.03 REFERENCE

A. General information regarding the geotechnical instruments is presented on the Drawings.

1.04 JOB CONDITIONS

A. The decommissioning and installation of the geotechnical instrumentation may require access of subconsultant personnel and a drill rig to portions of the landfill and perimeter berm area for extended periods.

1.05 SUBMITTALS

A. Fourteen days prior to the start of site work activities, the Contractor shall submit a plan to the Project Manager for approval by the Designer detailing the methods that will be used to mark and protect instrumentation. The plan shall identify by list and location sketch all instrumentation located within or adjacent to the limits of work. The Contractor shall identify the individual(s) on the Contractor's staff permanently assigned to the job, who is/are competent and may act on behalf of the Contractor, who will coordinate with an instrumentation contractor during any concurrent instrumentation installation and/or monitoring work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall exercise care in performing work adjacent to instrumentation installations. Any disturbance of the instrumentation shall be reported immediately to the Project Manager. Damaged instrumentation shall be replaced or repaired, as directed by the Designer, at the Contractor's expense within one week of the damage occurring. All work shall be stopped within a 50-foot radius of a damaged installation, or as directed by the Designer, until the installation is repaired and accepted by the Designer. The installation shall be repaired by the Contractor or at the Contractor’s expense as coordinated with and approved by the Project Manager. All repair work will be subject to approval by the Designer.

B. The Contractor shall assist the Owner-designated subconsultant as necessary during geotechnical instrument installation-related activities. This may include, but may not be limited to:

1. Allocating time in the project schedule for the installation of certain instruments and signal cable below soil barrier layer subgrade or below perimeter berm embankment fill.

2. Providing a bulldozer or suitable equipment and operator to provide access and prepare work pads for a drill rig.

3. Providing a backhoe and operator to complete shallow trenches for signal cable installation, including backfilling.
4. Providing one or two laborers for short periods of time to assist with signal cable installation.
5. Providing drainage sand bedding and backfill for signal cable trenches, and HDPE risers as required to complete instrument installations.

[END OF SECTION]

SECTION 02120

TEMPORARY EROSION CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Due to the nature of the work and site soils, the Contractor shall implement strict erosion and sedimentation control measures throughout the duration of the work. A preventative approach to sedimentation control shall be implemented by the Contractor in that multiple measures shall be installed and maintained to prevent sedimentation and/or erosion of exposed soils. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all operations necessary to provide, monitor, and maintain erosion control devices to limit erosion, control sedimentation that occurs during construction operations, and contain runoff within the work area. This shall include all stockpile, laydown, and borrow areas. Such controls shall be implemented and maintained throughout the construction until the stabilization of permanent erosion control devices.

B. The Contractor shall implement the project-specific Erosion and Sedimentation Control Plan (ESCP), which is attached to these specifications as an appendix and made part of these Contract Documents by reference.

C. Regardless of any minimum requirements set forth in this section, it is the Contractor's sole responsibility to select, implement, and maintain proper and fully adequate erosion and sediment controls at all times (24 hours a day on all days) throughout the project. Repair of any damage and all restitution for liabilities resulting from improper erosion and sediment control shall be at the Contractor's expense.

1.02 APPLICABLE SECTIONS

A. Section 02130 - Clearing, Grubbing, and Stripping

B. Section 02140 - Excavation and Storage of Silt Clay

C. Section 02190 - Contingency Asbestos Waste Excavation/Relocation

D. Section 02200 - Earthwork

1.03 REFERENCES

A. Project-specific Erosion and Sedimentation Control Plan (ESCP).

B. "Maine Erosion and Sediment Control Best Management Practices (BMPs)" Department of Environmental Protection; hereinafter referred to as the BMPs.

1.04 QUALITY ASSURANCE

A. Work Plan Outline: Prior to the start of construction, the Contractor shall meet with the Project Manager to discuss erosion control requirements as set forth in the project-specific ESCP, and, at the request of the Project Manager, to develop a written work plan that outlines the materials and methods that will be used to implement the ESCP. The Contractor shall complete the work plan outline and submit it to the Project Manager for review and approval at least one week prior to the start of construction. As a minimum, the temporary erosion control structures specified herein and required in accordance with the ESCP shall be installed prior to the start of construction.

1.05 SUBMITTALS

A. Upon request, the Contractor shall provide to the Project Manager copies of BMPs, test results, and/or manufacturer's data to verify that proposed materials and methods are in compliance with these specifications.

PART 2 - PRODUCTS

2.01 MATERIALS.

A. The Contractor shall use the following materials in construction of temporary erosion control devices in accordance with the BMPs; other materials require approval of the Owner, unless specifically allowed per the BMPs.

1. Seed:
   a. Type and use as specified in the Vegetation BMP.
   b. Seed mixture as approved by the Project Manager or Designer.

2. Mulches and Mats:
   a. Type and use as specified in the Mulching BMPs, inclusive of Erosion Control Mix (ECM).
   b. Materials as approved by the Project Manager or Designer.

3. Silt Fence: Woven polypropylene and/or polyester material that meets the following minimum average roll values:

FABRIC PROPERTY	TEST METHOD	FABRIC REQUIREMENT
Grab Tensile Strength (lbs.)	ASTM D4632	100
Burst Strength (psi)	ASTM D3787	175
Apparent Opening Size (U.S. Standard Sieve)	ASTM D4751	30 max.

4. Hay Bales: Rectangular shaped bales of hay weighing at least 40 pounds per bale. Hay bales shall be free of primary noxious weed seeds.

5. Sand Bags: Heavy-duty textile bags of approximately 1 cubic foot capacity filled with sand or gravel.

6. Crushed Stone: Type and use as specified in the Stone Check Dams BMP.

PART 3 - EXECUTION

3.01 TEMPORARY DEVICES

A. The Contractor shall use the following devices to limit erosion and control sedimentation. Other devices may be used in accordance with the BMPs and with the approval of the Project Manager.

1. Silt Fence Barriers: As a minimum, provide as shown on the Drawings. Type and use as specified in the Sediment Barriers BMP.
2. Temporary Check Dams: As a minimum, provide as shown on and in accordance with the Drawings. Type and use as specified in the Temporary Check Dams BMP.
3. Temporary Sumps and Sediment Traps: Type and use as specified in the Sediment Trap BMP. Sediment traps shall pond sediment-laden water until outletted via pumping. Sediment-laden runoff collected in sediment traps shall be pumped to an on-site location designated by the Owner.
4. Temporary Diversions: Provide as needed to prevent clean stormwater from outside the limits of work from entering the work area. Temporary diversions shall not result in erosion or sedimentation, or cause flooding outside the limits of work.
5. Geotextile: Use lightweight fabric (e.g., 6 oz/syd) to provide temporary erosion control.
6. Erosion Control Mix (ECM): Use bark mulch to direct and divert stormwater.

3.02 APPLICATION RATES

A. Seed: As specified in the Temporary Vegetation BMP.

B. Mulches: As specified in the Mulching BMP.

3.03 MAINTENANCE

A. All temporary erosion control measures shall be maintained by the Contractor throughout the course of site construction activities until final acceptance of the site vegetation by the Project Manager.

B. The Contractor shall provide personnel on a round-the-clock (overnight) basis whenever necessary to monitor and maintain all temporary erosion and sediment control devices.

3.04 REMOVAL OF TEMPORARY EROSION CONTROL

A. Temporary materials and devices shall be removed by the Contractor when permanent soil stabilization has been achieved and as approved by the Project Manager. Materials in good condition may be reused on the site if approved by the Project Manager. Materials unsuitable for reuse become the property of the Contractor and shall be disposed of at the Contractor’s expense.

[END OF SECTION]

SECTION 02130

CLEARING, GRUBBING, AND STRIPPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Owner will clear the approximate limits of work prior to construction.

B. The work of this section includes all construction activities related to the following:

1. Clearing, removing, and disposing of all remaining trees, brush, and vegetative cover from within the limits of work as needed to allow construction of the work.
2. Removing and disposing of tree stumps grubbed from within the limits of work.
3. Stripping, screening, hauling, and stockpiling surficial organics (topsoil) from within the limits of work; segregating wetland and upland topsoil if required per other Contract Documents.
4. Stripping of surficial sand or granular fill deposits in designated areas to expose the underlying natural silt clay deposits.
5. Removing and salvaging and/or disposing of temporary geosynthetics, including tarps, and cover soils as needed to allow construction of the work.

1.02 APPLICABLE SECTIONS

A. Section 02100 - Instrumentation

B. Section 02120 - Temporary Erosion Control

C. Section 02140 - Excavation and Storage of Silt Clay

D. Section 02190 - Contingency Asbestos Waste Excavation/Relocation

E. Section 02200 - Earthwork

F. Section 02240 - Soil Barrier Layer

G. Section 02560 - Stormwater Piping

H. Section 02780 - HDPE Piping

I. Section 02800 - Placement of Topsoil and Hydroseeding

1.03 REFERENCE

A. "Maine Erosion and Sediment Control Best Management Practices (BMPs)" Maine Department of Environmental Protection; hereinafter referred to as the BMPs.

1.04 JOB CONDITIONS

A. The project may require the removal of temporary geosynthetics and/or cover soils, trees, brush, stumps, and/or topsoil in preparation of construction of permanent project facilities.

B. The Contractor shall be responsible for the implementation and maintenance of all measures identified in Section 02120 prior to and during execution of the work related to this Section.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials generated as a result of work specified in this section may include:

1. Trees and Brush
2. Stumps
3. Topsoil, Upland and Wetland
4. Surficial Sand
5. Miscellaneous Fill
6. Temporary Geosynthetics/Tarps
7. Cover Soil

PART 3 - EXECUTION

3.01 CLEARING AND GRUBBING

A. General:

1. The areas to be occupied by the permanent construction required under these Specifications and the surface of all the borrow pits, stockpile, and waste pile sites shall be cleared of all trees, stumps, exposed roots, brush, rubbish, debris, and other materials as determined by the QAC or Project Manager. The intent of clearing and grubbing is to remove vegetation while leaving the topsoil.
2. No trees located more than 10 feet (horizontal distance) outside of areas mentioned above shall be cut without specific approval of the Project Manager. All trees designated to remain shall be protected from damage by the Contractor's construction operations.

3. The Contractor shall investigate and determine the limits of clearing required in accordance with this section. No clearing, grubbing, or stripping shall be undertaken prior to approval of the limits of clearing by the Project Manager. The Contractor shall notify the Project Manager at least one day (minimum 24 hours) before activities are scheduled to commence.

B. Disposal:

1. Suitable materials from clearing and grubbing operations including cut timber, down timber, dead timber, branches, stumps, and brush shall be transported to the wood grinding area on site.
2. All other materials resulting from the clearing and grubbing operations shall be transported by the Contractor to the unsuitables stockpile area designated on the Drawings.

3.02 STRIPPING

A. General:

1. The designated areas shall be stripped in accordance with the Specifications that follow.

B. Excavation:

1. Designated areas shall be stripped of surficial materials until suitable subgrade is exposed, in accordance with Section 02200 and as determined by the QAC.
2. Unsuitable materials to be removed by stripping shall include all perishable and other materials that are unsuitable for use in the permanent construction required under these specifications. Unsuitable materials resulting from the stripping operations shall be transported by the Contractor to the unsuitables stockpile area designated on the Drawings.
3. If other Contract Documents require wetland and upland Topsoil to be segregated, the upland topsoil shall be screened as necessary to achieve the requirements set forth in Section 02800. Otherwise, all Topsoil shall be screened as necessary to achieve the requirements set forth in Section 02800.
4. Wetland and upland Topsoil shall be separately stockpiled in the locations designated on the Drawings, or as directed by the Project Manager. The Contractor shall temporarily mulch and seed stockpiles in accordance with Section 02120 and the BMPs. Only straw mulch shall be used on segregated wetland Topsoil.
5. Topsoil removed from the existing Asbestos Landfill cover system shall be stockpiled for future use at stockpile locations designated on Drawings.

C. Excavation Below Stripping:

1. Excavation below stripping where directed by the Project Manager shall be to firm foundation materials as evaluated by the QAC.

D. Excavation of Surficial Sands and/or Granular Fill:

1. In landfill base areas designated for compacted Silt Clay Borrow or liner installation, surficial sands or Granular Fill may be encountered. In areas where the underdrain layer (sand blanket) for wick drains will not be installed, with the exception of the Asbestos Landfill area, the Contractor shall excavate the sands or granular fill to expose silt clay to provide a firm and impervious base for construction, unless specifically directed otherwise by the project drawings, or the Designer.
2. Excavated sands or Granular Fill shall be reused in accordance the Drawings and Specifications or stockpiled by the Contractor in the locations designated on the Drawings or as directed by the Project Manager. The Contractor shall temporarily mulch and seed stockpiles in accordance with Section 02120 and the BMPs.
3. Topsoil removed from the existing Asbestos Landfill cover system shall be stockpiled for future use at stockpile locations designated on Drawings.

E. Removal of Temporary Geosynthetics and/or Cover Soils:

1. Temporary geosynthetics (tarps) and/or cover soils shall be removed by the Contractor from the work area to expose the required subgrade, as directed by the Project Manager.
2. Temporary geosynthetics (tarps) and/or cover soils removed as part of the work shall be salvaged and stored, stockpiled, and/or disposed of by the Contractor as directed by the Project Manager. These materials shall be used as daily cover over exposed waste or as temporary tarps to minimize generation of leachate, as directed/approved by the Project Manager or Owner.
3. The Contractor shall temporarily mulch and seed any resulting stockpiles in accordance with Section 02120 and the BMPs.
4. For stripping activities associated with asbestos waste relocation, the Contractor shall follow all requirements set forth in Specification 02190.

[END OF SECTION]

SECTION 02140

EXCAVATION AND STORAGE OF SILT CLAY

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Silt Clay removed from excavations for the permanent construction required under these specifications is to be re-used as Silt Clay Borrow or Cohesive Common Borrow, provided the material satisfies the specifications set forth in Section 02200. The work associated with this section consists of excavating and transporting Silt Clay from excavations completed as part of this work to stockpile areas or directly to embankment and subgrade construction areas.

1.02 APPLICABLE SECTIONS

A. Section 02100 - Instrumentation

B. Section 02120 - Temporary Erosion Control

C. Section 02130 - Clearing, Grubbing, and Stripping

D. Section 02200 – Earthwork

1.03 REFERENCE

A. "Maine Erosion and Sediment Control Best Management Practices (BMPs)" Maine Department of Environmental Protection; hereinafter referred to as the BMPs.

PART 2 - PRODUCTS

2.01 SILT CLAY

A. Soils to be used on-site as Silt Clay Borrow or Cohesive Common Borrow may include Silt Clay generated from excavations required to achieve the grades shown on the Drawings, provided the material satisfies the requirements of Section 02200.

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to submitting bids, bidders may sample and test borrow materials from excavation areas designated by the Project Manager.

B. The type of equipment and methods used by the Contractor in the excavation of Silt Clay materials to be used as Soil Barrier Layer material shall not result in the mixing of the Silt Clay with other materials.

3.02 PREPARATION

A. Project areas from which Silt Clay is to be obtained shall be cleared, grubbed, and stripped in accordance with Section 02130.

3.03 EXCAVATION AND TRANSPORTATION

A. The Contractor shall, to the extent practicable, transport suitable Silt Clay directly from a borrow excavation to locations requiring compacted Silt Clay Borrow, Soil Barrier Layer material, or Cohesive Common Borrow.

B. Silt Clay having an unacceptable water content or needing to be stockpiled for future use shall be transported to the stockpile areas designated on the Drawings or as directed by the Project Manager.

C. Stockpiled Silt Clay shall be placed in a configuration that promotes shedding of storm water. The surface shall be sealed by tracking with a bulldozer, smooth drum roller, or equivalent equipment approved by the QAC.

D. Silt Clay stockpiles shall be constructed with sideslopes no steeper than 2H:1V and to a height no greater than 30 feet above the surrounding ground.

E. The soil stockpile area shall be constructed with temporary erosion controls in accordance with Section 02120.

3.04 DISPOSAL OF UNSUITABLE MATERIAL

A. Materials deemed unsuitable by the QAC shall be transported by the Contractor to the unsuitables stockpile area designated on the Drawings, or as directed by the Project Manager.

B. Erosion controls shall be implemented around the stockpiles to control erosion, as necessary, in accordance with Section 02120. All stockpile areas shall be graded by the Contractor to drain, covered with topsoil, and seeded in accordance with the BMPs, as directed by the Project Manager.

[END OF SECTION]

SECTION 02170

WICK DRAIN AND UNDERDRAIN

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work of this section includes construction activities related to the following, as applicable:

1. Construction of the underdrain system, including, but not limited to, preparation of subgrade, stone trenches, and underdrain collection sand layer, in accordance with the Drawings and Specifications and in conformity with the limits and grades indicated on the Drawings.
2. Placing Drainage Sand for the underdrain collection sand layer over prepared subgrade in accordance with the Drawings and Specifications and in conformity with the limits and grades indicated on the Drawings.
3. Pre-augering or pre-penetrating by other approved means through the very stiff clay crust, the Asbestos Landfill stability berm, or other layers, as necessary, to aid wick drain installation.
4. Furnishing and installing prefabricated vertical wick drains in accordance with the project Specifications and meeting the spacing and depth requirements set forth on the Drawings.
5. Installing sideslope riser/cleanout piping in accordance with the project Drawings and Specifications and in conformity with the lines and grades indicated on the Drawings.

1.02 APPLICABLE SECTIONS

A. Section 02120 - Temporary Erosion Control

B. Section 02130 - Clearing, Grubbing, and Stripping

C. Section 02200 - Earthwork

D. Section 02510 - Geotextiles

E. Section 02780 - HDPE Piping

1.03 REFERENCES

A. ASTM D4716 - Standard Test Method for Determining the (In-plane) Flow rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic using a Constant Head

B. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile

1.04 CONSTRUCTION SEQUENCE / JOB CONDITIONS

A. The Contractor and any Subcontractors shall be aware of the general construction sequence described below and shall adhere to this general sequence unless otherwise approved by the Designer and QAC.

B. Subgrade preparation and Common Borrow placement over exterior portion of the Asbestos Landfill may be feasible for stormwater/erosion and sedimentation control purposes. It is noted that the following activities describe the general process by which installation of the underdrain and wick drains is to be accomplished. It is not intended to be a rigid step-by-step procedure; however, substantial deviations from the overall sequence shall be pre-approved by the Designer and QAC.

C. The Contractor shall:

1. Prepare subgrade by cut/fill earthwork grading operations as shown on the Drawings.
2. Install geotextile separator over the prepared subgrade as shown on the Drawings or as required by the Designer or QAC.
3. Install the granular underdrain collection sand layer.
4. Install wick drains on set centers.
5. Install geotextile separator over sand blanket.

It is recognized that many of the activities described above will be performed concurrently in designated sections of the site.

D. The Contractor and Subcontractors shall be aware of the working conditions, which will be encountered during the wick drain and underdrain installation. These conditions may include, but will not be limited to those described below:

1. Each wick drain must be installed to strictly prescribed depths in order to avoid full penetration of the glaciomarine clay layer.
2. The bottom tip of the wick drain must remain at the prescribed depth of installation and shall not be disturbed by the process of withdrawing the mandrel.
3. The granular underdrain collection sand layer shall have a minimum thickness shown on the Drawings. The sand layer shall remain clean of mud and other dirt, debris or materials, which might cause detrimental effects on the transmissivity of the sand layer.
4. The wick drains shall be located so as to avoid all buried and/or previously installed work, such as conveyance pipes, gravel trenches, sumps, and geotechnical instrumentation.

1.05 SUBMITTALS

A. At least one week prior to the pre-construction meeting, the Contractor shall identify a qualified subcontractor and provide descriptions of at least five projects of similar size and/or complexity where the proposed procedures were successfully employed and completed by that subcontractor.

B. At least one week prior to the pre-construction meeting, the Contractor shall submit a detailed construction sequence and schedule for the multiple aspects of underdrain system construction and wick drain installation that clearly demonstrates the Contractor's understanding of the scope of the work, and addresses all potential conflicts within the work scope, and protection of completed work during subsequent work tasks.

C. At least 60 days prior to commencing the construction, the wick drain Subcontractor shall submit a Wick Drain Installation Plan to the Designer. A copy of the plan will be submitted by the Project Manager to the Town of Norridgewock and Maine Department of Environmental Protection (MEDEP) a minimum of 60 days prior to commencing construction. The plan shall include, but not limited to:

1. Paper and AutoCAD-compatible electronic copies of the proposed wick drain layout plan that shows the locations of each wick drain and a means, such as rows and columns, for identifying each wick drain in the field. The electronic copy of the layout plan will be used by the Designer to pre-determine the depth of each wick drain. The plan shall identify which wick drains are proposed to be installed as part of the trial wick drain program (see Paragraph 3.04 of this Section) and the proposed production wick drain installation sequence.
2. Configuration of proposed wick drain installation rig(s) to include size, type, weight, ground pressure exerted by the tracks, maximum pushing force and (vibratory) hammer rated energy (if applicable).
3. Details of the mandrel.
4. Details of drain anchorage.
5. Proposed method for determining the ground elevation at each wick location, then carefully controlling the depth to which each wick is installed.
6. Proposed methods for verifying the plumbness, continuity, and as-built depth of each wick drain.
7. Proposed methods for splicing drains.
8. Proposed methods for overcoming obstructions.
9. Detailed description of the proposed trial installation program, and the installation sequence and methods for production wick drains (see Paragraph 3.04 of this Section).

10. Copies of the installation plan will be forwarded by the Project Manger to the Town of Norridgewock and the MEDEP.

D. At least 30 days prior to installation of wicks, the Contractor shall submit a sample of the proposed wick drain material along with a copy of the manufacturer's cut sheet for the product. Samples shall bear the manufacturer's trade name and be accompanied by the associated manufacturer's literature.

E. The Contractor shall submit manufacturer's certificate(s) demonstrating all wick drain material delivered to the site is in compliance with the requirements set forth in these Specifications. Manufacturer's certificates shall provide sufficient information to track the material delivered to the site.

1.06 QUALITY ASSURANCE

A. The Contractor shall assist the QAC in obtaining the necessary samples of wick drain material delivered to the site for conformance testing in accordance with the Quality Assurance Manual (QAM). The Subcontractor is encouraged to familiarize himself with the material conformance testing and documentation requirements set forth in the appropriate sections of the QAM.

B. The Contractor shall clearly mark, at the ground surface, the locations of all buried utilities such as pipes, stone trenches, and stone sumps within the wick drain area prior to the commencement of wick drain installation. Markings shall be maintained and/or restored throughout wick-drain installation as requested by the Designer and/or QAC.

C. Prior to commencing trial or production wick drain installation, the wick drain subcontractor shall locate and flag each wick drain in accordance with the approved project wick drain layout plan. The means for rapidly identifying each wick drain in the field, as depicted on the layout plan, shall also be clearly marked in the field.

D. Before commencing wick drain installation work, the Subcontractor shall field check the existing drainage blanket elevations with those shown on the Drawings. Any discrepancies shall be corrected by the Contractor prior to wick drain installation.

E. The wick drain installation shall be completed in the presence of the Designer or QAC.

F. The Subcontractor's crew shall have the ability to determine the ground surface elevation at any wick drain location immediately prior to the wick drain installation as requested by the Designer or QAC, or otherwise needed to properly control the elevation of the bottom tip of the wick drain.

G. Should unexpected soil / subsurface conditions be encountered that might affect the work of this section, the subcontractor shall notify the Project Manager and QAC before further proceeding with work in the subject area.

PART 2 – PRODUCTS

2.01 EARTH MATERIALS

A. Unless otherwise approved by the Designer, earth materials, such as Silt Clay Borrow, Sand, and 1-1/2-inch Crushed Stone, to be used as part of the construction of the underdrain, shall be as specified in Section 02200 - Earthwork.

2.02 GEOTEXTILE

A. Unless otherwise approved by the Designer, Geotextile to be used for the separation of 1-1/2-inch rushed Stone, granular underdrain collection sand, and subgrade as part of the construction of the underdrain system shall be as specified in Section 02510 - Geotextiles.

2.03 HDPE PIPES

A. Unless otherwise approved by the Designer, piping to be used as part of the construction of the underdrain system shall be as specified in Section 02780 - HDPE Piping.

2.04 WICK DRAINS

A. Unless otherwise approved by the Designer, Geocomposite wick drains used in conjunction with the underdrain sand layer shall consist of a prefabricated continuous polypropylene corrugated or finned drainage core wrapped in a geotextile filter fabric to provide a three-dimensional structure to collect water through the filter fabric surface and for water flow along the length of the composite assembly.

B. The geotextile filter fabric shall not be bonded to the core and shall have an Equivalent Opening Size of 40 to 120 U.S. Standard Sieve numbers as determined by ASTM D4751.

C. The wick drain composite assembly shall have a minimum width of 3.5 inches and a minimum cross-section thickness of 0.125 inch. The installed composite assembly shall provide a minimum discharge capacity of 1.5 gallon per minute with a gradient of 1 and confining pressure of 1.45 psi when tested in accordance with ASTM D4716.

D. Acceptable products include the following, or equivalent as approved by the Designer:

   1. AMERDRAIN 407, by American Wick Drain Corporation
   2. Mebra-Drain MD-7407, by HB Wick Drains (formerly Nilex Corporation)

C. Wick drains shall be free of holes, tears, and defects. Drains shall be wrapped in heavy-duty covering for protection during shipment and storage. Drain shall be protected from sunlight, dirt, mud, dust, debris, and detrimental materials during storage. If, in the opinion of the QAC, any of the drain is delivered or becomes inferior prior to installation, the Contractor shall replace the inferior drain at no additional expense to the Owner.

PART 3 – EXECUTION

3.01 EARTHWORK

A. All earthwork shall be completed in accordance with the requirements of Section 02200 - Earthwork.

B. The granular underdrain collection sand layer shall be placed and spread as shown on the drawings prior to installation of wick drains. The Contractor shall take all necessary precautions to avoid introducing fine-grained soils (mud, silt, dust, etc.) into the underdrain (sand blanket) layer during installation of the wick drains.

3.02 GEOTEXTILE FABRIC PLACEMENT

A. Geotextile fabric shall be placed in accordance with the requirements of Section 02510 - Geotextiles.

3.03 PIPE INSTALLATION

A. All pipes shall be placed in accordance with the requirements of Section 02780 – HDPE Piping.

3.04 WICK DRAIN INSTALLATION

A. Preparation

1. The location of each wick drain shall be flagged by the wick drain subcontractor prior to commencing installation work in a designated area. The wick drain subcontractor shall establish in the field means for identifying each wick drain (e.g., a numbering system). The subcontractor shall take all reasonable precautions to preserve the flags and markings and cause minimum of disturbance of the subsoil.
2. The Subcontractor shall locate and protect and/or preserve the functionality of all buried and/or previously installed work throughout the duration of the wick drain installation work.

B. General

1. The Subcontractor shall use the underdrain collection sand layer as a working mat for construction of the wick drains. The Subcontractor shall protect the

underdrain collection sand layer from any contamination, particularly by silts and clays, due to the installation of the drains including pre-augering, if needed.

2. Methods used to project the underdrain collection sand layer/working mat shall be those proposed in the approved wick drain installation plan, but such approval does not relieve the Subcontractor of their responsibility to remove and replace any contaminated underdrain collection sand layer material. If the Subcontractor encounters areas of the working mat that are unsuitable for their operations, the Contractor shall provide additional underdrain collection sand layer material, as approved by the Designer, and/or take whatever actions necessary to produce a suitable working mat at no additional expense to the Owner. In no circumstance will the Contractor be allowed to add additional sand (i.e., make the underdrain collection sand layer thicker) to a level that is above the subgrade elevations for the compacted clay liner component, unless pre-approved by the Designer, QAC, and Owner.
3. If, in the opinion of QAC, the drainage blanket material becomes contaminated for any reason, the Subcontractor shall remove and replace the contaminated material with material meeting the requirements for the underdrain collection sand layer material at no additional expense to Owner. Any related damage to the installed wicks shall be corrected to the satisfaction of the Designer at no additional cost to the Owner.
4. In areas designated on the Drawings where instrumentation, such as vibrating wire piezometers and/or vibrating wire settlement systems, are to be installed, the as-built locations of wick drains shall be flagged to insure the instrumentation can be accurately placed.

C. Installation Criteria

1. Wick drains shall be installed with approved modern equipment of a type that will cause limited disturbance or displacement of the subsurface soils and peripheral smear of the vertical drain cavity during the installation operation.
2. Wick drains shall be installed using a continuous push by static (hydraulic pressure) or vibratory methods. Use of falling weight impact hammers or jetting shall not be permitted for installation of the wick drains.
3. The hollow mandrel shall protect the wick drain material from tears, cuts, and abrasions during installation. The wick drain mandrel shall be sufficiently stiff to prevent wobble or noticeable deflection during installation.
4. The Subcontractor should note that the wick drains shall be terminated in the very soft clay at prescribed distances indicated on the Drawings, a minimum 12 ft above the underlying till layer. An anchor plate or other devise shall be attached to the end of each wick drain to prohibit soil from entering the mandrel and to anchor the wick drain in the soil at the proper installation depth after the mandrel is removed. The projected cross-sectional area of the mandrel-anchor combination shall not exceed 12 square inches. Alternative methods (such as filling the

mandrel with water) for ensuring that the bottom tip of the wick drains remains at the prescribed depth during removal of the mandrel may be proposed by the wick drain installer.

5. Prior to and during advancement of each drain, the equipment shall be checked for plumbness.
6. Upon completion of a wick drain installation, six to twelve inches of the drain shall protrude above the surface of the underdrain collection sand layer.
7. Splices or connections in the wick drain material shall be done in such a manner to insure continuity of the wick material. A maximum of one splice per drain installed will be permitted and the jacket and core shall be overlapped a minimum of 6 inches at any splice.
8. The wick drains shall be installed to the predetermined depth identified by the Designer. Shallow refusals, based on interpreted subsurface conditions, may be treated as an obstruction at the discretion of the Designer or QAC.
9. The Subcontractor shall be responsible for penetrating the very stiff clay crust and the Asbestos Landfill stability berm as necessary to satisfactorily install the drains without causing damage to the wick drain material.
10. When obstructions are encountered, the following procedure shall be implemented in the listed sequence:
    a. The Subcontractor shall immediately notify the QAC prior to completing the drain installation and prior to installing any other drains within a 50-ft radius. The QAC will notify the Designer.
    b. The Subcontractor shall then attempt to install wick drains that are offset within 1 foot of the obstructed wick drain. If the offset wick drains encountered obstructions, the wick drain subcontractor shall, with the approval of the Designer, attempt obstruction clearance procedures as described in the approved Wick Drain Installation Plan. A maximum of two attempts shall be made to bypass the obstruction prior to attempting clearance procedures.
    c. In the vicinity of proposed geotechnical instrumentation, all wick drains, including unsuccessful installations, shall be located in detail and clearly staked and flagged.

D. Trial Wick Drain Program

1. The wick drain subcontractor's attention is directed to the fact that very soft, sensitive glaciomarine clays underlie most of the site. These deposits are easily disturbed by cyclic loading/vibrations with the possible result of a rapid and dramatic decrease in strength. The very soft glaciomarine deposit is overlain by an approximately six-foot-thick very stiff desiccated clay crust and is underlain by dense glacial till and/or bedrock.
2. It is anticipated that 3 to 8 trial drains will be installed. The primary objectives of the trial wick drain installation program are to: (i) evaluate the proposed installation method; (ii) evaluate the proposed drain anchorage system; and (iii) to

establish the field procedures for measuring and confirming the installation depth (i.e., the as-built bottom tip elevation of each wick).

3. Prior to the installation of production wick drains within the areas designated on the plans, the Subcontractor shall demonstrate that their equipment, methods, and materials produce a satisfactory installation in accordance with these specifications.
4. Trial drains which do not meet the requirements of these specifications may be left in-place but shall be replaced with satisfactory installations.
5. Approval by the Owner, CQA Site Manager, and/or Designer of the method and equipment used to install the trial drains shall not necessarily constitute acceptance of the method for the remainder of the project. If, at any time, the QAC and/or Designer consider that the method of installation results in serious displacement or disturbance of the subsurface soils, smearing of the drain periphery, contamination of drainage materials, or does not otherwise produce a satisfactory wick drain, the wick drain subcontractor shall alter his method of equipment as necessary to comply with these specifications.

E. Tolerances

1. The horizontal location of the top of each wick drain shall not vary by more than 8 inches from the locations indicated on the approved layout plan, or as approved by the Designer. Completed drains shall not deviate more than 1 inch per foot from vertical outside of the sump areas.
2. It is the intent of this work that the Subcontractor makes a good-faith effort to set the tip of the wick drains at the required bottom elevations. The following tolerances are meant to allow some exceptions and not to limit the responsibility of the Subcontractor. The bottom tip of each wick drain shall be installed to an elevation that is no deeper than the bottom elevation shown on the approved layout plan, and an elevation that is no shallower than 1 ft above the prescribed elevation.
3. The Subcontractor shall provide the QAC, and/or Designer with a suitable means of verifying the plumbness of the mandrel and determining the depth of advancing wick drain at any time and the depth and length of wick drain installed at each location.
4. Wick drains that are out of their specified tolerances for location, bottom tip depth, or alignment, or drains that are improperly completed, will be rejected by the QAC and/or Designer, and shall be replaced by the wick drain subcontractor with satisfactory installations at no additional cost to Owner.
5. Rejected wick drains that have a tip elevation deeper than specified shall be grouted, unless approval is received from MEDEP, at no additional cost to the Owner.

[END OF SECTION]

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work of this section includes construction activities related to the following, as applicable:
   1. Excavations for Liner System Installation, Pipe Trenches, and Structures
   2. Embankment Construction
   3. Construction of Swales and Sedimentation Basins
   4. Drainage Sand Layer Construction
   5. Silt Clay Borrow and Common Borrow Placement
   6. Backfilling of Pipe Trenches and Around Structures and General Backfilling
   7. Riprap Installation
   8. Access Roadway Construction

1.02 APPLICABLE SECTIONS

A. Section 02100 - Instrumentation

B. Section 02120 - Temporary Erosion Control

C. Section 02130 - Clearing, Grubbing, and Stripping

D. Section 02140 - Excavation and Storage of Silt Clay

E. Section 02170 - Wick Drain and Underdrain

F. Section 02240 - Soil Barrier Layer

G. Section 02510 - Geotextiles

H. Section 02560 - Stormwater Piping

I. Section 02570 - Manholes and Catchbasins

J. Section 02780 - HDPE Piping

1.03 REFERENCES

A. The latest versions of the following American Society for Testing and Materials (ASTM) standards shall be used:
   1. ASTM C88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

2. ASTM C127 Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
3. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
4. ASTM C535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
5. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
6. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
7. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
8. ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
9. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
10. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
11. ASTM D2937 - Standard Test Method for Density of Soil In-Place by the Drive-Cylinder Method
12. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
13. ASTM D4373 - Standard Test Method for Rapid Determination of Carbonate Content of Soils.
14. ASTM D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
15. ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
16. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.04 QUALITY ASSURANCE

A. The latest versions of the following documents:
   1. Quality Assurance Manual (QAM), Landfill Cell Construction, Crossroads Landfill.
   2. "Standard Specification for Highways and Bridges," Maine Department of Transportation.

B. Testing and Inspection: Owner will pay for a QAC and a Soil Quality Assurance Laboratory (Soil QAL) during construction to verify compliance with these

Specifications. Subject to the discretion of the Project Manager, the cost (labor and expenses) for all re-tests resulting from failing initial tests shall be conducted by the QAC and/or Soils QAL at the Contractor’s expense.

C. Inspection of Material Sources: The QAC may inspect off-site sources of materials and request the Contractor to perform tests of those materials to verify compliance with these specifications. The QAC may also make his own tests in accordance with the QAM.

1.05 CONTRACTOR’S SOIL SUBMITTALS

A. At least ten days prior to commencing filling operations, the Contractor shall submit to the QAC results of laboratory testing performed on representative samples of soil materials from the proposed sources. The testing shall be performed at the Contractor's expense. The test results shall demonstrate compliance of each material with the properties required in these specifications. Upon request by the QAC, the Contractor shall also provide a sample of material from each proposed source.

B. The Contractor shall follow the same procedure set forth in Part 1.05A of this section for any required or desired change in material sources. The test results, and, if requested, representative sample, shall be submitted by the Contractor to the QAC at least five working days prior to using soil from the proposed soil.

C. If the Contractor’s test results fully satisfy the specification requirements, the test results may be counted by the QAC as the first conformance test for the subject material, as set forth in the QAM.

D. The Contractor shall submit all other documents required herein to the QAC for review and acceptance in accordance with this specification and the QAM.

1.06 JOB CONDITIONS

A. General:

1. Construction of portions of this project will require cuts and fills to achieve the design grades shown on the Drawings. The subgrade soils will, in part, consist of silt clay. This type of soil is sensitive to water content and repetitive loading. Significant disturbance of the silt clay, resulting in softening, commonly occurs when saturated soil of this type is subjected to repetitive construction-type loadings. It is the Contractor's responsibility to become familiar with the types of soil to be encountered and coordinate activities to ensure the integrity of the in-place soils are not adversely affected by construction activities. Repair of such conditions shall be performed at the Contractor’s sole expense.

PART 2 - PRODUCTS

2.01 MATERIALS, DEFINITION

A. General:

1. Definitions: All earth materials which may contain varying amounts of the following:
    a. Rock Fragments - Pieces of rock which are generally not rounded.
    b. Boulders - Detached pieces of rock, generally rounded but may be subrounded to angular, which are larger than 12 inches in maximum dimension.
    c. Cobbles - Rounded pieces of rock which are not greater than 12 inches but are larger than 3 inches in maximum dimension.
    d. Soils - Soils consist of sands, gravels, clay, and silt. Definitions of "clay" and "silt" are provided below:
        i. **Clay** - Plastic soil which passes a U. S. Standard No. 200 sieve and has a particle size less than 2 microns.
        ii. **Silt** - Soil which passes a U. S. Standard No. 200 sieve and is larger than 2 microns in particle size.
2. Glacial Till:
   An unsorted, unconsolidated deposit consisting of a heterogeneous mixture of clay, silt, sand, gravel, cobbles, and boulders varying widely in size and shape.
3. Peat:
   An unconsolidated deposit of semi-carbonized plant remains of a water-saturated environment, such as a bog, and of persistently high moisture content.
4. Glaciomarine:
   An unconsolidated deposit of uniformly graded sands, silts, and clays. These soils generally have a high water content and experience a loss of strength when disturbed.

2.02 MATERIALS, FILL

A. General: Excavations made at the site for the construction of project facilities will generate soil materials. These soils will either be suitable or unsuitable for use as fill in the construction of earth-related portions of the project.

1. Suitable Materials: Those materials generated from on-site excavations that satisfy the property requirements for the material for which it is to be used (e.g., Silt Clay Borrow, etc.). Specified properties for suitable project materials are set forth in Parts 2.02B through 2.02N. The specified properties must be met unless approved otherwise by the Designer.
2. Unsuitable Materials: Those materials generated from on-site excavations that do not satisfy the specifications for the project materials identified in Parts 2.02B

through 2.02N. Generally, these materials will contain vegetation, organic matter, debris, or frozen materials. Disposal or stockpiling of unsuitable materials shall be in accordance with Part 3.01E.

B. Drainage Sand:

1. Drainage Sand shall contain no sharp angular stone or other material capable of penetrating the geomembrane(s).

2. Drainage Sand shall be select pervious mixtures of sand and gravel having a hydraulic conductivity greater than or equal to $1x10^{-2}$ cm/sec when tested in accordance with ASTM D2434 at 88% maximum dry density as determined by ASTM D698.

3. Drainage Sand shall have no more than 5% carbonate content when tested in accordance with ASTM D4373, or other test methods as approved by the Designer.

4. Drainage Sand shall be reasonably well graded within the following limits:

SIEVE DESIGNATION	% PASSING BY WEIGHT
1-inch	100
1/2-inch	85-100
No. 4	75-100
No. 10	60-95
No. 40	0-50
No. 100	0-15
No. 200	0-6

C. Underdrain Collection Sand Layer:

1. Underdrain material used in the uppermost 1 foot on the base of the landfill (immediately below the compacted clay barrier) shall have a minimum hydraulic conductivity of $1x10^{-2}$ cm/s tested in accordance with ASTM D2434 at 88% maximum dry density as determined by ASTM D698..

2. Unless otherwise approved by the Designer, the material used for the Underdrain Collection Sand Layer shall be a granular material meeting the following particle-size criteria:

SIEVE DESIGNATION	% PASSING BY WEIGHT
6-inch	100
No. 200	0-12

Note: The Designer may consider variations to the material passing the No. 200 sieve. If approved, the material could be used for the working mat (below the upper 1-ft immediately beneath the compacted clay liner).

3. The d_{15} of the material must be greater than or equal to 0.09 mm, and the coefficient of uniformity (C_u) must be greater than or equal to 1.6.

D. Silt Clay Borrow:

1. Silt Clay Borrow used for general and/or embankment fill, part of cover section construction, and/or anchor trench backfill shall consist of a mixture of silt clay material. Silt Clay Borrow shall conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
2-inch	100
No. 200	71-100

2. Silt Clay Borrow used for grading the foundation below the cell bottom liner system shall have a hydraulic conductivity no greater than $1x10^{-5}$ cm/sec as determined by ASTM D5084 when compacted to 95% of the maximum dry density as determined by ASTM D698.

3. Silt Clay Borrow used as the Soil Barrier Layer (Compacted Clay Layer) shall meet the requirements of and placed in accordance with specification Section 02240.

E. Common Borrow (Granular and Cohesive):

1. Common Borrow shall consist of soil considered by the Designer to be suitable for embankment, flexible pipe bedding, and general fill where identified on the Drawings. Granular Common Borrow shall be utilized to the maximum extent allowed for on the Drawings. It shall be free from frozen material, perishable rubbish, peat, and other unsuitable material, and conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT	
	Cohesive	Granular (See Notes 1 and 2)
8-inch	100	100
No. 200	> 70	< 35

Note 1: Granular Common Borrow shall have a maximum dry density of at least 110 pounds per cubic foot (pcf) when tested in accordance with ASTM D1557.
Note 2: Granular Common Borrow shall be a fairly well graded material (i.e., uniformity coefficient (D_{60}/D_{10}) ≥ 2.5 with a smooth and reasonably symmetrical grain size curve.)

F Structural Fill:

1. Structural Fill to be used in access road construction, for filter berm construction, as a bedding layer for stormwater manholes and catch basins, and for structure footings, as indicated on the Drawings, shall consist of hard, durable stone with

coarse to fine sand. It shall be free of ice, snow, debris, organic and other deleterious materials, and lumps of clay and conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
4-inch	100
1/2-inch	45-90
No. 4	40-80
No. 40	5-35
No. 200	0-10

G. Granular Fill:

1. Granular Fill to be used in access road construction, sedimentation basin perimeter berm construction, flexible pipe bedding, and/or as backfill around catch basins, manholes, and structure footings/walls shall be free of ice, snow, debris, organic and other deleterious materials, and lumps of clay and conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
6-inch	100
No. 10	30-95
No. 40	10-60
No. 200	2-8

H. 3/4-Inch Crushed Stone:

1. 3/4-Inch Crushed Stone to be used as bedding for rigid pipe (RCP), sedimentation basin outlet structure base pad, leachate transfer system structures, and/or to be used in swale and sedimentation basin underdrain construction shall be hard, durable, resistant to weathering, and free from overburden, spoil, and organic materials. Shale and stone with shale seams are not acceptable. 3/4-Inch Crushed Stone shall be washed and uniformly blended according to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
1-inch	100
3/4-inch	65-100
1/2-inch	10-70
1/4-inch	0-20
No. 4	0-6
No. 200	0-2

I. 1-1/2-Inch Crushed Stone:

1. 1-1/2-Inch Crushed stone to be used in header trenches, sumps, cover system perimeter drain, and temporary stone check dam construction shall be hard, durable, resistant to weathering and to water action, and free from overburden, spoil, and organic materials. Shale and stone with shale seams are not acceptable. The material must be essentially non-carbonate, exhibiting less than 5 percent loss of weight when tested in accordance with ASTM D4373, or other test methods as approved by the Designer. 1-1/2-Inch Crushed stone shall be washed and uniformly blended according to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
3-inch	100
1-1/2-inch	90-100
1-inch	35-100
1/2-inch	0-30
No. 4	0-5
No. 200	0-2

M. Surface Course:

1. Surface Course to be used in access road construction shall be free of ice, snow, debris, organic and other deleterious materials, and lumps of clay and conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
1-inch	95-100
3/4-inch	90-100
No. 4	40-65
No. 10	10-45
No. 200	2-6

J. Riprap:

1. Stone used for riprap shall be hard, durable, and angular in shape; resistant to weathering and to water action; and free from overburden, spoil, and organic materials. Rounded stone or boulders will not be accepted unless authorized by the Designer.

2. Shale and stone with shale seams are not acceptable. The minimum unit weight of the stone shall be 155 lb/ft^3 as computed by multiplying the specific gravity (bulk- saturated-surface-dry basis, per ASTM C127) times 62.4 lb/ft^3.

3. The source of the stone shall be selected at least fourteen days in advance of the time when the stone will be required in the work. The acceptability of the stone will be determined by service records (i.e., certification from the source) and/or by suitable tests. If testing is required, representative samples of stone shall be taken in the presence of the QAC at least fourteen days in advance of the time when placing of riprap is expected to begin. The approval of some rock fragments from a particular quarry site shall not be construed as constituting the approval of all rock fragments taken from the quarry.

4. In the absence of service records, resistance to disintegration from the type of exposure to which the stone will be subjected shall be determined by the Contractor using the following tests:

   a. The abrasion test in the Los Angeles machine (ASTM C535). The stone shall have a percentage loss of not more than 40 after 500 revolutions.

   b. The sulfate soundness test (ASTM C88). Stones shall have a loss not exceeding ten percent after five cycles.

5. Riprap (D_{50} as indicated on the Drawings) shall meet the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT			
	D_{50} = 4 in.	D_{50} = 6 in.	D_{50} = 8 in.	D_{50} = 12 in.
18-inch	–	–	–	100
12-inch	–	–	100	40-70
9-inch	–	100	–	–
8-inch	–	–	40-70	–
6-inch	100	40-70	20-40	20-40
4-inch	40-70	–	–	–
3-inch	–	0-20	0-20	0-20
2-inch	–	0-10	0-10	–
1-1/2-inch	0-20	–	–	–
3/4-inch	0-10	–	–	–

Neither breadth nor thickness of a single stone shall be less than one-third its length. Rounded stone or boulders will not be accepted unless authorized by the Designer.

6. Control of riprap gradation will be by visual inspection by the QAC. If necessary, the Contractor shall provide two samples of rock, at least five tons each, meeting the specified gradation. One of the samples shall be provided at the construction site and may be a part of the finished riprap covering. The other sample shall be stockpiled at the quarry or distribution source for the riprap. These samples shall be used as a reference for judging the gradation of the riprap supplied.

7. Any difference of opinion between the QAC and the Contractor shall be resolved by dumping and checking the gradation of two random truckloads of stone. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 EXCAVATIONS

A. General:

1. Refer to Section 02130 for preparation of the site prior to excavations required as part of the construction of the project facilities.
2. Excavation refers to the removal of all materials encountered to the limits shown on the Drawings or designated in the specifications. All surficial sand deposits and other materials shall be excavated to expose existing silt clay in areas proposed for compacted Silt Clay Borrow placement or liner system components, to provide a firm and impervious base for construction, unless specifically directed otherwise on the Drawings or unless approved otherwise by the Designer.
3. No additional allowance above the prices bid in the schedule for excavation will be made on account of any of the material being wet or frozen.
4. Common excavation includes all material, including peat, silt clay, glacial till, and sand.

B. Open Excavation and Trench Excavations:

1. Excavations shall be made to the full dimensions required and shall be finished to the prescribed lines and grades.
2. Any and all excess excavation for the convenience of the Contractor or overexcavation performed by the Contractor for any purpose or reason, except as pre-approved in writing by the Project Manager, shall be at the expense of the Contractor whether or not due to the fault of the Contractor. Where required to complete the work, all such excess excavation and overexcavation shall be refilled with materials furnished and placed at the expense of the Contractor.
3. The Contractor shall inform the QAC and the Project Manager of all substantial overexcavation operations prior to commencing any such work, so that any

associated stability issues may be identified. The Contractor shall be prepared to alter their operations to enhance stability.

4. All excavation to subgrade for liner system construction, embankment construction, pipe installation, and structure foundations shall be performed in a dry condition, with adequate dewatering procedures implemented.
5. All necessary precautions shall be taken to ensure that the material below and beyond the established excavation lines remains in the soundest possible condition.

C. Subgrade Preparation - General:

1. Prior to fill placement, the subgrade shall be firm, dry, and free from debris, ice, and snow. Fill shall not be placed over frozen soil unless otherwise approved by the Designer.
2. Subgrade preparation shall be followed as closely as possible by fill placement. Deterioration of the subgrade between excavation and initial fill placement shall be the responsibility of the Contractor and shall be repaired at the Contractor's expense.
3. In landfill base areas, the Contractor shall proofroll exposed silt clay subgrade using a smooth-drum roller or loaded end dump prior to placing Silt Clay Borrow, Underdrain Collection Sand, or liner system components. Proofrolling shall be performed in the presence of the QAC.
4. All subgrade must be inspected and approved by the QAC in accordance with the QAM prior to fill placement. Sufficient time shall be given to the QAC to inspect and perform any necessary tests (e.g., field moisture-density tests) on the subgrade as set forth in Part 3.07 of this section, as well as to visually inspect proofrolling activities.

D. Refilling Unauthorized Excavation:

1. <u>Trenches</u>: The Contractor shall use materials selected by the Designer based on the location of the excavation.
2. <u>Other Excavations</u>: The Contractor shall use compacted Silt Clay Borrow within landfill boundaries, or other materials selected by the Designer outside landfill units.

E. Disposition of Excavated Materials:

1. Suitable materials generated from excavations shall be used, to the maximum extent shown on the Drawings, to construct the earthwork components of the project.
2. Suitable materials are those materials meeting the property requirements set forth in Part 2.02 of this section.
3. Excavated materials which are unsuitable for, or are in excess of, the project earthwork requirements shall be stored in the stockpile areas designated on the Drawings or as directed by the Project Manager.

4. The Contractor's operations in excavations shall yield as much suitable material for construction as practicable. The Contractor shall excavate unsuitable materials separately from the suitable materials to be stored, and the unsuitable materials shall be segregated by loads during the excavation operations. The suitable materials shall be placed in the designated final locations directly from the excavation or shall be placed in temporary stockpiles and later placed in the designated locations.
5. Excavated materials which are dry are suitable for embankments and general fill construction. Excavated materials, which are too wet for immediate compaction in the embankment when excavated, shall be placed temporarily in stockpiles or processing areas approved by the Project Manager until the moisture content is reduced to the limits stated in Part 3.04.
6. Excavated materials which are suitable for reuse shall be placed and compacted as soon as practicable following excavation. During winter-like working conditions (freezing temperatures), the Contractor's operations shall be coordinated, and the appropriate equipment used to ensure the reuse of excavated materials is maximized to the extent practicable. Frozen materials shall not be allowed for reuse unless allowed to thaw and properly adjusted for moisture content. If material is placed while still frozen, the Contractor shall remove and handle as an unsuitable material at no additional expense to the Owner.

3.02 STABILITY OF EXCAVATIONS

A. General:

1. Sideslopes of excavations and means for access/egress shall comply with OSHA, other Federal, and State Regulations and Local Codes. The Contractor shall shore and brace in accordance with Part 3.02B where sloping is not feasible.
2. The Contractor shall maintain sides and slopes of excavations in safe conditions until completion of backfilling.

B. Shoring and Bracing:

1. The Contractor shall provide materials for shoring and bracing to comply with all OSHA, other Federal, and State regulations and local codes.
2. The Contractor shall maintain shoring and bracing in excavations regardless of the time period excavations remain open. The Contractor shall carry down shoring and bracing as excavation progresses.
3. The design, supporting calculations, and proposed construction procedure for bracing systems shall be prepared and stamped by a Professional Engineer registered in the State of Maine and submitted to the Designer for review at least one week prior to commencing excavation.

3.03 DEWATERING

A. General:

1. The Contractor shall perform all work in the dry conditions and shall prevent surface water and groundwater from flowing into excavations and from flooding any portion of the project site or surrounding area.
2. To the extent practicable, the Contractor shall not allow water to accumulate in excavations. The Contractor shall provide and maintain sumps, pumps, and dewatering system components as necessary to convey water out of and/or away from excavations.
3. The Contractor shall be responsible for dewatering the liner or cover system anchor trench throughout all stages of the Work.
4. The Contractor shall convey all water removed from excavations or diverted from the work area to the sedimentation ponds (Erosion Control Structures) as indicated on the Drawings or as directed by the Project Manager. The Contractor shall establish and maintain temporary drainage ditches and other diversions outside excavation limits and provide temporary erosion control measures in accordance with Section 02120 and the Erosion and Sedimentation Control Plan. Excavation of temporary drainage ditches or construction of other diversions shall be subject to the prior approval of the Project Manager and/or Designer. The Contractor shall not use trench excavations as temporary drainage ditches unless approved otherwise by the Designer.
5. Failure to keep excavations dry could result in softening of the exposed subgrade. Softened soils, caused as a result of inadequate dewatering, shall be removed and replaced with compacted material or otherwise repaired to the satisfactory of the QAC and/or the Designer at the Contractor's expense.

3.04 FILL MATERIAL PLACEMENT

A. Silt Clay Borrow

1. Material: Silt clay shall meet the requirements set forth in Part 2.02.D.
2. Moisture Control: The workability of silt clay is acutely sensitive to moisture content. The water content of Silt Clay Borrow used as fill shall be controlled by the Contractor to stay in the range of 2 percent dry of the laboratory-determined optimum water content to 4 percent wet of optimum water content. Silt clay not meeting this range of water contents shall be removed or reworked until the moisture content is within these limits, unless approved otherwise by the Designer.
3. Compaction Criteria: Silt Clay Borrow shall be compacted to at least 95% of maximum dry density as determined by ASTM D698. The Contractor shall adjust the moisture content of the Silt Clay Borrow as necessary to achieve the required degree of compaction.

4. Placement: Silt Clay Borrow shall be placed in continuous, approximately horizontal layers, not more than 12 inches in loose depth for material compacted by heavy construction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Fill material shall not be placed on surfaces that are muddy, frozen, or contain frost or ice.

   The distribution and gradation of the Silt Clay Borrow throughout earthwork components shall be such that the fills will be free from lenses, pockets, streaks, or layers of material differing substantially in texture, gradation, or moisture from the surrounding material. The combined excavation, separation, and placement operations shall be such that the materials, when compacted, will be blended sufficiently to secure the best practicable distribution of the material.

   If, in the opinion of the QAC, the surface of the prepared foundation or the compacted surface of any layer of earthfill is too dry or smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or worked with harrow, scarifier, or other suitable equipment, in an approved manner to a sufficient depth, to provide a satisfactory bonding surface before the next succeeding layer of fill material is placed. If, in the opinion of the QAC, the compacted surface of any layer of in-place fill is too wet for proper compaction of the layer of earthfill material to be placed thereon, it shall be removed, allowed to dry or be worked with a harrow, scarifier, or other suitable equipment to reduce the moisture content to the specified amount, and then it shall be recompacted before the next succeeding layer of earthfill material is placed. If, in the opinion of the QAC, (a portion of) any layer of fill freezes prior to the placement of the succeeding lift of earthfill material, the frozen material shall be removed and handled as unsuitable material or allowed to thaw and then adjusted to meet the required moisture content criteria.
5. Compaction: When each layer of material has been conditioned to have the specified moisture, it shall be compacted by at least 4 passes of the compaction equipment selected in accordance with Part 3.04.A.6. The passage of compaction equipment in either direction (forward or backward) is considered a single “pass.” When compacted, the density shall be essentially uniform throughout the layer. Compacted earth material having a moisture content or dry density that does not meet the criteria specified shall be reworked and recompacted, to the satisfactory of the QAC, to obtain the specified moisture content and dry density.
6. Compaction Equipment: Compaction of the silt clay shall be by equipment capable of producing a kneading action for the full depth of each lift. A padfoot, sheepsfoot, or tamping feet roller shall be used, unless approved otherwise by the Designer. Using loaded dump trucks will not be considered a satisfactory compaction method.

7. Smooth Roll Surface: At the completion of each work day, the Contractor shall "seal" the surface by compacting the surface with several coverages of a smooth drum roller. This procedure will encourage runoff from storms, and thus limiting development of excessively moist or wet lenses of soil within the fill. The sealed surface shall be roughened prior to placing the next lift of silt clay to promote a bond between lifts.
8. Placement and Compaction of Silt Clay Borrow in Areas of Difficult Access: Where compaction of silt clay by means of the rollers specified for use is impracticable or undesirable, the fill shall be placed in accordance with the practically applicable provisions of this Part except placement may require layers thinner than those specified for roller compaction of earthfill to obtain the desired compaction with the equipment used.

B. Common Borrow (Granular/Cohesive)

1. Material: Common Borrow shall meet the requirements of Part 2.02.E.
2. Placement: Common Borrow shall be placed in continuous, approximately horizontal layers, not more than 12 inches in loose depth for material compacted by heavy construction equipment; and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Fill material shall not be placed on surfaces that are muddy, frozen, or contain frost or ice.

   Cohesive Common Borrow, and Silt Clay Borrow material that is used as Cohesive Common Borrow, shall be placed in accordance with the requirements specified in Part 3.04.A.4.

3. Compaction Criteria and Moisture Control: Cohesive Common Borrow shall be compacted to at least 95% of maximum dry density as determined by ASTM D698, unless otherwise approved by the Designer. Moisture content of Cohesive Common Borrow shall be controlled in accordance with the requirements specified in Part 3.04.A.2.

   Granular Common Borrow shall be compacted to at least 95% of its maximum dry density as determined by ASTM D1557, unless otherwise approved by the Designer. The Contractor shall adjust the moisture content of the Granular Common Borrow soils as necessary to achieve the required degree of compaction.

C. Structural Fill and Granular Fill for Roadways

1. Structural Fill, and Granular Fill shall be compacted using vibratory equipment to at least 95% of the material's maximum dry density as determined by ASTM D1557. Placement of these materials shall be in layers not exceeding 12 inches in loose lift thickness. The Contractor shall adjust the moisture content of Structural Fill, and Granular Fill as necessary to achieve the required degree of compaction.

D. Structural Fill for Bedding for Structures and Granular Fill

1. Structural Fill bedding for structures shall be placed in continuous, approximately horizontal layers, not more than 12 inches in loose depth for material compacted by heavy construction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Structural Fill bedding shall be compacted to at least 95 percent of the material's maximum dry density as determined by ASTM D1557.
2. Granular Fill shall be placed in continuous, approximately horizontal layers, not more than 12 inches in loose depth for material compacted by heavy construction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Granular Fill shall be compacted to at least 95 percent of the material's maximum dry density as determined by ASTM D1557.

E. Riprap

1. Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of riprap in layers, by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.
2. The larger stones shall be well distributed, and the entire mass of stone shall conform to the gradation specified in Part 2.02.I. All material comprising riprap protection shall be so placed and distributed so that there will be no large accumulations of either the larger or smaller sizes of stone.
3. A fairly compact riprap protection, in which all sizes of material are placed in their proper proportions, shall be produced. Hand-placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.
4. Unless otherwise authorized by the Project Manager, the riprap protection shall be placed in conjunction with the dressing and preparation of the drainage swales with only sufficient lag in construction of the riprap protection as may be necessary to allow for proper construction of the portion of the drainage swale protected. The Contractor shall maintain the riprap protection until accepted by the Project Manager.
5. The riprap shall extend to firm undisturbed soil. A well established cover of grass with a thick root mat should be provided at the lateral and upper limits of the riprap, unless approved otherwise by the Designer.
6. The perimeter of all riprap areas shall be blended into surrounding contours.

F. Drainage Sand

1. General:
   a. Drainage Sand material shall be furnished and placed to the lines and dimensions shown on the Drawings to provide a protection and drainage blanket between and/or above the liner components within landfill units.

b. The materials to be used for Drainage Sand shall meet the specifications stated in Part 2.02.B.

c. A separate and independent contract will be issued to the Geosynthetic Installer for liner construction including installing geomembrane, drainage geocomposite, geotextile, and geosynthetic clay liner components of the lining/cover system. The Earthwork Contractor will place the drainage sand component of the liner system.

d. The Earthwork Contractor shall coordinate their efforts with the Geosynthetic Installer and allow for mutual access to the work areas. The Earthwork Contractor shall perform and schedule their work so as not to impede the work of the Geosynthetic Installer.

2. Placement: The Drainage Sand shall be provided, delivered, and stockpiled by the Contractor. The Drainage Sand material shall be handled and placed in such a manner as to prevent segregation. The method of placing the Drainage Sand shall be subject to approval by the QAC, and as follows. Drainage Sand placed over geocomposite shall be placed in one continuous lift using a low-ground-pressure bulldozer having a maximum ground pressure of 5.0 pounds per square inch and shall be placed in an upslope direction.

The Contractor shall verify that the in-place thickness of the Drainage Sand is as specified on the Drawings. This shall be done by carefully hand-excavating test holes approximately 50 feet on center, or by using alternate methods, such as cardboard tubes, as approved by the QAC.

The Contractor shall stage their work and access the work area in such a manner as to minimize the possibility of damage to the geosynthetics. Damage to the geosynthetics resulting from the Contractor's construction activities shall be repaired at the Contractor's expense in accordance with Sections 02400, 02510, 02520, and 02530.

In no instance shall the Contractor operate any earthmoving or other heavy equipment directly on the geosynthetics. Low-ground-pressure equipment having a maximum ground pressure of 5.0 pounds per square inch may operate, with care, on a minimum thickness of 12 inches of soil overlying the geomembrane, as approved by the QAC. All other equipment traversing a geosynthetic layer shall be on a minimum thickness of 3 feet of approved soil overlying the geosynthetic layer.

G. Underdrain Collection Sand Layer

1. General:

a. Underdrain material shall be furnished and placed to the lines and dimensions shown on the Drawings.

b. The materials to be used for Underdrain shall meet the specifications stated in Part 2.02.C.

c. Prior to placing the Underdrain material, the Contractor shall confirm with the QAC whether a separator geotextile is needed or would be beneficial to subsequent waste-excavation and/or earthwork activities. If deemed necessary by the Contractor or the Project Manager, a woven geotextile meeting the applicable requirements of Specification 02510 shall be placed over the subgrade prior to placing the Underdrain material upon the approval of the Project Manager.

2. Placement: The Underdrain material shall be provided, delivered, and stockpiled by the Contractor. The Underdrain material shall be handled and placed in such a manner as to prevent segregation. The Contractor shall place the Underdrain material in lifts not to exceed 5 ft thick, unless approved by the Designer. In areas where the Underdrain material is to be placed over soft subgrade conditions, low-ground-pressure bulldozer(s) should be used to spread the material and to track it in. Alternatively, the material may be placed using an excavator and tamped in place. The method of placing the Underdrain material shall be subject to approval by the QAC and/or Designer.

   The Contractor shall verify that the in-place thickness of the Underdrain layer is as specified on the Drawings. This shall be done by surveying methods, or by using alternate methods such as hand-excavating test holes approximately 100 feet on center, or as otherwise approved by the QAC.

3.05 PIPE BEDDING AND TRENCH BACKFILL

A. General:

1. The Contractor shall prepare subgrade to the lines and grades shown on the Drawings, allowing for a 6-inch minimum thickness of pipe bedding material.
2. The Contractor shall place the specified pipe.
3. The Contractor shall complete placement of the backfill specified on the Drawings, limiting the loose lift thickness to 6 inches. Where no specific backfill material is indicated on the Drawings, Granular Fill shall be utilized.
4. Trench backfill materials shall be compacted to the following minimum percentages of the maximum dry density:

	DEGREE OF COMPACTION	
	Granular Material (ASTM D1557) (see Note 1)	Silt Clay Material (ASTM D698) (see Note 2)
Trenches through unpaved areas	92%	95%
Trenches beneath or adjacent to roads, paved or gravel surface, within top 2 feet beneath road subgrade	95%	98%
Trenches beneath or adjacent to roads, paved or gravel surface, below top 2 feet beneath road subgrade	92%	95%

Note 1: Granular Materials include: Structural Fill, Granular Fill, and Surface Course
Note 2: Silt Clay Materials include: Silt Clay Borrow

B. The Contractor shall be responsible for placing and compacting backfill in the liner or cover system anchor trench, in accordance with Part 3.05.A of this Section. All anchor trench work shall be performed in a manner that does not damage the geosynthetic components of the liner or cover system.

3.06 BACKFILL AROUND STRUCTURES

A. General:
   1. The Contractor shall place the specified soil material in layers to required elevations shown on the Drawings and listed below.
   2. The Contractor shall backfill and compact to minimize settlement of the material and provide adequate support for structure walls, and/or the surface treatment or structure to be placed on the material.

B. Placement:
   1. The Contractor shall place material in approximately horizontal layers beginning at the lowest area to be filled. The Contractor shall place backfill and fill materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. The Contractor shall not place backfill or fill material on surfaces that are wet, frozen, or contain frost or ice.
   2. The Contractor shall place backfill and fill materials evenly adjacent to structures, to required elevations. The Contractor shall take care to prevent wedging action of backfill against structures by carrying material uniformly around structures to approximately the same elevation in each lift.

C. Compaction:
   1. The Contractor shall use methods that produce the required degree of compaction throughout the entire depth of material placed without damage to new or existing facilities. The Contractor shall adjust the moisture content of soil as required and remove and replace material that is too wet to compact to the required density.

2. Granular backfill materials (i.e., Structural Fill, Granular Fill, or Surface Course) used as backfill around structures shall be compacted to at least 92% of the maximum dry density as determined by ASTM D1557, unless otherwise indicated on the Drawings or in the Specifications. Silt clay backfill materials (i.e., Silt Clay Borrow) used as backfill around structures shall be compacted to at least 95% of the maximum dry density as determined by ASTM D698, unless otherwise indicated on the Drawings or approved by the Designer.

3.07 TESTING

A. General:

1. The QAC will measure the actual in-place moisture and density of fill materials using field tests. Costs for initial tests will be paid by the Owner.
2. The Contractor shall perform, at no additional cost to the Owner, additional work to obtain proper compaction if in-place moisture or density does not meet specifications.
3. The QAC will observe construction and perform testing at the minimum frequencies set forth in the QAM, and at locations that they will select. The results of these tests will be made available to the Contractor on a timely basis so the Contractor can take such actions as are required to remedy indicated deficiencies.
4. Removal of non-conforming drainage sand could damage components of the liner system. For this reason, conformance testing of these materials (i.e., grain size distribution, etc.) will be performed on samples obtained by the QAC at either the borrow pit or from on-site stockpiles. Placement of these materials shall not commence until satisfactory test results are received and approval to place the fill material is given to the Contractor by the QAC.
5. Delivery and compaction of fill materials shall be made during the presence of the QAC and shall be subject to testing to determine compliance with material, placement, and compaction specifications. The QAC's presence does not include supervision or direction of the actual work by the Contractor, their employees, or agents. Neither the presence of the QAC nor any observations and testing performed by them shall excuse the Contractor from defects discovered in his work.

B. Tests: The quality of materials shall be monitored by testing in accordance with the testing methods specified in this section.

3.08 GRADING

A. Grading: The Contractor shall uniformly grade areas within limits of grading including adjacent transition areas. The Contractor shall smooth finish surfaces within the following specified tolerances:

1. Roadside Areas: Finish areas to receive topsoil to within 0.20 feet above or below required subgrade elevations.
2. Fills and Embankments: Finish areas to receive topsoil within 0.20 feet above or below required subgrade elevation, and finish areas to receive the liner system or structures or road sections within 0.10 feet above or below required subgrade elevation.
3. Lined Areas: Grading in areas to receive liner components shall be performed to within +/- 0.1 feet, provided all required tolerances set forth in the other sections of theses specifications (e.g., Sections 02240, 02560, and 02780) are met.

B. Compaction: After grading, the Contractor shall compact the surface to the percentage of maximum density specified for each area and fill material, unless approved otherwise by the Designer.

3.09 MAINTENANCE

A. Protection of Graded Areas: The Contractor shall protect newly graded areas from traffic or erosion and keep free of trash and debris. The Contractor shall repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas: Where completed, compacted areas are disturbed by subsequent construction operations or adverse weather, the Contractor shall scarify the surface, re-shape, and compact to the required moisture and density at no additional cost to the Owner.

3.10 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. The Contractor shall dispose of excess and asbestos waste materials in accordance with Sections 02130 and 02140.

[END OF SECTION]

SECTION 02240

SOIL BARRIER LAYER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work in this section includes construction activities related to Soil Barrier (Compacted Clay) Layer placement, tie-in to existing Soil Barrier Layer, conditioning, and compaction, as shown on the plans and specified herein. This specification has been developed to achieve an as-placed hydraulic conductivity less than or equal to 1×10^{-7} centimeters per second.

B. The Contractor is advised that a test pad program may be required prior to full-scale soil barrier (compacted clay) layer construction.

1.02 APPLICABLE SECTIONS

A. Section 02120 - Temporary Erosion Control

B. Section 02200 - Earthwork

C. Section 02400 - Geomembrane

1.03 REFERENCES

A. ASTM D698- Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12400 ft-lbf/ft3 (600kN-m.m3)).

B. ASTM D2216 - Standard Method of Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

C. ASTM D2937 Standard Test Method for Density of Soil In-Place by the Drive-Cylinder Method

D. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

E. ASTM D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

F. ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.

G. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.04 QUALITY ASSURANCE

A. Quality Assurance Manual (QAM).

1. The Contractor shall agree to participate in and conform with all items and requirements of the QAM.
2. Testing and Inspection: The Owner will pay for a QAC and a QAL during construction to verify compliance with these specifications.
3. Inspection of Material Sources: The QAC may inspect off-site sources of materials and test these materials to verify compliance with these specifications.

B. "Maine Erosion and Sediment Control Best Management Practices (BMPs)" Maine Department of Environmental Protection; hereinafter referred to as the BMPs.

PART 2 - PRODUCTS

2.01 MATERIALS - DEFINITION

A. General Definitions:

1. Soils consist of sands, gravels, clay, and silt. Definitions of "clay" and "silt" are provided below:
   a. Clay - Plastic soil which has a particle size less than 2 microns.
   b. Silt - Non-plastic soil which passes a U.S. Standard No. 200 sieve and is larger than 2 microns in particle size.
2. Glaciomarine Silt-Clay
   a. An unconsolidated deposit of primarily silts and clays. These soils generally have a high water content and experience a loss of strength when disturbed.

2.02 MATERIALS - FILL

A. Soil Barrier Material

1. Soil to be used for the soil barrier (compacted clay) layer shall consist of glaciomarine silt-clay material.
2. Material shall be free of organic material, debris, ice, snow, and other deleterious material, with no stone larger than 1-inch. Unless approved otherwise by the Designer, materials used for the barrier layer shall contain greater than 90 percent silt and clay content (minus No. 200 U.S. Std. Sieve) by dry weight, a Liquid Limit greater than or equal to 28, and a Plasticity Index greater than or equal to 11.
3. Unless directed otherwise by the Project Manager, Soil Barrier Layer material will be obtained from a borrow area owned and licensed by the Owner, as shown on the Drawings. If a source other than the Baker Borrow source is used, an

acceptable permeability zone of the Test Pad Work Plan will need to be revised based on the test results of the proposed material.

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to Soil Barrier Layer (compacted clay) material placement in the areas where there will not be the underdrain collection sand layer, the subgrade shall be firm, dry, and free from debris, ice, and snow. Material shall not be placed over frozen soil unless otherwise approved by the Designer.

B. The subgrade shall be prepared as indicated in Section 02200 and Part 3.02 in this section. Subgrade preparation shall be followed as closely as possible by clay placement. Deterioration of the subgrade prior to placement of the soil barrier layer shall be the responsibility of the Contractor and shall be repaired at no expense to the Owner.

C. All subgrades must be inspected and approved by the QAC prior to fill placement. Sufficient time shall be given to the QAC to inspect and perform any necessary tests on the subgrade as discussed in Section 02200 and in this section.

D. The Contractor shall design and properly construct temporary haul roads with proper materials and thicknesses to protect natural subgrades, fill grades, the proposed geomembrane, and other work as shown on the Drawings and specified in this section. Temporary haul roads must support construction equipment. No rutting of underlying material shall be allowed.

E. The Contractor shall perform all work in a dry condition. The Contractor shall prevent surface water and groundwater from flowing into the work area or from flooding any portion of the project site or surrounding area.

F. To the extent practicable, the Contractor shall not allow water to accumulate in the work area. The Contractor shall provide and maintain sumps, pumps, and dewatering system components as necessary to convey water away from excavations.

G. The Contractor shall convey water removed from excavations or diverted from the work area to sedimentation basins (Erosion Control Structures) as indicated on the Drawings or as directed by the Project Manager. The Contractor shall establish and maintain temporary erosion control measures, including drainage ditches and other diversions as specified in Section 02120, and the project Erosion and Sedimentation Control Plan. Excavation of temporary drainage ditches or construction of other diversions shall be subject to the prior approval of the Project Manager and/or the Designer and shall be in accordance with Maine BMPs. The Contractor shall not use trench excavations as temporary drainage ditches unless approved otherwise by the Designer.

F. The existing silt clay layer on the Asbestos Landfill may be used as the Soil Barrier Layer, if it meets the requirements Soil Barrier Layer specifications. The QAC will obtain Shelby tube samples of the existing silt clay layer and coordinate testing for hydraulic conductivity. If the existing silt clay layer meets the Soil Barrier layer hydraulic conductivity specifications, it shall be left in place as the Soil Barrier Layer. Additional grading in this area to achieve grades shown on the Drawings, shall be performed as described in the drawings.

3.02 REQUIRED EXCAVATION AND SUBGRADE PREPARATION

A. As part of liner subgrade preparation in landfill base areas where there will not be underdrain collection sand layer, the Contractor shall remove existing granular surficial soils, where present, to expose silt clay soils. The Contractor shall proofroll exposed subgrade soils in the presence of the QAC using a smooth-drum roller prior to placing Silt Clay Borrow or Soil Barrier Layer (compacted clay) material. Other methods of evaluating the suitability of the subgrade may be used as approved by the QAC.

B. Where natural silt clay soils are encountered above the subgrade elevation for the Soil Barrier Layer, the silt clay soils shall be removed to subgrade and the exposed subgrade proofrolled.

C. Where the compacted clay layer is underlain by underdrain collection sand and a geotextile fabric, the sand/geotextile surface shall be firm and stable.

D. The Contractor shall scarify, proof roll, and moisture condition existing Asbestos Landfill silt clay layer prior to the QAC obtaining samples for hydraulic conductivity testing.

3.03 SOIL BARRIER LAYER (COMPACTED CLAY) CONSTRUCTION

A. Thickness: Lifts shall consist of 6-inch-thick compacted lifts. After compaction, the soil barrier layer shall be not less than 12 inches thick.

B. Hydraulic Conductivity: The in-place hydraulic conductivity of the soil barrier layer in liner system applications shall be less than 1×10^{-7} cm/sec when determined using ASTM D5084.

C. Moisture Control: The water content of the compacted clay material shall be controlled by the Contractor to stay within the acceptance zone of in-place moisture contents. Material compacted outside of the moisture acceptance zone shall be removed or reworked by the Contractor until the moisture content is within the specified limits.

D. Density Control: The Contractor shall apply sufficient compaction effort (Parts 3.03.G and 3.03.H) to each lift of material to achieve densities within the acceptance zone.

1. If, in the opinion of the QAC, the surface of the compacted surface of any previous layer is too dry, contains too many desiccation cracks, or is too smooth to bond properly with the layer of material to be placed thereon, it shall be repaired as follows and as recommended by the QAC. If drying (desiccation cracking) is limited to the upper 2-1/2 inches, the surface shall be moistened and tracked with a bulldozer prior to placing the next lift. If drying extends deeper than the upper 2-1/2 inches, the lift shall be moisture conditioned by harrowing or using a roto-tiller, in an approved manner and to a sufficient depth, and recompacted before the next succeeding layer of fill material is placed.
2. If, in the opinion of the QAC, the compacted surface of any lift of compacted clay material is too wet for proper compaction of the layer to be placed thereon, the wet material shall be either removed and replaced with material meeting these specifications, or be allowed to dry by exposing to the sun and wind, and/or by harrowing the material or working the material with a roto-tiller to reduce the moisture content to the specified amount and recompacting the material before the next succeeding layer is placed.

E. Placement: Material shall be placed in continuous loose lifts of sufficient thickness to achieve a 6-inch lift after compaction. Placement and compaction of all lifts (and especially the first lift) shall be performed in a manner that does not damage the underdrain collection sand layer, wick drains, or geotextile separator.

F. Conditioning: After compaction, the material shall contain uniform moisture throughout the lift, shall be thoroughly remolded, and shall not contain interconnected macro-voids.

1. If, at the discretion of the QAC, the clay material is dry of the moisture acceptance zone, water shall be added to the surface of the loose lift, and the lift shall be worked in a manner to knead the soil and/or with a roto-tiller to achieve uniform moisture throughout the lift and to reduce clod size prior to compaction.
2. If, at the discretion of the QAC, the material is wet of the moisture acceptance zone, the loose lift shall be conditioned with repeated passes of the roto-tiller and/or repeated harrowing to reduce clod size and to aid drying of the Soil Barrier Layer material. The roto-tiller shall be set to till a minimum depth of 6 inches so that the entire loose lift as well as the surface of the previous lift are conditioned.

G. Compaction: When each lift of the Soil Barrier Layer material has been processed to be within the specified moisture range, it shall be compacted using the same equipment and the minimum number of full-coverage passes approved during the test pad program. If a test pad program is not completed, then each lift shall be compacted by at least six full-coverage passes using an Ingersoll Rand Propac 115, a Caterpillar CP-563 pad foot roller, or approved equivalent by the QAC. The passage of compaction equipment in either direction (forward or backward) is considered a single "pass."

H. Smooth Roll Surface: At the completion of each lift, the Contractor shall "seal" the silt-clay surface by compacting the surface with one pass of a smooth drum roller. Sealing the lifts will encourage runoff from storms, thus limiting development of excessively moist or wet lenses of soil within the barrier layer. The lift surface shall be scarified or otherwise roughened by tracking with a bulldozer prior to placing the next lift of Soil Barrier Layer material to result in good bonding between lifts. Subsequent to compacting the final lift of compacted clay with the pad foot roller, the Contractor shall smooth the surface of the lift in preparation for testing and /or geomembrane deployment by rolling the surface with a minimum of two passes with a smooth drum roller.

I. Geosynthetic Clay Liner (GCL) Subgrade: The surface of the Soil Barrier Layer to be covered with GCL shall be smooth and free of rocks, stones, sticks, roots, sharp objects, or debris of any kind. The surface shall provide a firm, unyielding foundation for the GCL with no sudden, sharp, or abrupt changes or break in grade exceeding 1 inch in diameter. No standing water or excessive moisture will be allowed.

1. GCL shall be placed on the surface as soon as practicable after the subgrade is prepared. Prior to installing the GCL, the Contractor shall maintain the surface and protect it against wetting, drying, and erosion. This shall be accomplished by adjusting the moisture content and recompacting affected areas as needed, or by protecting the soil barrier layer with temporary plastic sheeting or by other means subject to approval by the QAC. At the discretion of the QAC, minor surficial drying or desiccation within half-inch of the subgrade surface may be considered acceptable.
2. If drying (desiccation cracking) of the Soil Barrier Layer extends less than 2-1/2 inches, the Contractor shall uniformly apply moisture to the geomembrane subgrade, back-blade the moisture conditioned surface with a bulldozer and roll the surface with 2 to 4 passes of a smooth-drum roller set at low frequency. If drying extends deeper than 2-1/2 inches, repair of the surface (i.e., the GCL subgrade) shall be in accordance with Part 3.03.D.
3. Prior to the installation of any GCL material, the Geosynthetic Installer and QAC will inspect the surface on which the GCL will be installed. The Geosynthetic Installer or QAC will identify the horizontal limits of any areas requiring remedial work by the Contractor to bring the surface to the specifications required for GCL installation. The QAC will assess the vertical limits of non-conforming barrier layer soil. If the depths of the non-conforming barrier layer soils are contained within the uppermost lift, the Contractor, at his/her option, shall either remove and replace the non-conforming material with material meeting the project specifications, or roto-till, adjust the moisture content and recompact the soil in-place. If the depths of the non-conforming barrier layer soils extend into buried lifts, the non-conforming materials shall be removed and replaced. If subgrade materials are removed and replaced, the exposed barrier layer soils shall be roughened in accordance with the project specifications to promote bonding between lifts. Fill placement shall proceed in accordance with these specifications.

J. Adjoining Lifts: Connecting barrier layer lifts to a completed barrier layer section (as a result of repairs or sequential construction of the barrier layer) shall be accomplished by offsetting the lateral limit(s) of the lift(s) by one-half equipment width to create a horizontal bench(es) without vertical joints that are continuous through both lifts of the barrier layer.

3.04 TESTING

A. General:

1. Materials to be used in the soil barrier layer will be pre-approved by the QAC based on conformance testing of the material in accordance with the QAM. Conformance tests will be completed on each proposed borrow source. Test holes shall be repair by the Contractor by filling the hole with bentonite powder.
2. The QAC will measure the in-place moisture and density of the Soil Barrier Layer material using field tests. Costs for these tests will be paid by the Owner.
3. The Contractor shall perform additional work at no additional cost to the Owner to obtain proper compaction if in-place moisture or density does not meet these specifications.
4. The QAC will observe construction and perform testing at the minimum frequencies set forth in the QAM, and at locations that he will select. The results of these tests will be made available to the Contractor on a timely basis so the Contractor can take such actions as are required to remedy indicated deficiencies.
5. Delivery and compaction of Soil Barrier Layer materials shall be made during the presence of the QAC and shall be subject to additional testing to determine compliance with material, placement, and compaction specifications, at the discretion of the QAC. The QAC's presence does not constitute or include supervision or direction of the actual work by the Contractor, their employees, or agents. Neither the presence of the QAC nor any observations and testing performed by him/her shall excuse the Contractor from defects discovered in his work.

3.05 GRADING

A. Grading: The Contractor shall uniformly grade areas within limits of grading including adjacent transition areas. The Contractor shall smooth finish surfaces within the following specified tolerances:

1. The Soil Barrier Layer shall be a minimum of 12.0 inches thick in all areas. In all areas, the surface of the Soil Barrier Layer shall drain as shown on the Drawings, without localized or widespread depressions, and shall be fine graded to ensure proper drainage of all pipes as shown on the Drawings. Provided these requirements are satisfied, the Soil Barrier Layer shall be fine graded to within +/- 0.1 feet of the grades shown on the Drawings.

[END OF SECTION]

SECTION 02400

GEOMEMBRANE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Supply and install geomembrane for landfill liner system.

1.02 APPLICABLE SECTION

A. Section 02200 - Earthwork

B. Section 02240 - Soil Barrier Layer

C. Section 02510 - Geotextiles

D. Section 02520 - Drainage Geocomposite/Geonet

E. Section 02530 - Geosynthetic Clay Liner

1.03 REFERENCES

A. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

B. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

C. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.

D. ASTM D1204 - Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.

E. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer (Condition 190/2.16).

F. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

G. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics.

H. ASTM D3895 - Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry,

I. ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

J. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

K. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.

L. ASTM D5397 - Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.

M. ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

N. ASTM D5641 - Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

O. ASTM D5721 - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.

P. ASTM D5820 - Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

Q. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.

R. ASTM D5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembrane.

S. ASTM D6392 - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced using Thermo-Fusion Methods.

T. ASTM D6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

U. ASTM D7238 - Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus.

V. ASTM D7466 - Standard Test Method for Measuring Asperity Height of Textured Geomembrane

1.04 QUALITY ASSURANCE PROGRAM

A. The Contractor and Geosynthetic Installer shall agree to participate in and conform to all items and requirements of the QAM.

B. The Contractor and Geosynthetic Installer shall attend the pre-construction meeting.

1.05 QUALITY CONTROL SUBMITTALS

A. Pre-installation: The Geosynthetic Installer shall submit the following to the QAC for approval, prior to delivery of geomembrane to the site.

1. Resin origin (supplier's name and production plant) and identification (brand name and number)

2. Copies of dated quality control certificates issued by resin supplier.

3. Results of tests conducted by geomembrane manufacturer to verify that resin used to manufacture geomembrane meets the specifications in Part 2.01A.
4. Statement that the amount of reclaimed polymer added to resin during manufacturing was done with appropriate cleanliness and did not exceed 10 percent by weight.
5. List of materials that comprise the geomembrane, expressed in the following categories as percent by weight: high-density and low-density polyethylene, carbon black, and other additives.
6. Manufacturer's specification that includes properties listed in Part 2.01A measured using the appropriate test methods.
7. Written certification that minimum values given in geomembrane manufacturer's specification are guaranteed by geomembrane manufacturer.
8. Quality control certificates, signed by a responsible entity employed by geomembrane manufacturer. Each quality control certificate shall include applicable roll identification numbers, testing procedures, and results of quality control tests required by Part 2.03A.
9. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.
10. Resume of the Geosynthetic Installer’s Superintendent to be assigned to this project, including dates and duration of employment.
11. A panel layout drawing showing the proposed installation layout identifying field seams as well as any variance or additional details that deviate from the project plans or specifications. The layout shall be adequate for use as a construction plan and shall include dimensions, details, and the estimated quantity of geomembrane required for the project.
12. The proposed installation schedule.
13. A list of personnel performing field seaming operations along with pertinent experience information.

B. Installation: The Geosynthetic Installer shall submit the following to the QAC as installation proceeds:

1. Quality control documentation recorded during installation.
2. Subgrade surface acceptance certificates, signed by the Geosynthetic Installer, for each area that will be covered directly by geomembrane. The Geosynthetic installer shall submit subgrade surface acceptance certificates to the QAC prior to geomembrane deployment. Deployment of geomembrane will be considered as acceptance of subgrade if certificate is not submitted.

1.06 SAMPLES

A. Geomembrane sampling shall be conducted in accordance with the QAM for the following:

1. Conformance Testing (Part 3.01.A of this section)
2. Destructive Seam Testing (Part 3.04.D of this section)

1.07 DELIVERY, STORAGE, AND HANDLING

A. The Geosynthetic Installer shall inform the Project Manager a minimum of 48 hours before any delivery.

B. Packing and Shipping

1. Labels on each roll delivered to site shall identify the following:
   a. Manufacturer's Name
   b. Product Identification
   c. Thickness
   d. Lot Number
   e. Batch Number
   f. Roll Number
   g. Roll Dimensions
2. The Geosynthetic Installer shall ensure that geomembrane rolls are properly loaded and secured to prevent damage during transit.
3. The Geosynthetic Installer shall protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions.
4. The Geosynthetic Installer shall ensure personnel responsible for loading, transport, and unloading of geomembrane are fully aware of the consequences of damage to geomembrane, and familiar with handling and transport constraints imposed by manufacturer.
5. The Contractor is responsible for providing all equipment and personnel necessary to promptly unload geosynthetic materials upon delivery to the site. The materials shall be stockpiled by the Contractor in accordance with the requirements of these specifications, in the areas designated on the Drawings or as directed by the Project Manager. The Geosynthetic Installer shall provide the Contractor with no less than 24 hours notice prior to all deliveries and shall be present during unloading unless the Geosynthetic Installer has not yet been mobilized to the site.

C. Acceptance at Site

1. The Geosynthetic Installer and the Contractor shall assist the QAC in inventory and inspection for defects and damage, of all geomembrane rolls upon delivery.

2. Damage resulting from handling and transport of geomembranes shall be repaired at no cost to the Owner. If irreparable, in the opinion of the QAC, damaged materials shall be replaced at no cost to the Owner.

D. Storage and Protection

1. The Owner will provide on-site storage area for geomembrane rolls from the time of delivery until installed.

2. The Geosynthetic Installer and the Contractor shall store and protect geomembrane from dirt, water, and other sources of damage.

3. The Geosynthetic Installer and the Contractor shall preserve integrity and readability of geomembrane roll labels.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Unless approved otherwise by the Designer, the geomembrane shall be manufactured using high density polyethylene (HDPE) resin (R1) with the following properties:

PROPERTY	VALUE	METHOD
Density	0.932 g/cc min.	ASTM D1505
Melt Index	1.0g/10 minutes max.	ASTM D1238
Carbon Black Content	2 to 3 percent	ASTM D1603 or D4218

B. Unless approved otherwise by the Designer, geomembrane type GM1 – 40-mil Thick Smooth HDPE Geomembrane shall meet or exceed the properties set forth in Table 02400 - 1.

C. Unless approved otherwise by the Designer, geomembrane type GM2 – 40-mil Thick Double-sided Textured, HDPE Geomembrane shall meet or exceed the properties set forth in Table 02400 - 2.

D. Unless approved otherwise by the Designer, geomembrane type GM3 – 60-mil Thick Smooth, HDPE Geomembrane shall meet or exceed the properties set forth in Table 02400 - 3.

E. Unless approved otherwise by the Designer, geomembrane type GM4 – 60-mil Thick Double-Sided Textured, HDPE Geomembrane shall meet or exceed the properties set forth in Table 02400 - 4.

F. Geomembrane shall be manufactured from new polyethylene resin, with no more than 10% reworked resin allowed. The use of geomembrane recycled during the manufacturing process shall be permitted if done with appropriate cleanliness.

G. Geomembrane manufactured from non-complying resin shall be rejected.

H. Resin shall be designed and manufactured specifically for use in geomembranes.

I. The geomembrane shall have the following characteristics:

1. Contain a maximum of 1 percent by weight of additives, fillers, or extenders (not including carbon black).
2. Contain between 2 percent and 3 percent by weight of carbon black for ultraviolet light resistance. This shall be added to the otherwise pure polyethylene resin as part of resin manufacturing or roll manufacturing process.
3. Contain no pinholes, bubbles, or other surface features that compromise geomembrane integrity. The geomembrane shall be free of blisters, nondispersed raw materials, or other signs of contamination by foreign matter.

2.02 SEAMING AND TESTING EQUIPMENT

A. Welding: The Geosynthetic Installer shall:

1. Maintain on-site a minimum of two spare operable seaming apparatus, unless otherwise agreed upon at pre-construction meeting.
2. Use seaming equipment that does not damage geomembrane.
3. Protect geomembrane from damage in trafficked areas.
4. Use extrusion welding apparatus equipped with gauges giving temperature of extrudate at nozzle of apparatus or utilize hand-held gauges to measure extrudate temperatures.
5. Use fusion-welding apparatus that are self-propelled devices equipped with the following:
   a. A gauge indicating temperature of heating element.
   b. A method of monitoring relative pressure applied to geomembrane.

B. Vacuum testing equipment shall consist of the following:

1. Vacuum box assembly consisting of: rigid housing, transparent viewing window, soft neoprene gasket attached to bottom of housing, porthole or valve assembly, and vacuum gauge.
2. Pump assembly equipped with pressure controller and pipe connections.
3. Pressure/vacuum rubber hose with fittings and connections.
4. Bucket of soapy solution.

5. Wide paint brush, or other means of applying soapy solution.

C. Air pressure testing equipment shall consist of the following:

1. Air pump (manual or motor driven), equipped with a pressure gauge, capable of generating, sustaining, and measuring pressure between 20 and 30 psi, and mounted on a cushion to protect geomembrane.

2. Rubber hose with fittings and connections.

3. Sharp hollow needle, or other approved pressure feed device.

4. An air pressure monitoring device.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Geomembranes shall be tested by geomembrane manufacturer for quality control to demonstrate that material meets these specifications.

2. Geomembrane manufacturer shall continuously monitor during manufacturing process for inclusions, bubbles, or other defects. Geomembranes which exhibit defects shall not be delivered to the site.

3. Geomembrane manufacturer shall monitor thickness continuously during manufacturing process. No geomembrane shall be acceptable for installation which fails to meet specified values.

4. The Geomembrane Manufacturer shall, at a minimum, perform the following tests:

   a. Density, ASTM D1505;

   b. Carbon black content, ASTM D1603 or D4218;

   c. Carbon black dispersion, ASTM D5596;

   d. Thickness, ASTM D5199 (smooth) or ASTM D5994 (textured);

   e. Tensile properties, ASTM D6693;

   f. Puncture resistance, ASTM D4833; and

   g. Asperity, ASTM D7466 (textured materials only).

   The Geomembrane Manufacturer shall perform these tests on geomembrane at a minimum of once every 50,000 ft^2 with the exceptions of carbon black dispersion and puncture resistance that shall be tested at a minimum of once every 70,000 ft^2. Samples not satisfying specifications shall result in rejection of the rolls represented by the tests. At the geomembrane manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify non-complying rolls and to qualify individual rolls.

5. The Geomembrane Manufacturer shall perform stress crack resistance testing ASTM D5397 on geomembrane at a minimum of once every resin batch.

6. The following tests need not be run at 1 per 50,000 ft^2 or 70,000 ft^2 frequencies. The Geomembrane Manufacturer, however, shall submit signed certifications that these tests have been performed for each resin in accordance with test methods specified in Part 2.01A of this section.

   a. Dimensional stability, ASTM D1204, modified and

   b. Low temperature brittleness, ASTM D746.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Conformance Testing

1. The QAC will collect samples of geomembrane to be installed, for conformance testing, as outlined in the QAM. The Geosynthetic Installer may request retesting of failed conformance tests, as outlined in the QAM. The Geosynthetic Installer shall bear cost of retesting if results lead to material rejection. The QAC shall bear cost of retesting if original conformance tests are found to be in error.

3.02 PREPARATION

A. Surface Preparation

1. Within 12 hours prior to deployment on any given work day, the Geosynthetic Installer shall inspect the subgrade in the area of deployment for that day. Prior to deploying geomembrane, the Geosynthetic Installer shall sign subgrade acceptance forms and submit them to the QAC.

2. After prepared surface has been accepted, the Geosynthetic Installer shall inform the QAC of any change in supporting soil (i.e., subgrade) condition that may require repair work. The Contractor shall maintain an acceptable prepared soil surface.

3. The Geosynthetic Installer shall not place geomembrane onto an area that has become softened by precipitation or cracked due to desiccation. The Geosynthetic Installer shall frequently evaluate softening and desiccation cracking and inform the QAC of conditions that are inadequate for deployment.

4. The Contractor shall, at no additional cost to the Owner, repair damage to the subgrade caused by installation activities.

3.03 INSTALLATION

A. Panel Nomenclature

1. A field panel is defined as a unit of geomembrane which is to be seamed in the field, that is, a field panel is a roll or a portion of roll cut in the field.

2. The Geosynthetic Installer shall identify each field panel with an identification code (number or letter-number). This identification code shall be agreed upon by the QAC.

B. Protection. The Geosynthetic Installer shall:

1. Not use equipment which damages geomembrane during handling or trafficking, or by excessive heat, leakage of hydrocarbons, or other means. The use of any vehicular equipment by the Geosynthetic Installer to deploy liner components is subject to the approval of the QAC. Such equipment may include low-ground-pressure rubber tire vehicles, if the QAC deems the use of such equipment allowable for the conditions and methods proposed by the Geosynthetic Installer. In all cases, operation of such approved vehicles directly on the geosynthetic components of the liner system shall be exclusively for deployment purposes only.

2. Not permit personnel to smoke or wear shoes that can damage the geomembrane while working on geomembrane. Personnel shall not bring glass bottles on geomembrane.

3. Unroll panels in a manner which does not cause excessive scratches or crimps in geomembrane and does not damage supporting soil.

4. Place panels in a manner which minimizes wrinkles, especially differential wrinkles between adjacent panels, while providing sufficient material to prevent bridging. In the event of bridging, repairs may include compensation panels, etc., which shall be approved by the QAC.

5. Prevent wind uplift by providing adequate temporary loading or anchoring (for example, sandbags and tires) that shall not damage geomembrane. In case of high winds, provide continuous loading along panel edges.

6. Protect geomembrane in areas where excessive traffic is expected with geotextiles or extra geomembrane.

C. Field Panel Deployment. The Geosynthetic Installer shall:

1. Install field panels at locations that, unless approved otherwise by the QAC, are in general accordance with the Geosynthetic Installer’s proposed panel layout plan.

2. Replace torn, twisted, or crimped field panels, or portions, at no cost to Owner. Repair less serious damage according to Part 3.03.H of this section. The QAC shall determine if material is to be repaired or replaced.

3. Remove from work area damaged panels or portions of damaged panels which have been rejected.

4. Not proceed with deployment at an air temperature below 32 degrees Fahrenheit or above 104 degrees Fahrenheit unless otherwise authorized by the QAC.

5. Not deploy during precipitation, in the presence of excessive moisture such as fog or dew, in an area of pond water or during excessive winds.

6. Not undertake deployment if weather conditions will preclude material seaming on same day as deployment.

7. Not deploy more geomembrane field panels in one day than can be seamed during that day.

D. Seam Layout. The Geosynthetic Installer shall:

1. Orient seems in general accordance with the proposed Panel Layout Drawing, unless approved otherwise by the QAC.

2. Orient seams parallel to line of maximum slope, such as oriented along, not across, the slope. Horizontal seams on slopes steeper than 10H:1V will not be allowed without written approval by the Designer.

3. Place panels such that no horizontal seams are closer than 5 feet from toe of slope on liner floor.

4. Not locate seams in areas of potential stress concentrations.

5. Maximize lengths of field panels and minimize number of field seams, where practicable.

E. Temporary Bonding. The Geosynthetic Installer shall:

1. Be allowed to use hot air devices (Liester) to temporarily bond geomembrane panels that are to be extrusion welded.

2. Apply minimal amount of heat to lightly tack geomembrane panels together, and control temperature of hot air at nozzle of any temporary welding apparatus to prevent damage to geomembrane.

3. Not use solvent or adhesive.

F. Seaming Methods. Approved processes for field seaming are extrusion fillet welding and fusion welding. Proposed alternate processes shall be documented and submitted to the QAC for review. Alternate seaming procedures shall be used only after being approved in writing by the QAC, the Designer, and the Project Manager.

1. The Geosynthetic Installer shall produce seams (both fusion and extrusion) meeting the following requirements:

a. For HDPE Geomembrane (Types GM1, GM2, GM3, and GM4):

PROPERTY	SPECIFIED VALUE(1)	TEST METHOD
Bonded Seam Shear Strength	90% of PMTYS(2) (3)	ASTM D6392

PROPERTY	SPECIFIED VALUE(1)	TEST METHOD
Peel Adhesion	52% of PMTYS$^{(2)(3)}$	ASTM D6392

(1) Criteria in Part 3.04 D.6 must be met.

(2) Parent Material Tensile Yield Strength (PMTYS) determined in accordance with Part 3.03 F.1.b or Part 3.03 F.1.c.

(3) In addition to the minimum passing values, passing seams shall not separate more than 10 percent of the width into the weld and shall exhibit the following location of breaks:

Fusion Welded Seams – BRK, SE1, SE2, and AD-BRK

Extrusion Welded Seams – SE1, SE2, SE3, BRK1, and BRK2

Observation of Film Tear Bond (FTB) is acceptable in the field.

b. The parent material tensile yield strength (PMTYS) for each type of geomembrane shall be defined as the average from a minimum of 10 samples obtained at a frequency of at least one sample every 25,000 ft^2 from geomembrane rolls designated for the project at the manufacturing facility or delivered to the site prior to the commencement of deployment activities. The samples shall be a minimum of 12 inches by 12 inches and shall be taken from the side edges of the rolls, but not closer than 2 feet from the end of a roll. Five 1-inch wide specimens shall be cut in the cross-machine direction from each sample and tested in accordance with ASTM D6693 (see Part 1.03).

c. If geomembrane rolls arrive at the site after the average PMTYS (as described in Part 3.03.F.1.b) has been determined, then additional tensile testing will be performed on sample(s) from the additional rolls at a frequency of at least one sample every 50,000 ft^2. If the average PMTYS from the additional samples is within ±10 percent of the original average PMTYS, then the original average shall continue to govern all seams. If, however, the average PMTYS from the additional samples is not within ±10 percent of the original average PMTYS, then an average PMTYS from the additional samples will be determined in accordance with Part 3.03.F.1.b and used as the PMTYS for seams using the additional geomembrane rolls. For seams where the original geomembrane is connected to the additional geomembrane, the lesser of the two average PMTYS values will govern.

2. The Geosynthetic Installer shall align geomembrane panels to have an overlap of 3 inches for extrusion welding and 5 inches for fusion welding, providing sufficient overlap to allow peel tests to be performed on seam.

3. The Geosynthetic Installer shall use double-fusion welding as the primary method of seaming adjacent field panels, and:

a. For cross seam tees, associated with fusion welding, extrusion weld to a minimum distance of 4 inches on each side of tee.

b. Place electric generators on a smooth base such that no damage occurs to geomembrane. Any fuel spills shall be cleaned up and reported to QAC and the Project Manager.

c. Place a protective layer, such as insulating plate or fabric, beneath hot welding apparatus after usage.

d. When subgrade conditions dictate, use a movable protective layer such as extra piece of geomembrane, directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent dust or debris from collecting around pressure rollers.

4. The Geosynthetic Installer shall use conventional fillet extrusion welding as a secondary method for seaming between adjacent panels and as a primary method of welding for detail and repair work. The Geosynthetic Installer shall:

a. Purge heat-degraded extrudate from barrel of extruder under the following conditions:

i. Prior to beginning a seam.

ii. Whenever extruder has been inactive.

b. Place electric generator on a smooth base so no damage occurs to geomembrane.

c. Place a smooth insulating plate or fabric beneath hot welding apparatus after usage.

d. Use clean and dry welding rods or extrudate pellets.

e. Complete grinding process, without damaging geomembrane, within one hour of seaming operation. Remove sufficient material to smooth textured surface.

f. Minimize exposed grinding marks adjacent to an extrusion weld, specifically not allowing exposed grinding marks to extend more than ¼-inch outside the finished seam area.

g. Perform grinding such that it does not exceed 10% of parent material thickness and is perpendicular to seam where practical. The edge of the upper sheet should be beveled during grinding.

G. Seaming Procedures

1. General Seaming Conditions shall be as follows:

a. Ambient temperature between 32 and 104 degrees Fahrenheit;

b. Dry conditions such as no precipitation nor other excessive moisture, such as fog or dew; and

c. No excessive winds.

2. General Seaming Procedures. The Geosynthetic Installer shall:

a. If required, provide a firm substrate by using an extra piece of geomembrane, or similar hard surface directly under seam overlap to achieve proper support for seaming apparatus.

b. Align seams with the fewest possible number of wrinkles and fishmouths.

c. Provide adequate illumination if seaming operations are carried out at night.

d. Extend seams to outside edge of panels placed in anchor trench.

e. Not field seam without master seamer being present.

f. Prior to seaming, ensure that seam area is clean and free of moisture, dust, dirt, debris, or foreign material of any kind.

g. Cut fishmouths or wrinkles along ridge of wrinkle in order to achieve a flat overlap. Seam the cut fishmouths or wrinkles and patch portions where overlap is inadequate. Use oval or round patch of same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

3. Cold Weather Seaming Procedures. The Geosynthetic Installer shall meet the additional following conditions if seaming is conducted when ambient temperature is below 32 degrees Fahrenheit. Ambient temperature will be determined by the QAC by measuring the air temperature at a height of 18 to 36 inches above the liner.

a. The QAC shall determine geomembrane surface temperatures at intervals of at least once per 100 feet of seam length or at start and end of seam if less than 100 feet to determine if preheating is required. For extrusion welding, preheating is required if surface temperature of geomembrane is below 32 degrees Fahrenheit.

b. Preheating may be waived based on recommendation from the QAC, if demonstrated that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

c. If preheating is required, QAC shall observe all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been subjected to excessive heating.

d. The QAC shall confirm that surface temperatures are not lowered below minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for seam area at no cost to Owner.

e. Preheating devices used shall be pre-approved by the QAC prior to use.

f. Additional destructive seam tests (as described in Part 3.04.D of this section) shall be performed as requested by the QAC.

g. Sheet grinding may be performed before preheating, if required.

h. Trial seaming, as described in Part 3.04.B of this Section, shall be conducted under the same ambient temperature and preheating conditions as the actual seams. New trial seams shall be conducted if ambient temperature drops by more than 10^{o} Fahrenheit from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature drop.

4. Warm Weather Procedures. The Geosynthetic Installer shall meet the following conditions, in addition to general seaming procedures, if seaming is conducted when ambient temperature is above 104^{o} Fahrenheit.

a. At ambient temperatures above 104^{o} Fahrenheit no seaming of geomembrane shall be permitted unless demonstrated to the QAC's satisfaction that geomembrane seam quality will not be compromised.

b. New trial seams shall be conducted if ambient temperature rises by more than 10^{o} Fahrenheit from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature rise.

c. Additional destructive seam tests (as described in Part 3.04.D) shall be performed as requested by the QAC.

H. Repair Procedures:

1. The Geosynthetic Installer shall repair portions of geomembrane exhibiting a flaw or failing a destructive or nondestructive test.

2. Final decision as to appropriate repair procedure shall be as approved by the QAC.

3. Repair Alternatives:

a. Patching: A piece of same geomembrane extrusion welded into place. Use to repair large holes, tears, nondispersed raw materials, and contamination by foreign matter.

b. Spot welding or seaming: A bead of molten extrudate placed on flaw. Use to repair small tears, pinholes, or other minor, localized flaws.

c. Capping: A strip of same geomembrane extrusion welded into place over an inadequate seam. Use to repair large lengths of failed seams.

d. Removal and replacement: Remove bad seam and replace with a strip of same geomembrane welded into place. Use to repair large lengths of failed seams.

e. It is noted that extrusion welding the overlap flap of a fusion weld shall NOT be considered an acceptable repair technique for this project.

4. For any repair method, the Geosynthetic Installer shall:

a. Grind surfaces of geomembrane which are to be repaired using extrusion methods, in accordance with Part 3.03.F.4.

b. Ensure surfaces are clean and dry at time of repair.

c. Ensure seaming equipment used in repairing procedures meets specification requirements.

d. Extend patches or caps at least 6 inches beyond edge of defect. Round corners of patches with a radius of at least 3 inches.

5. The Geosynthetic Installer shall not place overlying layers over locations which have been repaired until appropriate passing nondestructive and destructive (laboratory) test results are obtained, and the QAC has approved the repairs.

I. Anchor Trench. The Geosynthetic Installer shall:

1. Verify anchor trenches are constructed to lines and grades shown on design drawings, prior to geomembrane placement.

2. Verify slightly rounded corners are in anchor trench to avoid sharp bends in geomembrane.

3. Remove all construction-related debris from anchor trench.

4. Ensure excessive amounts of loose soil do not underlie geomembrane in anchor trench.

5. Coordinate activities with the Contractor to ensure that the anchor trench will be adequately drained to prevent ponding or softening of adjacent soils while trench is open. Dewatering the anchor trench is the responsibility of the Contractor.

6. Coordinate activities with the Contractor so anchor trench can be backfilled and compacted after geomembrane installation is completed.

3.04 FIELD QUALITY CONTROL

A. Visual Inspection. The Geosynthetic Installer shall:

1. Allow the QAC to examine seam and non-seam areas of geomembrane for identification of defects, holes, blisters, nondispersed raw materials, and any sign of contamination by foreign matter.

2. Clean and wash geomembrane surface if the QAC determines that the amount of dust or mud inhibits examination.

3. Not seam any geomembrane panels that have not been examined for flaws by the QAC.

4. Nondestructively test each suspect location as in seam and non-seam areas using methods described in Part 3.04.C of this section as appropriate.

B. Trial Seams. The Geosynthetic Installer shall:

1. Make trial seams on fragment pieces of same geomembrane liner to verify that conditions are adequate for production seaming.

2. Make trial seams at the beginning of each seaming period and at the beginning of each five-hour period for each seaming apparatus used that day. Each seamer shall make at least one trial seam each day when that seamer welds. Additional trial welds will be required by the QAC when a seaming apparatus is shut-off, power is interrupted, temperature settings are adjusted and/or weather conditions change.

3. Make trial seams under same field conditions as actual seams.

4. Make trial seams only under observation of the QAC.

5. Make trial seam overlap as indicated in Part 3.03.F of this section.

6. Make trial seam sample at least 5 feet long by 1-foot wide (after seaming) with seam centered lengthwise.

7. Cut four specimens from sample with a 1-inch wide die. These specimen locations shall be selected randomly along trial seam sample by the QAC. Test specimens in peel (both tracks), and shear using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute, and shall be calibrated, with a certificate of calibration less than one year old kept with the tensiometer. Specimens must pass the criteria set forth in Part 3.04 D.5 of this section. Allow the QAC to document test results.

8. If a specimen fails, the entire trial seam test operation shall be repeated. If the additional specimen fails, the Geosynthetic Installer shall not use seaming apparatus and seamer until the deficiencies are corrected and two consecutive successful trial welds are achieved.

C. Nondestructive Seam Testing

1. General. The Geosynthetic Installer shall:

a. Nondestructively test field seams over their full length using a vacuum test (for extrusion seams), air pressure (for double-fusion seams), or other method as approved by the QAC.

b. Perform nondestructive testing and document test results as seaming work progresses, not at the completion of all field seaming.

2. The following procedure shall be used by the Geosynthetic Installer for Vacuum Testing of all extrusion seams. If additional instruction is required, refer to ASTM D5641.

    a. Energize vacuum pump and reduce tank pressure to approximately 5 psi (10 inch of mercury) gauge pressure.

    b. Wet strip of geomembrane approximately 12-inch by 48-inch with soapy solution. The Geosynthetic Installer shall demonstrate to the QAC the sudsing characteristics of the solution.

    c. Place box over wetted area.

    d. Close bleed valve and open vacuum valve.

    e. Ensure that a leak-tight seal is created.

    f. For a period of not less than 15 seconds, apply vacuum and examine geomembrane through viewing window for presence of soap bubbles.

    g. If no bubbles appear within 15 seconds, close vacuum valve and open bleed valve, move box over to next adjoining area with a minimum 3-inch overlap and repeat process.

    h. Mark and repair areas where soap bubbles appear in accordance with Part 3.03.H of this section.

3. The following procedure shall be used by the Geosynthetic Installer for Air Pressure Testing of all Double-Track Fusion Seams. If additional is required, refer to ASTM D5820.

    a. Temporarily seal both ends of seam to be tested using locking pliers or other method as approved by the QAC.

    b. Insert needle or other approved pressure feed device into air channel created by fusion weld.

    c. Place a protective layer between air pump and geomembrane.

    d. Pressurize air channel to a pressure of approximately 30 psi. Close valve and allow pressure to stabilize for approximately 2 minutes. Ensure after 2-minute stabilization period the pressure is within 24 to 30 psi.

    e. Observe the air pressure 5 minutes after the initial 2-minute stabilization period ends. If pressure loss exceeds a Maximum Permissible Pressure Differential of 4 psi for 40-mil; 3 psi for 60-mil, or the pressure does not stabilize, locate faulty area and repair in accordance with Part 3.03.H.

    f. Cut opposite end of tested seam area once testing is completed to verify continuity of air channel. If air does not escape, locate blockage and retest unpressurized area. Repair cut end of air channel in accordance with Part 3.03.H of this section.

g. Remove needle or other approved pressure feed device and seal hole in the annulus.

4. Inaccessible Seams. The Geosynthetic Installer shall:

   a. Cap-strip seams that cannot be nondestructively tested using material composed of the same type and thickness geomembrane as the geomembrane to be capped.

   b. Examine cap-stripping operations with the QAC for uniformity and completeness.

D. Destructive Seam Testing

1. General:

   a. The destructive seam testing program shall be implemented as seaming progresses; not at the completion of all field work.

   b. A failed destructive seam sample shall result if grips of testing machine cannot be closed on sample test flap (available flap is ½-inch long or less) due to excessive temporary welding.

2. Location and Frequency:

   a. Test at a minimum frequency of one test location per 1,000 linear ft of seam length. This minimum frequency is to be determined as an average taken throughout the entire facility.

   b. Test locations shall be determined during seaming, with samples obtained at locations selected by the Geosynthetic QAC.

   c. The Geosynthetic Installer will not be informed in advance of the locations where seam samples will be taken.

   d. The Owner reserves the right to increase the frequency of testing in accordance with performance results of samples previously tested.

3. Sampling Procedures. The Geosynthetic Installer shall:

   a. Cut samples at locations chosen by the Geosynthetic QAC.

   b. Repair holes in geomembrane resulting from destructive seam sampling immediately in accordance with repair procedures described in Paragraph 3.03.H of this section.

   c. Nondestructively test continuity of new seams in the repaired area according to Paragraph 3.04.C of this section.

4. Sample Dimensions: The Geosynthetic Installer shall take the following two types of samples at each sampling location. Final determination of sample sizes shall be agreed upon at the preconstruction meeting. Sample sizes shall be as small as possible, but shall be adequate for the required/anticipated test program.

a. Take two samples for field testing. Cut each of these samples with a 1 inch wide die, with seam centered parallel to width. The distance between these two samples shall be 42 inches. If both samples pass the field test described in Paragraph 3.04.D.5 of this section, take a sample for laboratory testing as described in Paragraph b below.

b. The sample for laboratory testing shall be located between the samples cut for field testing. Cut sample for laboratory testing 42 inches along the seam by 14 inches wide across the seam. Cut this sample into three equal parts, distributed as follows:

   i. One portion to the Geosynthetic Installer for optional laboratory testing.

   ii. One portion to the Geosynthetic QAC to be sent to the Geosynthetic Quality Assurance Laboratory (QAL) for testing.

   iii. One portion to the Project Manager for archive storage until acceptance of project record documents.

5. Field Testing. The Geosynthetic Installer shall:

   a. Test the two 1-inch-wide strips described in Paragraph 3.04.D.4 for peel (both tracks) and shear strength. Use a tensiometer as described in Paragraph b below to conduct these tests. These tests shall not fail according toSeam strength shall meet the criteria in Part 3.03.F.1 of this section.

   b. Use a tensiometer capable of maintaining a constant jaw separation rate of two inches per minute. The tensiometer shall be calibrated, and a certificate of calibration less than one year old kept with the tensiometer.

   c. Test field samples only under the QAC's observation.

   d. If test sample passes in accordance with this Section, the seam qualifies for laboratory testing.

   e. If any field test sample fails to pass, then follow procedures outlined in Part 3.04.D.7 of this section.

   f. Final judgment regarding seam acceptability, based on failure criteria in these specifications, rests with the QAC.

6. The following procedure shall be applied to determine pass or fail criteria for each scan tested destructively at laboratory.

   a. Part 3.03.F.1 of this section shall be used to determine pass/fail criteria.

   b. Four out of five samples shall pass as follows:

      i. Extrusion Weld: Bonded seam strength and peel adhesion.

ii. Fusion Weld: Bonded seam strength and peel adhesion for both tracks (double track).

c. The fifth sample's values must exceed 50 percent of the first four samples' criteria.

d. Locus of break shall be reported.

7. Destructive Test Failure Procedures. The Geosynthetic Installer shall apply the following procedures when a sample fails destructive testing, whether that test is conducted by the Geosynthetic QAL or by the Geosynthetic Installer using a field tensiometer.

a. The Geosynthetic Installer has following options:

i. Repair seam between any two passing destructive test locations.

ii. Trace welding path to an intermediate point 10 feet minimum from point of failed test in each direction) and take a small sample with a 1-inch wide die for an additional field test at each location. If these additional samples pass the test, take full laboratory samples. If these laboratory samples pass the tests, repair seam between these locations. If either sample fails, repeat process to establish zone in which seam should be repaired.

b. Acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet of repaired seam, a sample taken from zone in which seam has been repaired shall pass destructive testing. The Geosynthetic Installer shall make repairs in accordance with Part 3.03.H.

c. When a sample fails, the QAC may require additional destructive testing of seams that were welded by the same welder and/or welding apparatus during the same time shift.

E. Repair Verification. The Geosynthetic Installer shall:

1. Nondestructively test each repair using methods described in Part 3.04.C as appropriate. Document test results. Passing nondestructive test results indicate an adequate repair.

2. Repairs more than 150 feet long require destructive test sampling, in accordance with Part 3.04.D of this section. Failed destructive or nondestructive tests indicate that the repair shall be redone and retested until passing nondestructive and destructive test results are obtained.

F. Large Wrinkles - A wrinkle is considered to be large when geomembrane can be folded over onto itself.

1. When seaming of geomembrane liner is completed, and prior to placing overlying materials, the Geosynthetic Installer shall accompany the QAC in identifying all excessive geomembrane wrinkles.
2. The Geosynthetic Installer shall cut and reseam all wrinkles identified by QAC. Testing seam produced while repairing wrinkles in accordance with Part 3.03.H. When practicable, wrinkle repairs should be made during coldest part of installation period.

3.05 COMPLETION

A. Upon completion of the installation, the Geosynthetic Installer shall submit:

1. The warranty obtained from the Manufacturer.
2. The installation warranty.

Table 02400 - 1
REQUIRED PROPERTY VALUES FOR
40-MIL THICK SMOOTH HDPE GEOMEMBRANE

Properties	Test Method	Test Value
Thickness (min. ave.) • lowest individual of 10 values	ASTM D5199	nom. 40 mil -10%
Formulated Density mg/l (min.)	ASTM D1505/D792	0.940 g/cc
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	ASTM D6693 Type IV	84 lb/in. 152 lb/in. 12% 700%
Tear Resistance (min. ave.)	ASTM D1004	28 lb
Puncture Resistance (min. ave.)	ASTM D4833	72 lb
Stress Crack Resistance *(2)*	ASTM D5397 (App.)	500 hr.
Carbon Black Content (range)	ASTM D4218 *(3)*	2.0-3.0%
Carbon Black Dispersion	ASTM D5596	note *(4)*
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT; or (b) High Pressure OIT	 ASTM D3895 ASTM D5885	 100 min. 400 min.
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days; or (b) High Pressure OIT (min. ave.) - % retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	 55% 80%
UV Resistance *(7)* (a) Standard OIT (min. ave.); or (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	ASTM D7238 ASTM D3895 ASTM D5885	 N.R. *(8)* 50%

Notes

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gage length of 1.3 inches; break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(10) Table adapted from GRI GM13.

Table 02400 - 2
REQUIRED PROPERTY VALUES FOR
40-MIL THICK DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE

Properties	Test Method	Test Value
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	ASTM D5994	nom. (-5%) -10% -15%
Asperity Height mils (min. ave.) *(1)*	ASTM D7466	16 mil
Formulated Density (min. ave.)	ASTM D1505/D792	0.940 g/cc
Tensile Properties (min. ave.) *(2)* • yield strength • break strength • yield elongation • break elongation	ASTM D6693 Type IV	84 lb/in. 60 lb/in. 12%. 100%
Tear Resistance (min. ave.)	ASTM D1004	28 lb
Puncture Resistance (min. ave.)	ASTM D4833	60 lb
Stress Crack Resistance *(3)*	ASTM D5397 (App.)	500 hr.
Carbon Black Content (range)	ASTM D4218 *(4)*	2.0-3.0 %
Carbon Black Dispersion	ASTM D5596	note *(5)*
Oxidative Induction Time (OIT) (min. ave.) *(6)* (a) Standard OIT; or (b) High Pressure OIT	 ASTM D3895 ASTM D5885	 100 min. 400 min.
Oven Aging at 85°C *(6), (7)* (a) Standard OIT (min. ave.) - % retained after 90 days; or (b) High Pressure OIT (min. ave.) - % retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	 55% 80%
UV Resistance *(8)* (a) Standard OIT (min. ave.); or (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	ASTM D7238 ASTM D3895 ASTM D5885	 N.R. *(9)* 50%

Notes

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gage length of 1.3 inches; break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(11) Table adapted from GRI GM13.

(12) Regardless of Asperity value, the geomembrane must be tested in accordance with the Interface and Internal Shear Resistance Testing Program Work Plan and validated by project specific stability analysis.

Table 02400 - 3
REQUIRED PROPERTY VALUES FOR
60-MIL THICK SMOOTH HDPE GEOMEMBRANE

Properties	Test Method	Test Value
Thickness (min. ave.) • lowest individual of 10 values	ASTM D5199	nom. 60 mil -10%
Formulated Density mg/l (min.)	ASTM D1505/D792	0.940 g/cc
Tensile Properties *(1)* (min. ave.) • yield strength • break strength • yield elongation • break elongation	ASTM D6693 Type IV	126 lb/in. 228 lb/in. 12% 700%
Tear Resistance (min. ave.)	ASTM D1004	42 lb
Puncture Resistance (min. ave.)	ASTM D4833	108 lb
Stress Crack Resistance *(2)*	ASTM D5397 (App.)	500 hr.
Carbon Black Content (range)	ASTM D4218 *(3)*	2.0-3.0%
Carbon Black Dispersion	ASTM D5596	note *(4)*
Oxidative Induction Time (OIT) (min. ave.) *(5)* (a) Standard OIT; or (b) High Pressure OIT	 ASTM D3895 ASTM D5885	 100 min. 400 min.
Oven Aging at 85°C *(5), (6)* (a) Standard OIT (min. ave.) - % retained after 90 days; or (b) High Pressure OIT (min. ave.) - % retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	 55% 80%
UV Resistance *(7)* (a) Standard OIT (min. ave.); or (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	ASTM D7238 ASTM D3895 ASTM D5885	 N.R. *(8)* 50%

Notes

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gage length of 1.3 inches; break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(10) Table adapted from GRI GM13.

Table 02400 - 4
REQUIRED PROPERTY VALUES FOR
60-MIL THICK DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE

Properties	Test Method	Test Value
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	ASTM D5994	nom. (-5%) -10% -15%
Asperity Height mils (min. ave.) *(1)*	ASTM D7466	16 mil
Formulated Density (min. ave.)	ASTM D1505/D792	0.940 g/cc
Tensile Properties (min. ave.) *(2)* • yield strength • break strength • yield elongation • break elongation	ASTM D6693 Type IV	126 lb/in. 90 lb/in. 12% 100%
Tear Resistance (min. ave.)	ASTM D1004	42 lb
Puncture Resistance (min. ave.)	ASTM D4833	90 lb
Stress Crack Resistance *(3)*	ASTM D5397	500 hr.
Carbon Black Content (range)	ASTM D4218 *(4)*	2.0-3.0 %
Carbon Black Dispersion	ASTM D5596	note *(5)*
Oxidative Induction Time (OIT) (min. ave.) *(6)* (a) Standard OIT; or (b) High Pressure OIT	 ASTM D3895 ASTM D5885	 100 min. 400 min.
Oven Aging at 85°C *(6), (7)* (a) Standard OIT (min. ave.) - % retained after 90 days; or (b) High Pressure OIT (min. ave.) - % retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	 55% 80%
UV Resistance *(8)* (a) Standard OIT (min. ave.); or (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	ASTM D7238 ASTM D3895 ASTM D5885	 N.R. *(9)* 50%

Notes

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gage length of 1.3 inches; break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.

The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(11) Table adapted from GRI GM13.

(12) Regardless of Asperity value, the geomembrane must be tested in accordance with the Interface and Internal Shear Resistance Testing Program Work Plan and validated by project specific stability analysis.

[END OF SECTION]

SECTION 02510

GEOTEXTILES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools and equipment and perform all operations necessary to furnish, deploy, and install geotextiles in the areas indicated on the Drawings, except for placing Geotextile Fabric components of the liner, which will be performed by the Geosynthetic Installer.

1.02 APPLICABLE SECTIONS

A. Section 02120 - Temporary Erosion Control

B. Section 02170 - Wick Drains and Underdrain

C. Section 02200 - Earthwork

D. Section 02240 - Soil Barrier Layer

E. Section 02520 - Drainage Geocomposite/Geonet

F. Section 02560 - Stormwater Piping

G. Section 02570 - Manholes, Sump, and Catchbasins

H. Section 02780 - HDPE Piping

1.03 REFERENCES

A. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a XenonArc Type Apparatus. Modification: Utilize ASTM D4632 to evaluate effect of exposure on geotextile.

B. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

C. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextile.

D. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

E. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

F. ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

G. ASTM D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

H. GRI Test Method GT12(a) - Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials.

1.04 QUALITY CONTROL SUBMITTALS

A. Prior to delivery of geotextile for installation within the landfill liner or cover system, the Geosynthetic Installer shall submit the following information to the QAC:

1. Written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles using a metal detector and found the geotextile to be needle-free.

2. Written quality control certificates, signed by a responsible party employed by the Manufacturer and stating that the product will meet the minimum values given in the specification are guaranteed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for:

   a. Mass per unit area (ASTM D5261)

   b. Grab strength (ASTM D4632)

   c. Trapezoidal tear strength (ASTM D4533)

   d. Puncture strength (ASTM D4833 or D6241)

   These quality control tests shall be performed in accordance with the test methods for at least 100,000 ft^2 of geotextile produced within each lot.

B. For Geotextile that is not part of the liner/cover system, the Contractor or Geosynthetic Installer shall submit to the QAC samples of the proposed geotextiles, and certification that the geotextiles meet the required specifications, prior to delivery of materials to the site.

C. The following shall be maintained by the geotextile Manufacturer or Geosynthetic Installer and will be available upon request:

1. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.

2. Reports on tests conducted by the Manufacturer to verify that resin used to manufacture the geotextile meets the Manufacturer's resin specifications.

3. A list of the materials which comprise the geotextile, expressed in the following categories as percent by weight: base polymer, carbon black, other additives.

1.05 MATERIALS SHIPPING, STORAGE, AND HANDLING

A. Shipping:

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

2. Geotextile rolls shall be marked or tagged with the following information:

   a. Manufacturer's name;

   b. Product identification;

   c. Roll number; and

   d. Roll dimensions.

3. The Contractor is responsible for providing all equipment and personnel to promptly unload geosynthetic materials upon delivery to the site. The materials shall be stockpiled by the Contractor in accordance with the requirements of these specifications, in the areas designated on the Drawings or as directed by the Project Manager. The Geosynthetic Installer shall provide the Contractor with no less than 24 hours notice prior to all deliveries and shall be present during unloading unless the Geosynthetic Installer has not yet been mobilized to the site.

B. Storage and Handling:

1. The Contractor and Geosynthetic Installer shall be responsible for the handling, storage and care of geotextiles from the time of delivery to the site until final acceptance of the completed work by the Project Manager. The Contractor and Geosynthetic Installer shall be liable for all damages to the materials during such time.

PART 2 - PRODUCTS

2.01 GENERAL

A. The geotextiles provided shall meet or exceed the property values specified herein. Geotextiles shall be comprised of polymeric yarns or fibers or weld or drawn strands oriented into a stable network which will retain its structure during handling, placement, and long-term service. The geotextile must be certified as exhibiting no less than 70% strength at 500 hours when tested using ASTM D4355.

B. Synthetic fabrics shall be non-biodegradable. The Contractor shall follow the manufacturer's recommendations regarding handling and installation of such materials.

2.02 GEOTEXTILE FABRIC

A. (Nonwoven) Geotextile Fabric, Types NW7, NW10, NW12, NW16 shall be non-woven, polypropylene or polyester material which meets the following minimum average roll values in accordance with GRI-GT12(a). Polyester materials shall not be used as the geotextile fabric wrapped around 1-1/2-inch Crushed Stone surrounding primary, secondary, surface water management system pipes, and leachate collection/detection header pipes. Polyester materials may be used for site drainage construction, or as a component of the geocomposite drainage layer, as set forth in Section 02520.

FABRIC PROPERTY	TEST METHOD	FABRIC REQUIREMENT				
		Type NW7	Type NW10	Type NW12	Type NW16	Type NW32(2)
Mass per unit area (oz/yd^2)	ASTM D5261	7	10	12	16	32
Grab Tensile Strength (lbs, machine direction)	ASTM D4632	200	230	300	370	500
Grab Tensile Elongation (%, machine direction)	ASTM D4632	75	50	50	50	50
Trapezoidal Tear Strength (lbs)	ASTM D4533	75	95	115	145	215
Apparent Opening Size (U.S. Standard Sieve)	ASTM D4751	70 max.	100 max.	100 max.	100 max.	—
Puncture Strength (lbs)	ASTM D6241	540	700	800	900	1700

Note:

1. In accordance with GRI GT12(a) and at the discretion of the Engineer, test method ASTM D4833 may be performed in lieu of ASTM D6241 for Puncture Strength. For ASTM D4833, the minimum values (in lbs) for puncture strength are 110 (NW7), 120 (NW10), 140 (NW12) and 170 (NW16).
2. GRI-GT12 does not pertain to NW32.

B. (Woven) Geotextile Fabric, Type W6 shall be a woven polypropylene and/or polyester material which meets the following minimum average roll values:

FABRIC PROPERTY	TEST METHOD	FABRIC REQUIREMENT
Grab Tensile Strength (lbs)	ASTM D4632	300
Grab Elongation (%)	ASTM D4632	10
Burst Strength (psi)	ASTM D3787	600
Trapezoidal Tear (lbs)	ASTM D4533	120
Apparent Opening Size (U.S. Standard Sieve)	ASTM D4751	40 max.
Puncture Strength (lbs)	ASTM D4833	120

PART 3 - EXECUTION

3.01 INSTALLATION

A. Geotextile Fabric shall be installed in accordance with the manufacturer's recommendations, and as shown on the Drawings and specified herein. The Contractor and Geosynthetic Installer shall be trained and experienced in field handling, storing, deploying, installing, and protecting geotextiles.

B. The Contractor or Geosynthetic Installer shall ensure that geotextiles are not damaged during handling. The geotextile shall be deployed as described below, unless approved otherwise by the Designer.

1. On slopes, the geotextile shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.

2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.

4. The Geosynthetic Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

C. Geotextiles shall be overlapped a minimum of 3 inches prior to seaming. No horizontal seams (oriented perpendicular to the fall line) shall be allowed on sideslopes, except as part of a patch. When horizontal seams are necessary, seams shall be offset in adjacent panels and shall be “shingled” downhill. On slopes steeper than 10:1 (horizontal:vertical), all geotextiles shall be continuously sewn. Spot sewing is not allowed. On bottoms and slopes shallower than 10:1, geotextiles shall be continuously sewn, or thermally bonded with the approval of the Designer. Sewing shall be done using polypropylene thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. The color of the sewing thread shall contrast the background color or the geotextile. Sewing shall be done using a single-stitch “prayer” seam. Stitch density shall be at least four stitches per inch.

D. Unless indicated otherwise on the Drawings, geotextile shall be overlapped a minimum of 12 inches wherever continuous stitching is not required.

E. Folds or excessive wrinkling of deployed geotextile shall be removed to the extent practicable. The Contractor or Geosynthetic Installer shall exercise care not to entrap stones, excessive dust, or foreign objects in the geotextile. Large stones and foreign objects shall be removed. Exposed geotextile shall be adequately weighted, using sand bags or equivalent. Geotextile placed on sideslopes shall be securely anchored in the anchor trench prior to deployment.

F. Any holes or tears in the geotextile shall be repaired using the following procedures, unless approved otherwise by the Designer.

1. On sideslopes, a patch made from the same geotextile shall be thermally bonded or sewn into place in accordance with the project specifications.

2. On non-sideslope areas, a patch made from the same geotextile shall be thermally bonded or sewn into place with a minimum of 12-inch overlap in all directions. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

3. All holes and tears in the geotextile that is not part of the liner/cover system shall be repaired as directed by the QAC.

G. All soil materials located on top of a geotextile shall be deployed in such a manner as to ensure:

1. The geotextile and underlying lining materials are not damaged.

2. Minimal slippage of the geotextile on underlying layers occurs.

3. No excess tensile stresses occur in the geotextile.

[END OF SECTION]

SECTION 02520

DRAINAGE GEOCOMPOSITE/GEONET

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Geosynthetic Installer shall furnish all labor, materials, tools and equipment and perform all operations necessary to furnish, deploy, and install Drainage Geocomposite (Geocomposite Drainage Layer) in the areas indicated on the Drawings or as required by the Designer or Owner.

B. Except where related to specific material requirements, all references to "Drainage Geocomposite" herein shall also apply to "Geonet Drainage layer", "Drainage Geonet" and "Geonet." The term "Drainage Geocomposite" shall apply equally to the term "geocomposite."

1.02 APPLICABLE SECTIONS

A. Section 02200 - Earthwork

B. Section 02400 - Geomembrane

1.03 REFERENCES

A. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

B. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer (condition 190/2.16).

C. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

D. ASTM D1603 - Standard Test Method for Caron Black Content in Olefin Plastics.

E. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.

F. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

G. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

H. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

I. ASTM D4716 - Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.

J. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

K. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

L. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.

M. ASTM D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.

N. ASTM D6241 - Standard Test Methods for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

O. ASTM D7005 - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.

1.04 QUALITY CONTROL SUBMITTALS

A. Prior to delivery of drainage geocomposite to the site, The Geosynthetic Installer shall submit the following information to the QAC for the geonet component of the geocomposite.

1. Copies of dated quality control certificates issued by the HDPE geonet resin supplier.

2. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.

3. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control tests. At a minimum, results shall be given for:

   a. Density (ASTM D792 or D1505);

   b. Mass per unit area (ASTM D5261), if not provided for the separate components;

   c. Thickness (ASTM D5199), if not provided for the geonet component; and

   d. Carbon black content (ASTM D1603).

Quality control tests shall be performed in accordance with the test methods for every 50,000 ft^2 of geonet produced within each lot.

4. The following shall be maintained by the geonet Manufacturer and will be available upon request:

    a. The origin (supplier's name and production plant) and identification (brand name and number) of the resin.

    b. Results of tests conducted by the Manufacturer to verify that the resin used to manufacture the geonet meets the project specifications.

    c. A list of the materials which comprise the geonet, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.

B. Prior to delivery of drainage geocomposite to the site, the Geosynthetic Installer shall submit the following information to the QAC for the geotextile component of the geocomposite:

1. Written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles using a metal detector and found the geotextile to be needle-free.

2. Written quality control certificates, signed by a responsible party employed by the Manufacturer and stating that the product will meet the minimum values given in the specification are guaranteed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for:

    a. Mass per unit area (ASTM D5261);

    b. Grab strength (ASTM D4632);

    c. Trapezoidal tear strength (ASTM D4533); and

    d. Puncture strength (ASTM D4833).

    These quality control tests shall be performed in accordance with the test methods for at least 90,000 ft^2 of geotextile produced within each lot.

3. The following shall be maintained by the geotextile Manufacturer and will be available upon request:

    a. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.

    b. Reports on tests conducted by the Manufacturer to verify that resin used to manufacture the geotextile meets the Manufacturer's resin specifications.

    c. A list of the materials which comprise the geotextile, expressed in the following categories as percent by weight: base polymer, carbon black, other additives.

4. A statement from the Geotextile Manufacturer that the geotextiles will retain their structure during handling, placement, and long-term service; and be capable of withstanding direct exposure to sunlight for a minimum of 15 days with no measurable deterioration and 30 days with 70 percent retention of mechanical properties.

C. Prior to delivery of drainage geocomposite to the site, the Geosynthetic Installer shall submit the following information to the QAC for the assembled geocomposite:

1. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.

2. Quality control certificates for the geocomposite, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for:

a. Mass per unit area (ASTM D5261)

b. Thickness (ASTM D5199)

c. Geotextile-geonet adhesion (ASTM D7005)

d. Transmissivity (ASTM D4716)

3. Quality control tests shall be performed in accordance with the test methods for at least every 50,000 ft^2 of geocomposite produced, except for transmissivity that shall be at a rate of one test per 250,000 ft^2.

4. A sample of the drainage composite shall be provided to pre-qualify the material. ASTM D4716 method will be used as the pre-qualification test to verify only the hydraulic transmissivity. One specimen will be required to be run through 100 hours duration at the maximum confining pressure.

1.05 MATERIAL SHIPPING, STORAGE, AND HANDLING

A. The Geosynthetic Installer shall be responsible for the shipping, handling, storage, and care of the Drainage Geocomposite from the time of delivery to the site until final acceptance of the completed work by the Owner. The Geosynthetic Installer shall be liable for all damages to the materials during such time.

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

C. The Contractor is responsible for providing all equipment and personnel necessary to promptly unload geosynthetic materials upon delivery to the site. The materials shall be stockpiled by the Contractor in accordance with the requirements of these specifications, in the areas designated on the Drawings or as directed by the Project Manager. The Geosynthetic Installer shall provide the Contractor with no less than 24 hours notice prior to all deliveries and shall be present during unloading unless the Geosynthetic Installer has not yet been mobilized to the site.

PART 2 - PRODUCTS

2.01 MATERIAL PROPERTIES

A. The components of the double-sided drainage geocomposite shall meet or exceed the properties set forth in this section of the specifications unless approved otherwise by the Designer.

2.02 GEONET

A. The transmissivity of Drainage Geonet shall be such that the transmisvity of the drainage geocomposite meet the requirements of Part 2.03 and 2.04 of this specification

2.03 SINGLE-SIDED DRAINAGE GEOCOMPOSITE

A. Single-Sided Drainage Geocomposite will not be used for the cell liner construction.

2.04 DOUBLE-SIDED DRAINAGE GEOCOMPOSITE

A. The transmissivity of the Double-Sided Drainage Geocomposite for use in liner systems, measured using water at 68 degrees F with a gradient of 0.10 under a compressive stress of 6,750 psf between 60-mil textured HDPE and drainage sand, shall exceed 1.3 x 10^{-2} square feet per second (ft^2/sec) (1.2 x 10^{-3} m^2/s) as measured according to ASTM D4716.

B. The geonet/geotextile adhesion shall meet or exceed the following ply adhesion properties: when tested in accordance with ASTM D7005.

1. Minimum average of 1 ppi;
2. 3 of the 5 samples must be greater than or equal to 1 ppi; and
3. All samples must be greater than 0.5 ppi.

2.05 GEONET ALONE OR AS A COMPONENT OF GEOCOMPOSITES

A. The geonet portion of Drainage Geocomposite shall be manufactured of HDPE which has a carbon black content of 2 to 3 percent by weight according to ASTM D1603.

B. In addition to the properties specified above, Geonet and the geonet portion of the Drainage Geocomposite shall meet or exceed the specifications tabulated below.

Property	Units	Value	Test
HDPE Polymer specific gravity		0.93	ASTM D792 or D1505
HDPE Polymer melt index	g/10 min	<1.1	ASTM D1238
Thickness	mils	190	ASTM D5199
Mass per unit area	lb/1000 sf	162[1]	ASTM D5216

(1) Minimum roll value

2.06 GEOTEXTILE COMPONENT OF GEOCOMPOSITE

A. The geotextile portion of Drainage Geocomposite shall consist of non-woven polyester or polypropylene material and shall be heat-bonded to both sides of the HDPE drainage net. No burn through the geotextiles shall be permitted. No glue or adhesive shall be permitted. The geotextile shall meet the following minimum average roll values:

FABRIC PROPERTY	TEST METHOD	FABRIC REQUIREMENT
Mass per unit area (oz/yd^2)	ASTM D5261	7.0
Grab Tensile Strength (lbs)	ASTM D4632	200
Grab Tensile Elongation (%)	ASTM D4632	50
Trapezoidal Tear Strength (lbs)	ASTM D4533	75
Puncture Strength (lbs)	ASTM D4833/D6241	110/540
Permittivity (sec^{-1})	ASTM D4491	1.47
Apparent Opening Size (U.S. Standard Sieve)	ASTM D4751	70 max.
UV Exposure (%)	ASTM D4355	70

2.07 TIES

A. Ties used to secure adjacent sheets of Drainage Geocomposite shall be strings, plastic fasteners, or polymer braid. Metallic ties will not be allowed. Ties shall be yellow or white to facilitate inspection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Geocomposite shall be installed by the Geosynthetic Installer in accordance with the manufacturer's recommendations, and as shown on the Drawings and specified herein. The Geosynthetic Installer shall be trained and experienced in field handling, storing, and installing Drainage Geocomposite.

B. The use of any vehicular equipment by the Geosynthetic Installer to deploy liner components is subject to the approval of the QAC. Such equipment may include low-ground-pressure rubber tire vehicles, if the QAC deems the use of such equipment allowable for the conditions and methods proposed by the Geosynthetic Installer. In all cases, operation of such approved vehicles directly on the geosynthetic components of the liner system shall be exclusively for deployment purposes only.

C. The Contractor or Geosynthetic Installer shall handle all geocomposite in such a manner as to ensure they are not damaged, and the following shall be complied with:

1. After unwrapping the roll from its opaque cover, the exposed geotextile portion shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by Engineer. Approval may be based on a formal demonstration from the Geotextile Manufacturer that the geotextile is stabilized against ultraviolet degradation for a period in excess of 30 days.
2. On slopes, the geocomposite shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.
3. In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Sandbags shall be installed during deployment and shall remain until replaced with cover material.
4. Geocomposites shall be cut using a hook blade or other tool approved by the QAC. If in place, special care shall be taken to protect underlying geosynthetics from damage which could be caused by the cutting of the geocomposite. Care shall be taken not to leave the tools in the geocomposite.
5. The Geosynthetic Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
6. During placement of geocomposite, care shall be taken not to entrap in or beneath the geocomposite, stones, or dirt that could damage the geomembrane, cause clogging, or hamper subsequent seaming. In this regard, care shall be taken with the handling of sandbags, to prevent puncturing the sandbag.
7. The Contractor and the Geosynthetic Installer shall perform a visual examination of the geotextile component of the geocomposite over the entire surface, after installation, to ensure that no potentially harmful foreign objects are present.

D. In general, horizontal seams shall be minimized on sideslopes. Seams on sideslopes shall be along, not across, the slope, except as part of a patch. If horizontal seams are required on sideslopes, seams shall be offset in adjacent panels, shall allow only one seam on the slope per deployment run, shall be shingled downhill, and shall be located on the lower 1/3 of the slope. For all geocomposite seams, the following requirements shall be met, unless approved otherwise by the Designer:

1. Adjacent geocomposite shall be overlapped so that the geonet overlaps by at least 4 inches and geotextile overlap by at least 3 inches.
2. If double-sided geocomposite, overlap bottom geotextile.

3. The geonet overlaps shall be tied with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

4. Tying shall be every 5 feet along the slope, every 6 inches in the anchor trench, and every 6 inches along end-to-end seams on the base of the landfill.

5. If more than one layer of geocomposite is installed, joints shall be staggered.

6. Once geonet is tied, the top layer of geotextile of the geocomposite shall be seamed. On slopes steeper than 10:1 (Horizontal:Vertical), all geotextiles shall be continuously sewn. Spot sewing is not allowed. On bottoms and slopes shallower than 10:1, geotextiles shall be sewn (preferred), or thermally bonded with the written approval of the Designer. The Geosynthetic Installer shall pay particular attention to seams to ensure that no earth cover material could be inadvertently inserted beneath the geotextile.

7. Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using a single-stitch “prayer” seam.

E. Folds or excessive wrinkling of deployed Drainage Geocomposite shall be removed to the extent practicable. The Contractor and Geosynthetic Installer shall exercise care not to entrap stones, excessive dust, or foreign objects in the Drainage Geocomposite. Large stones and foreign objects shall be removed. Exposed Drainage Geocomposite shall be adequately weighted, using sand bags or equivalent. Drainage Geocomposite placed on side slopes shall be securely anchored in the anchor trench prior to deployment.

F. Defects and Repairs: If geonet is undamaged but the geotextile is damaged, the Geosynthetic Installer shall repair the damaged area as follows:

1. Remove damaged geotextile.

2. Cut patch of new geotextile to provide minimum 12-inch overlap in all directions.

3. Thermally bond geotextile patch to existing geocomposite.

G. If the geonet is damaged, the Geosynthetic Installer shall repair the damaged area as follows:

1. Remove damaged geonet.

2. Cut patch of new material to replace damaged geonet. Remove damaged portion.

3. Secure patch to original geonet by tying every 6 inches. Use tying devices as indicated in Part 2.07.

4. Place geotextile patch overlapping damaged area by minimum of 12 inches in all directions.

5. Thermally bond geotextile patch to existing geocomposite.

H. The Geosynthetic Installer shall replace geocomposite if judged by QAC to be large defect, or larger than 3 by 3 feet.

3.02 PLACEMENT OF SOIL MATERIALS

A. The Contractor shall place all soil materials over geocomposite such that:
1. the geocomposite and underlying materials are not damaged;
2. minimal slippage occurs between the geocomposite layer and underlying layers; and
3. excess tensile stresses are not produced in the geocomposite.

B. Equipment shall not be driven directly on the geocomposite drainage layer. Placement of the cover material shall occur as soon as practicable and shall occur from the base of the slope upwards. Unless otherwise specified by Designer, all equipment operating on soil material overlying the geocomposite drainage layer shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	Thickness of Overlying Compacted Fill (ft.)
<5	1.0
<10	1.5
<20	2.0
>20	3.0

3.03 INTERFACE WITH OTHER PRODUCTS

A. The Contractor shall ensure the following when deploying soil materials over geocomposite:

1. Geocomposite and underlying lining materials are not damaged.
2. Minimal slippage of geocomposite on underlying layers occurs.
3. No excess tensile stresses occur in geocomposite.

[END OF SECTION]

SECTION 02530

GEOSYNTHETIC CLAY LINER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Geosynthetic Installer shall furnish all labor, materials, tools and equipment, and perform all operations necessary to furnish, deploy, and install Geosynthetic Clay Liner (GCL) in the areas indicated on the Drawings and as specified herein.

1.02 APPLICABLE SECTIONS

A. Section 02200 - Earthwork

B. Section 02400 - Geomembrane

C. Section 02520 - Drainage Geocomposite/Geonet

1.03 REFERENCES

A. ASTM D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

B. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

C. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

D. ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

E. ASTM D5887 - Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.

F. ASTM D5890 - Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.

G. ASTM D5891 - Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

H. ASTM D5993 - Standard Test Methods for Measuring Mass per Unit Area of Geosynthetic Clay Liners.

I. ASTM D6496 - Standard Test Method for Determining Average Bonding Peel Strength between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.

J. GRI-GCL3 Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).

1.04 QUALITY CONTROL SUBMITTALS

A. Prior to delivery of GCL to the site, the Geosynthetic Installer shall submit the following information to the QAC for the bentonite component of the GCL:

1. Copies of dated quality control information issued by the bentonite supplier.

2. Results of quality control conducted by the GCL Manufacturer verifying that the bentonite supplied meets the GCL Manufacturer's specifications and the property requirements set forth in the project specifications. The following quality control tests shall be performed on the bentonite:

   a. Swell Index (ASTM D5890);

   b. Fluid Loss (ASTM D5891); and

   c. Moisture Content (ASTM D2216).

   These tests shall be performed at a frequency of 100,000 lbs. within each lot of sodium bentonite.

3. Written certification that the minimum values given in the project specifications are guaranteed by the Manufacturer.

B. Prior to the delivery of GCL to the site, the Geosynthetic Installer shall submit to the QAC a certification statement certifying that the geotextile carrier components of the GCL meet or exceed the property requirements set forth in the project specifications. Copies of dated quality control information from the geotextile manufacturer shall be submitted by the Geosynthetic Installer if requested by the QAC.

C. Prior to delivery of GCL to the site, the Geosynthetic Installer shall submit the following information to the QAC for the assembled GCL product:

1. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results for the GCL as a unit shall be given for:

   a. Moisture Content (ASTM D2216);

   b. Index Flux (ASTM D5887);

   c. Mass per Unit Area (ASTM D5993);

   d. Peel Adhesion (ASTM D4632 (mod) or D6496); and

   e. Grab Strength (ASTM D4632).

2. Moisture content, mass per unit area, peel adhesion, and grab strength control tests shall be performed in accordance with the test methods for at least every

50,000 ft^2 within each lot. Index flux tests shall be performed for at least every 250,000 ft^2 within each lot of GCL produced.

1.05 MATERIAL SHIPPING, STORAGE, AND HANDLING

A. The Geosynthetic Installer shall be responsible for the shipping, handling, storage, and care of the GCL from the time of delivery to the site until final acceptance of the completed work by the Owner. The Geosynthetic Installer shall be liable for all damages to the materials during such time.

B. The Geosynthetic Installer shall inform the Project Manager a minimum 24 hours before any delivery. During shipment and storage, the GCL shall be protected from ultraviolet light exposure, moisture, excessive humidity, puncture, cutting, or any other damaging conditions. GCL rolls shall be shipped and stored in relatively opaque and watertight wrappings. GCL rolls shall be stored away from wet ground and covered with a watertight tarp or under a roof to protect the stored rolls from hydration. The roll wrappings shall not be removed until shortly before deployment.

C. Roll Identification. The Geosynthetic Installer shall:

1. Provide GCL rolls wrapped in relatively impermeable and opaque protective covers and marked or tagged with the following information:

   a. Manufacturer's name;

   b. Product identification;

   c. Shipping lot;

   d. Roll number;

   e. Roll dimensions; and

   f. Roll weight.

2. Indicate special handling marked on GCL itself (e.g., "This Side Up”).

D. The Geosynthetic Installer shall handle GCL to ensure panels are not damaged.

E. The Geosynthetic Installer shall store GCL in dry place under roof or other protective cover, protect from moisture by placing on skids, pallets, or dry ground.

F. The Geosynthetic Installer shall remove and replace damaged GCL at no additional cost to Owner.

G. The Contractor is responsible for providing all equipment and personnel necessary to promptly unload geosynthetic materials upon delivery to the site. The materials shall be stockpiled by the Contractor in accordance with the requirements of these specifications, in the areas designated on the Drawings or as directed by the Project Manager. The Geosynthetic Installer shall provide the Contractor with no less than 24 hours notice prior to all deliveries and shall be present during unloading unless the Geosynthetic Installer has not yet been mobilized to the site.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Bentomat DN CETCO Lining Technologies.

B. Bentofix NSL, Bentofix Technologies, Inc.

C. Or equal, as approved by the Designer and the Project Manager.

2.02 GENERAL:

A. Except when specifically authorized, do not furnish special run or value added products.

B. GCL:

1. Flexible, layered liner consisting of continuous layer of sodium bentonite sandwiched between a woven geotextile carrier layer and a non-woven geotextile carrier layer and reinforced with needle-punched fibers. The reinforcement fibers shall be glued or heat-burnished to the fabric.

2. GCL shall be of type to maintain integrity during installation, placement, and covering procedures.

2.03 GCL PROPERTIES:

A. Unless approved otherwise by the Designer, the woven geotextile carrier component of the GCL shall have a minimum average roll value (MARV) mass per unit area of 3.1 oz/yd^2 when measured using ASTM D5261.

B. Unless approved otherwise by the Designer, the non-woven geotextile carrier component of the GCL shall have a MARV mass per unit area of 6.0 oz/yd^2 when measured using ASTM D5261.

C. Unless approved otherwise by the Designer, the bentonite component of the GCL shall meet or exceed the following properties:

PROPERTY	TEST METHOD	VALUE
Sodium Bentonite Content	-	90% minimum
Swell Index	ASTM D5890	20 ml/2 g of weight
Fluid Loss	ASTM D5891	18 ml maximum
Moisture Content	ASTM D2216	30% maximum

D. Unless approved otherwise by the Designer, the assembled GCL product shall meet or exceed the following properties:

PROPERTY	TEST METHOD	VALUE
Index Flux	ASTM D5887	$1x10^{-8}$ $m^3/m^2/s$ maximum

Bentonite Mass per Unit Area	ASTM D5993	0.75 lb/sf minimum @ 0% ω
Grab Tensile	ASTM D4632	90 lb (typical)
Puncture Resistance	ASTM D4833	90 lb (typical)
Peel	ASTM D4632 (mod) or D6496	15 lb or 2.5 lb/in (typical)

E. Bentonite adhesive shall be non-toxic and water soluble.

F. The requirements of the current version GRI-GCL3 for reinforced GCL may be substituted for the material properties specified herein at the discretion of the Engineer.

PART 3 - EXECUTION

3.01 EXPERIENCE

A. The Geosynthetic Installer shall be trained and experienced in field handling, storing, deploying, and installing GCL.

3.02 INSTALLATION

A. Subgrade Preparation. The Contractor shall:

1. Ensure subgrade is a smooth, compacted, uniform surface.
2. Prepare the subgrade to be free of protruding rocks greater than 1 inch in diameter.
3. Provide grading to allow surface water to be directed away from installation area.

B. Protection. The Contractor and the Geosynthetic Installer shall:

1. Not use equipment which damages GCL or other liner components during handling or trafficking, or by excessive heat, leakage of hydrocarbons, or other means. The use of any vehicular equipment by the Geosynthetic Installer to deploy liner components is subject to the approval of the QAC. Such equipment may include low-ground-pressure rubber tire vehicles, if the QAC deems the use of such equipment allowable for the conditions and methods proposed by the Geosynthetic Installer. In all cases, operation of such approved vehicles directly on the geosynthetic components of the liner system shall be exclusively for deployment purposes only.
2. Not permit personnel to smoke or wear shoes that can damage the GCL while working. Personnel shall not bring glass bottles on the GCL.
3. Unroll panels in a manner which does not cause tears or crimps in the GCL and does not damage supporting soil.
4. Place panels in a manner which minimizes wrinkles, especially differential wrinkles between adjacent panels, while providing sufficient material to prevent bridging.

5. Prevent wind uplift by providing adequate temporary loading or anchoring (for example, sandbags) that shall not damage the GCL.

C. Installation. The Geosynthetic Installer shall:

1. Thoroughly inspect and approve of the subgrade immediately prior to deploying the GCL.
2. Place non-woven side up.
3. Position the GCL by pulling roll suspended by inserting heavy duty steel pipe with spreader bar (to prevent damage to mat edge).
4. Lay the GCL on sideslopes perpendicular to base excavation.
5. Lay the GCL on base so upstream panel overlaps over (i.e., is shingled over) downstream panel.
6. Ensure the GCL overlap is free of dirt to provide seal. Apply granular or powdered bentonite along each seam at a rate of approximately ¼ pound per lineal feet.
7. Provide 6-inch minimum overlap at each side and 12 inches at each end.
8. Not install the GCL in any form of precipitation.
9. Notify the QAC before covering the GCL, and not cover until QAC has given approval.
10. Deploy no more GCL material during one working day than can be covered by the end of that day with seamed geomembrane. Geomembrane should extend approximately 2 feet beyond the leading edge of the GCL to ensure coverage. The leading edge of the geomembrane shall be adequately sandbagged to prevent uplift.

D. In the event of rain, the Geosynthetic Installer shall immediately cover exposed GCL with plastic sheeting or other methods to prevent damage and swelling.

E. Any portion of the GCL exhibiting flaws shall be repaired. Prior to acceptance of the installed GCL, the Geosynthetic Installer shall locate and repair all damaged areas of the liner as specified in this section. Defects or damage can be identified by rips, tears, premature hydration of the GCL or delamination of the geotextiles, or other features identified by the QAC. All repairs shall be performed by the Geosynthetic Installer at no additional cost to the Owner, as follows:

1. Rips or tears in the GCL shall have another piece of material meeting the project specifications inserted under the GCL panel. The material shall extend beyond the entire damaged area a minimum 24-inch overlap in all directions.
2. Where damaged areas exceed 10% of the roll width on liner sideslopes, the GCL roll shall be removed and replaced with an undamaged GCL panel.

F. The Contractor shall ensure a confining load (e.g., Drainage Sand) is installed on over the GCL within 7 days of GCL deployment. Subsequent deployment of overlying geosynthetic layers (i.e., geomembrane) will not be considered adequate confinement.

[END OF SECTION]

SECTION 02560

STORMWATER PIPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, and equipment and perform all operations necessary for stormwater drainage pipe construction. Pipe culverts and pipe drains shall consist of sections of pipe of the kinds and sizes shown on the Drawings and as specified, laid on the specified bedding overlying a firm foundation in a trench in accordance with these specifications.

B. Specifications for the polyethylene (PE) pipe construction for the leachate collection and underdrain systems are covered in Section 02780 of the project specifications.

1.02 APPLICABLE SECTIONS

A. Section 02170 - Wick Drains and Underdrain

B. Section 02200 - Earthwork

C. Section 02510 - Geotextiles

D. Section 02570 - Manholes and Catchbasins

E. Section 02780 - HDPE Piping

1.03 REFERENCES

A. AASHTO M170 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

B. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

C. ASTM F667 - Standard Specification for 2 through 24 in. Corrugated Polyethylene Pipe and Fittings.

1.04 QUALITY ASSURANCE

A. Lines and Grades:

1. Pipes shall be laid true to the lines and grades shown on the Drawings and within the tolerances specified in Parts 3.05.A and 3.05.B or as directed by the Designer. A variation exceeding the allowable tolerances will be deemed sufficient reason to

cause the work to be rejected. Work so rejected shall be corrected by the Contractor at their own expense in a manner acceptable to the Designer.

2. The Contractor shall demonstrate his proposed methods of maintaining the grade and alignment of pipe during construction for the QAC before the start of construction, and prior to backfilling operations.
3. The Contractor shall furnish all labor, materials, and tools to establish and maintain all lines and grades. Bench marks and reference points as required for control of the work shall be located by the Contractor along the job site. Transferring line and grade from those references shall be the responsibility of the Contractor.

C. Source Quality Control:

1. Submittals:
    a. The Contractor shall submit to the Project Manager a listing of manufacturer’s technical product data for all manufactured products to be used for pipe, drains, and appurtenances. Inferior performance on prior projects of a similar nature shall be grounds for rejecting a supplier's products.
    b. Upon the request of the Project Manager, the Contractor shall submit for approval shop drawings of pipes and fittings prior to ordering and receiving these materials.
    c. Upon the request of the Project Manager, the Contractor shall submit certificates of compliance with specified standards and tests from the manufacturer.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Inspection of Material and Delivery Point:

1. When delivered to the site and prior to unloading, the Contractor shall inspect all pipe and accessories for loss, damage, or lack of specified identification and markings.
2. Any defective or improper material shall be immediately returned to the supplier at no additional expense to the Owner prior to being unloaded.

B. Handling:

1. In shipping, storing, and installing, pipe shall be kept in a sound, undamaged condition. Pipe shall at all times be handled with care. Reinforced concrete pipe (RCP) shall not be dropped, dumped, or bumped against any other object. Any material(s) damaged shall be marked and immediately removed from the job site and replaced at the Contractor's expense.

C. Storing:

1. Pipe shall be stored off the ground on sticking or pallets. Pipe shall be stacked with spigot ends projecting from the stack in opposite directions from alternate rows, as applicable.

D. Defective Materials

1. All materials found at anytime during the progress of the work to have cracks, flaws, or other defects will be rejected and marked and the Contractor shall promptly remove such defective material from the work site.

PART 2 - PRODUCTS

2.01 MATERIAL PROPERTIES

A. The Contractor shall supply all pipe materials and accessories meeting or exceeding the specified properties listed in this Section unless approved otherwise by the Designer. Alternative materials, including all pipe, fittings, and accessories (e.g., cast-in-place concrete seepage cutoff collars for ADS Pipe or PE Drain Pipe) shall be pre-approved by the Designer prior to being used.

2.02 REINFORCED CONCRETE PIPE (RCP)

A. RCP shall conform to the requirements of AASHTO M170, for Class IV pipe.

B. RCP shall conform to AASHTO M170, Section 4.1.1. Test requirements shall be as provided in AASHTO M170, Sections 9.3.1 and 9.5 with the further provision that the pipe will withstand an additional ten percent of the D-load specified or brought to destruction. Permissible variation in pipe tolerances shall conform to AASHTO M170, Section 10.

MINIMUM STRENGTH REQUIREMENTS		
D-LOAD TO PRODUCE THE ULTIMATE LOAD = CLASS	D-LOAD TO PRODUCE A 0.01-INCH CRACK	AASHTO DESIGNATION CLASS
1500 D	1000	II
2000 D	1350	III
3000 D	2000	IV
3750 D	3000	V
4000 D	----	----

C. Workmanship and finish shall conform to AASHTO M170, Section 11. Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements of AASHTO M170, Section 14. Individual sections of pipe may be rejected because of the following reasons:

1. Fracture or cracks passing through the wall, except for a single end crack that does not exceed the depth of a joint.
2. Defects that indicate imperfect proportioning, mixing, and molding.
3. Surface defects indicating honey-combed or open texture.
4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.
5. Any continuous crack having a surface width of 0.01-inch or greater, regardless of position in the wall of the pipe.

D. Markings on pipe shall conform to AASHTO M170, Section 15 with the following information clearly marked on each section of pipe.

1. The pipe class and type wall.
2. The date of manufacture.
3. The name or trademark of the manufacturer.
4. Identification of plant.

2.03 REINFORCED CONCRETE PIPE JOINTS

A. Each pipe shall be constructed with a bell and spigot joint, capable of acting as an expansion joint and withstanding deflections caused by normal earth settlement and extremes of temperature. Each unit shall have an interior surface free of roughness, projections, indentations, offsets, or irregularities.

B. Pipe joints shall be of the round neoprene gasket type, in which the gasket is in compression, confined within the concrete groove of the spigot, and the smooth surface of the bell, permitting both longitudinal and angular movement. The bell and the spigot end of the pipe shall be formed by machine rings to ensure accuracy. The critical diameters of the joint surface, which influence the compression of the gasket, shall have a tolerance not to exceed 1/16 inch.

C. The neoprene gasket shall be confined in the annular space formed by a groove in the spigot end of the pipe and the interior surface of the bell, so movement of the pipe or hydrostatic pressure cannot displace the rubber gasket.

D. The neoprene gasket and joint shall be designed and manufactured so the completed joint will withstand an internal water pressure inside the pipe of 20 pounds per square inch (psi) or applicable ASTM specification without showing any joint leakage or displacement of the gasket.

E. The gaskets used to seal the joints shall be made of neoprene of such composition and texture to ensure a watertight and permanent seal and shall be the product of a manufacturer having at least five years experience in the manufacture of neoprene gaskets for pipe joints. The gaskets shall be continuous round rings of flexible joint rubber, of material resistant to common ingredients of surface water runoff and groundwater, and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to the requirements of ASTM C443 for joints, for circular concrete sewer and culvert pipe, using flexible watertight rubber type gaskets.

2.04 CORRUGATED PE DRAIN PIPE

A. PE Drain Pipe and fittings shall be non-perforated, corrugated, flexible polyethylene pipe manufactured with a smooth interior surface; shall conform to applicable ASTM and AASHTO standards; and shall be of the diameter shown on the Drawings. PE Drain Pipe shall be ADS N-12 pipe, or approved equivalent.

B. Fittings for PE Drain Pipe, including anti-seep collars, shall be produced by the same manufacturer that produces the PE Drain Pipe, and for use with the PE Drain Pipe material. Neoprene gaskets shall be utilized with couplings to provide a soil-tight joint.

2.05 UNDERDRAIN PIPE

A. The underdrain pipe covered in this article pertains to the ECS basin and does not pertain to the wick-drain sand blanket system which is covered in Section 02170 of these Specifications.

B. The underdrain pipe shall be perforated, corrugated, flexible polyethylene tubing; shall conform to ASTM F667; and shall be of the diameter shown on the Drawings. Underdrain Pipe shall be ADS perforated tubing, or approved equivalent.

C. Fittings for Underdrain Pipe shall be constructed of pipe meeting ASTM F667 and shall be produced by the same manufacturer that produces the Underdrain Pipe, and for use with the Underdrain Pipe material.

PART 3 - EXECUTION

3.01 GENERAL

A. All pipes, appurtenances and accessories shall be installed true to lines, grades and locations indicated on the Drawings and in accordance with Parts 3.05.A and B. Any deviations must be approved by the Designer before installation, and/or before final backfilling in accordance with Part 3.04.G.

3.02 EXCAVATION, BACKFILL AND COMPACTION

A. Trench excavation, pipe bedding placement and compaction, and trench backfilling and compaction shall be as specified in Section 02200.

3.03 PIPE BEDDING CONDITIONS

A. All pipes laid in open trench excavations shall be bedded in and uniformly supported over their full length on beddings of the types specified herein and shown on the Drawings. Flat-bottomed trenches shall be excavated in accordance with the specifications for excavation and backfill, prior to preparing the specified foundation. All work shall be performed in a dry trench.

B. Pipe bedding for rigid pipe (RCP) shall be 6 inches of 3/4-inch Crushed Stone wrapped in Type NW7 Geotextile Fabric. Pipe bedding for flexible pipe, excluding underdrain pipe that shall be installed as depicted on the Drawings, shall be a minimum of 6 inches of compacted Granular Fill. The Granular fill shall be underlain by Type NW7 Geotextile Fabric where subgrade soils are silt clay, or as indicated on the Drawings.

3.04 INSTALLATION OF PIPE AND FITTINGS

A. After the pipe trench and bedding has been brought to the proper grade, as herein before specified, the pipe and other relevant features shall be laid. Unless otherwise approved by the Designer, pipe laying shall only be done in the presence of the QAC, and the Contractor shall give ample notice of scheduled pipe laying operations to the QAC.

B. All pipe and fittings shall be carefully lowered into the trench by hand or by the proper equipment. Pipe becoming damaged during or following installation shall be marked by the Contractor or QAC and removed from the site as required herein.

C. Pipes shall be laid true to grades shown on the Drawings or as directed by the Designer. Each section of pipe shall rest upon the pipe bed for the full length of its barrel. Blocking will not be permitted. Any pipe that has its grades or joints disturbed after laying shall be taken up and relaid.

D. The pipe ends shall be thoroughly cleaned before the joint is made. All connections shall be made in accordance with instructions supplied by the manufacturer.

E. Joints between dissimilar pipes shall be made in accordance with the recommendations of the manufacturer of one or the other of the pipes.

F. RCP shall be laid with socket or collar ends of the pipe upgrade unless otherwise authorized by the Designer.

G. Before backfilling shall be done, the Contractor's surveyor and the QAC shall ascertain as-built grade and alignment and check the integrity of the pipe. In cases of poor grade or alignment, misplaced pipe, or other defects, such defects shall be remedied by the Contractor at no additional expense to the Owner. Where discrepancies between design and as-built grades and/or alignment occur, backfilling shall be limited to work necessary to maintain erosion and sedimentation control, and/or the integrity of the installation until such time that the discrepancies are resolved to the satisfaction of the Designer and Owner.

3.05 TOLERANCES

A. Installed piping shall flow in the direction intended per the Drawings and shall be free from sags or changes in slopes, unless required per the Drawings.

B. In the absence of specific requirements set forth on the Drawings, as-built slope shall be within 10 percent of design slope (i.e., +/- 0.001 ft/ft for a design slope of 0.01 ft/ft or +/- 0.1% for a design slope of 1%) and as-built invert in and out elevations shall be within 0.10 feet of design invert elevations.

[END OF SECTION]

SECTION 02570

MANHOLES AND CATCHBASINS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, and equipment to install manholes and catchbasins, and to modify existing manholes, if necessary, as shown on the Drawings. This section includes:
   1. Precast stormwater manholes and catchbasins
   2. Frames, covers, and grates

1.02 APPLICABLE SECTIONS

A. Section 02170 -Wick Drains and Underdrain

B. Section 02200 - Earthwork

C. Section 02560 - Stormwater Piping

D. Section 02780 - HDPE Piping

1.03 QUALITY ASSURANCE

A. General: Provide complete manhole structures capable of supporting AASHTO H20 loading and burial depth indicated on the Drawings.

B. Precast Manhole Components shall meet the requirements set forth in ASTM C478.1.03.

1.04 SUBMITTALS

A. Shop Drawings: The Contractor shall submit shop drawings for precast items to the QAC. Shop drawings shall show components to be used, elevations of top, base and pipe inverts, location of pipe penetrations, steps, etc.

B. Installation Plan: The Contractor shall submit installation plan for procedures to install manholes and catchbasins and include details of providing excavation supports, if requested by the QAC.

C. Product Data: The Contractor shall submit manufacturer's product data and installation instructions for frames, covers, grates, precast components, manhole sleeves, and joint sealants for precast sections to the QAC.

PART 2 - PRODUCTS

2.01 STRUCTURES

A. The Contractor shall supply manholes, catchbasins, and all accessories meeting or exceeding the specified properties listed in this section and as indicated on the Drawings, unless approved otherwise by the Designer.
   1. Base Section. Precast monolithic construction with steps or formed-in-place reinforced concrete base pads as shown on the Drawings.
   2. Barrel Sections. Precast with steps.
   3. Top Sections. Precast eccentric cone with steps for stormwater manholes and catchbasins precast flat top slabs for leachate transfer piping structures, unless otherwise indicated on the Drawings.
   4. Steps: Aluminum alloy 6061-T6 or polypropylene reinforced with steel rod. Meet OSHA requirements, minimum width of 16 inches. Coat aluminum to be cast into concrete with bituminous paint.
   5. Joints Between Precast Sections: Watertight, shiplap type, seal with two rings of 1-inch-diameter butyl rubber sealant or equivalent materials recommended by the manufacturer and approved by the Designer.

2.02 STRUCTURE AND PIPE CONNECTIONS

A. HDPE Pipe to Manhole Connections. All wall penetrations shall have a watertight seal. Pipe to wall penetration closures shall be Link-Seal as manufactured by Thunderline Corporation, or other product pre-approved by the Designer.

B. Reinforced Concrete Pipe (RCP) to Stormwater Manhole or Catchbasin Connections. Flexible sleeves equivalent to CP series manufactured by Interpace Corp., sized to fit diameter and type of pipe without gaskets, or as indicated on the Drawings.

C. Flexible Pipe to Stormwater Manhole or Catchbasin Connections. The annular space between the structure wall penetration and the pipe shall be sealed with grout to produce a watertight connection capable of withstanding normal settlement and other relative movement between the pipe and structure.

2.03 FRAMES, GRATES, AND COVERS

A. General: The Contractor shall supply frames, grates, covers, and all accessories meeting or exceeding the specified properties listed in this section, unless approved otherwise by the Designer.
   1. Coatings for All Frames, Grates, and Covers. Two coats of coal tar pitch varnish applied after sandblasting to provide a smooth, tough, non-brittle, non-scaling finish. Repair damage to coatings to the satisfaction of the Engineer.
   2. Cast Iron. ASTM A48 Class 30.

B. Manhole Frames and Covers:
   1. General: As required by the Drawings.
   2. Standard Frames and Covers: Bolted and gasketed for leachate transfer piping structures.

C. Catchbasin Frames and Grates:
   1. General. As required by the Drawings.
   2. Standard Frames and Covers. Equivalent to Model R-3807 median drain frame and two-piece grate assembly by Neenah Foundry.

2.04 MISCELLANEOUS

A. Dampproofing: The Contractor shall provide bituminous coating equal to Dehydrate No. 4 Dampproof by W.R. Grace or Bitumastic Super Service Black by Koppers Co. for field application, or equivalent as approved by the Designer.

B. Waterproofing: For precast structures the Contractor shall provide an exterior water-proofing coating equal to PPS 922 Superseal and an interior coating equal to Sherwin Williams Hi-mil Sher-Tar Epoxy.

PART 3 - EXECUTION

3.01 INSTALLATION OF STRUCTURES

A. Placement. Bases shall be placed on compacted bedding material in accordance with Section 02200 and as shown on the Drawings, so manhole structure is plumb and pipe inverts are at proper elevations. Barrel and top sections shall be placed in the appropriate height combinations. Height of cover to accommodate road grades shall be adjusted and positive drainage away from cover shall be allowed. All lifting holes inside and out shall be plugged with non-shrink mortar.

B. Joints. The Contractor shall follow requirement set forth in Part 2.01.A.5 or, if approved by Designer, follow manufacturer's instructions for sealing joints between precast sections. Joints shall be pointed with non-shrinking mortar.

C. Frame and Covers. Frame and covers shall be set flush with the grades in road areas, or 18 to 24 inches above finish grade in unpaved areas. Adequate temporary covers shall be provided to prevent accidental entry until final placement of frame and cover is made.

3.02 QUALITY CONTROL AND TOLERANCES

A. Before backfilling is done, the Contractor’s surveyor and the QAC shall ascertain as-built grades and check the integrity of the structures. In cases of poor grades or other defects, such defects shall be remedied by the Contractor at no additional expense to the

Owner. Where discrepancies between design and as-built grades occur, backfilling shall be limited to work necessary to maintain erosion and sedimentation control, or the integrity of the installation until such time that the discrepancies are resolved to the satisfaction of the Designer and Project Manager.

B. Manhole and catchbasin structures shall be free from soil and any other deleterious material prior to acceptance for operation. Vacuuming or alternate acceptable methods of cleaning the interior of the structures shall be at the Contractor's expense.

C. In the absence of specific requirements set forth on the Drawings, as-built rim, invert in, and invert out elevations shall be within 0.10 feet of design rim and invert elevations for stormwater structures and within 0.05 feet of design invert elevations for leachate transfer piping structures and shall be such that the piping systems flow in the intended direction without sags.

[END OF SECTION]

SECTION 02780

HDPE PIPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, and equipment and perform all operations necessary for the construction of leachate collection and underdrain pipes.

B. Pipe shall consist of sections of pipe of the kinds and sizes shown on the Drawings and as specified, laid on the specified bedding overlying a firm foundation in a trench in accordance with Section 02200 – Earthwork.

C. The leachate collection system construction work of this section includes providing single-walled, perforated and solid, HDPE pipe, and fittings for primary and leachate collection headers and cleanouts; sideslope risers; and bubbler tube risers within the limits of the lined areas.

1.02 APPLICABLE SECTIONS

A. Section 01669 - Testing Piping Systems

B. Section 02170 - Wick Drains and Underdrain

C. Section 02200 - Earthwork

D. Section 02570 - Manholes and Catchbasins

1.03 REFERENCES

A. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

B. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

C. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.

D. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

E. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

F. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.

G. ASTM D2122 - Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings.

H. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.

I. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

J. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

1.04 SUBMITTALS

A. The Contractor shall submit the following information to the Project Manager, if requested:

1. Manufacturer's test specification data listing resin type, cell classification, stock density, melt flow, flexural modulus, tensile strength, coloration, and pipe dimensions:
   a. Average outside diameter
   b. Average inside diameter; and
   c. Minimum and average wall thickness.
2. Manufacturer's instructions for fusing joints.
3. Installation plan for installation of extrusion welded sleeves, if used. On dual containment pipes, which are fixed, an electro fusion weld on the inner pipe may be used with an extrusion-welded sleeve used on the exterior of the pipe. The Contractor shall provide details of the proposed material and welding procedures of the sleeve. The plan shall provide dimensions of gap, the standard dimension ratio (SDR) of the sleeve and details of the beveled edges.

1.05 QUALITY CONTROL

A. Source Quality Control:

1. If manufacturer's test data is inadequate or unavailable, the Owner reserves right to reject or require additional tests to satisfy material requirements. Costs of these tests shall be solely borne by Contractor.

B. Work shall comply with appropriate codes and standards of Plastic Pipe Institute (PPI) for handling, heat fusion, and underground installation of low pressure polyethylene pipe.

C. Lines and Grades:

1. Pipes shall be laid true to the lines and grades shown on the Drawings and within the tolerances specified in Parts 3.04.B. or as directed by the Designer. A variation exceeding the allowable tolerances will be deemed sufficient reason to

cause the work to be rejected. Work so rejected shall be corrected by the Contractor at their own expense in a manner acceptable to the Designer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Pipe Storage. The Contractor shall:
   1. Store or stack pipe to prevent damage from marring, crushing or puncture.
   2. Limit maximum stacking height to 6 feet.
   3. Store in accordance with manufacturer's recommendations.

B. Pipe Handling. The Contractor shall:
   1. Protect pipe from excessive heat or harmful chemicals.
   2. Protect pipe from excessive gouging or surface abrasion as a result of handling or dragging.

PART 2 - PRODUCTS

2.01 The Contractor shall supply all materials and accessories meeting or exceeding the specified properties listed in this section, unless approved otherwise by the Designer.

2.02 PHYSICAL PROPERTIES OF PIPE RESIN

A. Density: ASTM D1505, not less than 0.941 - 0.955 gm/cu cm.

B. Melt Flow: ASTM D1238 - Condition E, not greater than 0.15.

C. Flexural Modulus: ASTM D790, 110,000 to less than 160,000 psi.

D. Tensile Strength at Yield: ASTM D638, 3,000 to less than 3,500 psi.

E. Environmental Stress Crack Resistance (ESCR): ASTM D1693 - Condition C, shall be in excess of 5,000 hours with zero failures.

F. Hydrostatic Design Basis: ASTM D2837, 1,600 psi at 23°C.

2.03 PIPE

A. Manufacturers:
   1. Chevron Phillips Chemical Co., Performance Pipe - Plexco/Spirolite
   2. Rinker- Polypipe

B. Extra high molecular weight, high-density polyethylene pipe (Type 3408 resin).

C. ASTM D1248 (Type III, Class C, Category 5, P34).

D. ASTM D3350, minimum cell classification value 345434C.

E. Required Standard Dimension Ratio (SDR) for stated use:

1. Use SDR-32.5 for: 8" diameter carrier pipe, force main and gravity drain, outside limits of lined area.
2. Use SDR-26 for: 14" diameter containment pipe, force main and gravity drain, outside limits of lined area.
3. Use SDR-17 for: 8" and 18" diameter risers within limits of lined area.
4. Use SDR-13.5 for: 8" diameter perforated leachate collection, cleanout and underdrain collection piping.

F. Markings at intervals of 5 feet or less:
   1. Manufacturer's name or trademark.
   2. Nominal pipe size.
   3. Type of plastic pipe (i.e., PE 3408).
   4. SDR.
   5. Extrusion date, period of manufacture or lot, or batch number.

G. Dimensions:
   1. Conform to standard dimensions and tolerances of ASTM D2122.

H. Size:
   1. As specified in this section or indicated on the Drawings.

2.04 FITTINGS

A. Fittings from polyethylene compound having cell classification equal to or exceeding compound used in pipe to ensure compatibility of polyethylene resins.

B. The Contractor shall provide factory-fabricated, dual containment fittings except as indicated below.

C. Fittings shall be of same manufacture as pipe being provided. Owner may allow substitution for approved material with use of flanged joint sections.

D. Dimensions of fittings conforming to standard dimensions and tolerances in accordance with ASTM D3261. Wall thickness of fittings shall be at least one SDR smaller than pipe to which it is fused.

E. Markings:
   1. Manufacturer's name or trademark.
   2. Nominal size.
   3. Type of plastic pipe (i.e., PE 3408).
   4. Standard dimension ratio.
   5. Extrusion date, lot number or batch number.

F. The Contractor shall seal space between containment pipe and manhole penetrations with Link-Seal as manufactured by Thunderline Corporation or approved equivalent.

2.05 ELECTRO-FUSION OR OVER-SLEEVE COUPLINGS

A. Electro-fusion or over-sleeve couplings shall be the ones manufactured specifically for joining HDPE pipe specified to be coupled; conform to pipe SDR and size. The Contractor shall submit manufacturer's data to QAC for approval prior to use.

B. Field fabricated extrusion welded sleeves for use on outer fixed dual containment pipe must be approved by the Designer prior to use.

2.06 PIPE BOOT

A. The Contractor shall provide flexible pipe-to-sump connector of ethylene propylene diene monomer (EPDM) rubber, sized to fit cleanout laterals, where indicated on the Drawings. Pipe boot shall include a stainless steel pipe clamp and a stainless steel expander ring.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to this Section including, but not limited to:
   1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2 inches in length at either end of pipe which could be cut off and discarded. Pipes within one shipment shall be rejected if defects exist in more than 5% of shipment or delivery.
   2. Cracks sufficient to impair strength, durability, or service ability of pipe.
   3. Defects indicating improper proportioning, mixing, and molding.
   4. Damaged ends, where such damage prevents making satisfactory joint.
   5. Damage due to handling.

B. Acceptance of fittings, stubs, or other specially fabricated pipe sections shall be based on visual inspection at job site and documentation of conformance to this section.

C. Before backfilling shall be done, the Contractor’s surveyor and the QAC shall ascertain as-built grade and alignment and check the integrity of the pipe. In cases of poor grade or alignment, misplaced pipe, or other defects, such defects shall be remedied by the Contractor at no additional expense to the Owner. Where discrepancies between design and as-built grades and/or alignment occur, backfilling shall be limited to work necessary to maintain erosion and sedimentation control, and/or the integrity of the installation until such time that the discrepancies are resolved to the satisfaction of the Designer and QAC.

3.02 INSTALLATION

A. The Contractor shall perform trench excavation, and bedding and backfill placement and compaction activities in accordance with Section 02200 – Earthwork.

B. Heat Fusion of Pipe: The Contractor shall:
1. Weld in accordance with manufacturer's recommendation for butt fusion methods. Provide qualified fusion operators.
2. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures.
3. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations. Solvents shall not be used unless approved by the Designer and the Project Manager.
4. Not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade.
5. Not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
6. Inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals before and after butt fusing pipe. Remove debris or animals from pipe.
7. Cover at end of each working day open ends of fused pipe. Cap to prevent entry by animals or debris.
8. Use compatible fusion techniques when polyethylenes of different melt indexes are fused together. Refer to manufacturer's specifications for compatible fusion.

C. Flange Jointing: The Contractor shall:
1. Use on flanged pipe connection sections.
2. Use galvanized steel backing rings for joining flanged pipe.
3. Butt fuse fabricated flange adapters to pipe.
4. Observe following precautions in connection of flange joints:
    a. Align flanges or flange/valve connections to provide tight seal. Gaskets are required for flange/valve connections.
    b. Place U.S. Standard round washers as may be required on some flanges in accordance with manufacturer's recommendations. Bolts shall be lubricated in accordance with manufacturer's recommendations.
    c. Tighten flange bolts in sequence and accordance with manufacturer's recommendations. Do not over-torque bolts.
5. Pull bolt down by degrees to uniform torque in accordance with manufacturer's recommendations.
6. Protect flange and bolt connections installed underground with Tapecoat mastic and tape.

D. Electro-Fusing:

1. Electro-fusion joints shall be provided in accordance with manufacturer's recommendations.

E. Pipe Placement:
1. Survey equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Dewatering: The Contractor shall conform to Section 02200 – Earthwork.
3. Unless otherwise specifically stated, the Contractor shall install pipe in accordance with manufacturer's recommendations.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion; but not to exceed 500 feet for dual containment and 1,000 feet for leachate collection pipe.
5. The Contractor shall cap pipe sections longer than single joint (usually 40 feet) on both ends during placement except during fusing operations.
6. The Contractor shall remove any coarse aggregate (3 inches or greater) or debris from within 12 inches of the installed pipe before backfilling.
7. The Contractor shall notify the QAC prior to installing pipe into trench and allow time for inspection.
   a. Correct irregularities found during inspection.
8. The Contractor shall complete tie-ins within trench whenever possible to prevent overstressed connections.
9. The Contractor shall allow pipe sufficient time to adjust to trench temperature prior to segment tie-ins, backfilling activity, and testing.
10. The Contractor shall install fittings at locations shown on details included on Drawings.
11. The Contractor shall install saddles at slope equal to and continuous with connecting piping as applicable and to reduce branch saddle stress.
12. The Contractor shall place in trench to allow for minimum 12-in./100 ft. for thermal contraction and expansion.

3.03 PIPE TESTING

A. The Contractor shall test leachate carrier/containment pipe located outside the limits of lined areas in accordance with Section 01669.

3.04 ACCEPTANCE

A. Installed pipe shall be cleaned by blowing out any debris and temporarily capped on a daily basis. Prior to start-up, installed pipe shall be televised at Contractor's expense. The QAC shall be present during televising. The Contractor shall provide video tape to Owner upon acceptance. Any dirt or debris in pipeline shall be removed at Contractor's expense, and pipeline re-televised to demonstrate pipe cleanliness.

B. Installed piping shall flow in the direction intended per the Drawings and shall be free from sags or changes in slopes, unless required per the Drawings. In the absence of specific requirements set forth on the Drawings, as-built slope shall be within 10 percent of design slope (i.e., +/- 0.001 ft/ft for a design slope of 0.01 ft/ft or +/- 0.1% for a design slope of 1%) and as-built invert in and out elevations shall be within 0.05 feet of design invert elevations.

[END OF SECTION]

SECTION 02800

PLACEMENT OF TOPSOIL AND HYDROSEEDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required to place Topsoil, finish grade, apply lime and fertilizer, hydraulically apply seed, mulch, anchor and protect seeded areas, and maintain all seeded areas as specified herein.

B. The Contractor shall seed all areas disturbed by their operations. All areas disturbed or not having sufficient vegetation to prevent erosion shall be seeded.

1.02 APPLICABLE SECTIONS

A. Section 02120 - Temporary Erosion Control

B. Section 02130 - Clearing, Grubbing, and Stripping

C. Section 02140 - Excavation and Storage of Silt Clay

D. Section 02200 - Earthwork

1.03 REFERENCES

A. "Maine Erosion and Sediment Control Best Management Practices (BMPs)" Maine Department of Environmental Protection; hereinafter referred to as the BMPs.

B. Standard Specification for Highways and Bridges, Maine Department of Transportation (hereinafter referred to as MEDOT Std. Specs).

1.04 QUALITY ASSURANCE

A. Submittals:

1. Samples of all materials shall be submitted by the Contractor for inspection and acceptance upon request of the QAC or Project Manager.
2. Certificates of Compliance, as described in Part 2, shall be submitted by the Contractor to the QAC at least two weeks prior to application of any materials or seed.
3. Schedules for seeding and fertilizing must be submitted by the Contractor to the Project Manager for approval at least 14 days prior to the work.
4. Prior to the start of work, the QAC shall be furnished with a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the hydroseeder.

PART 2 - PRODUCTS

2.01 The Contractor shall supply all materials and accessories meeting or exceeding the specified properties listed in this section, unless approved otherwise by the Designer.

2.02 MATERIALS

A. Topsoil shall be fertile, natural soil capable of sustaining vigorous plant growth, typical of the locality, free from large stones, roots, sticks, clay, weeds, and sod, and obtained from naturally well drained areas. Topsoil shall be a granular loamy mixture containing only a small percentage of silt- and clay-sized particles and having a maximum stone size of 3 inches. It shall not be excessively acid or alkaline nor contain toxic material harmful to plant growth. Topsoil stockpiled under other Sections may be used, but the Contractor shall furnish additional Topsoil as required.

B. Fertilizer shall be a complete commercial fertilizer, 10-20-20 grade for grass areas. It shall be delivered to the site in the original unopened containers, each showing the manufacturer's guaranteed analysis. Fertilizer shall be stored so that when used it shall be dry and free flowing.

C. Lime shall be ground limestone equivalent to fifty percent calcium plus magnesium oxide.

D. Grass seed shall be from the same or previous year's crop; each variety of seed shall have a percentage of germination not less than eighty, a percentage of purity of not less than eighty-five and shall have not more than one percent weed content. The seed mixture shall conform to the requirements of Method Number 2, Roadside Mixture specified in the MEDOT Standard Specifications, or other seed mix approved by the Designer.

E. The seed shall be furnished and delivered premixed in the specified proportions. A manufacturer's certificate of compliance to the specified mix shall be submitted by the manufacturer for each seed type. These certificates shall include the guaranteed percentages of purity, weed content, and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates to the Project Manager.

F. Cellulose fiber mulch shall be specially processed cellulose homogeneous fiber containing no growth- or germination-inhibiting factors. Processed cellulose fiber shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a slurry when sprayed on the ground. The material shall allow homogeneous absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

G. Hay or straw mulch (mulch) shall consist of cured hay or straw free from primary noxious weed seeds, twigs, debris and rough or woody materials. Mulch shall be free from rot or mold and shall be acceptable to the Project Manager and the Designer. Mulch shall be utilized on all newly-graded subgrade and Topsoil areas that cannot be seeded within 10 days.

H. Soil binder (tackifier) shall be an approved synthetic, spray-on emulsion manufactured for the purpose of mixing with water and applying to hay or straw mulch as a binder.

I. Erosion control mats and (mulch anchoring) netting shall consist of twisted kraft paper, yarn, jutes, excelsior, wood fiber mats, glass fiber, plastic film, or other commercially available netting and erosion control mats. Type and use shall be in accordance with the Temporary Mulching BMP.

PART 3 - EXECUTION

3.01 APPLICATION

A. Seeding and initial fertilizing are recommended to be performed between April 1 and September 15. Seed bed preparation and hydroseeding shall be completed in accordance with the Permanent Grass and Legume Cover BMP and the Temporary Mulching BMP.

B. In the event that the construction schedule precludes planting of permanent vegetation during the recommended period, temporary seeding and stabilization procedures shall be in accordance with the Temporary Grass and Legume Cover and Temporary Mulching BMPs, and Section 02120 of the project specifications. Regardless of the time of seeding, the Contractor shall be responsible for each seeded area until it is accepted as specified in Parts 3.03 and 3.04.

C. Unless otherwise shown on the Drawings, Topsoil shall be placed to a minimum depth of 6 inches after rolling.

D. For all areas to be seeded:

1. Lime shall be applied at the rate of one-hundred-forty pounds per 1,000 square feet unless specific analysis of Topsoil indicates a different application rate is appropriate, subject to approval of the Engineer. In addition, lime shall be incorporated into the upper two inches of fill after final grading and before Topsoil placement, if the pH of the fill is below 6.0. The necessity of liming and the application rate shall be based on analyses of the fill material.
2. Fertilizer (10-20-20) shall be applied at the rate of twenty pounds per 1,000 square feet.
3. Seed shall be applied at the rate of 3 pounds per 1000 square feet.
4. Cellulose fiber mulch shall be applied at the rate of fifty pounds per 1,000 square feet.
5. Hay or straw mulch shall be applied at a rate of eighty pounds per 1,000 square feet.

E. The application of fertilizer and lime may be performed hydraulically in one operation with hydroseeding. If lime is applied in this manner, the Contractor shall be responsible for cleaning all structures and paved areas of unwanted deposits.

F. Where hay or straw mulch will be applied over newly seeded areas, cellulose fiber mulch may be applied hydraulically in one operation with the soil binder (tackifier), rather than with the seeding operation.

3.02 INSTALLATION

A. The following steps, at a minimum, shall be completed by the Contractor in all areas to receive permanent grass cover and shall be completed in the order specified: seed bed preparation and hydraulic application of seed and cellulose fiber mulch. Lime and fertilizer may be applied mechanically prior to the seeding operation or may be applied hydraulically as part of the seeding operation, as specified herein. Except in areas to receive erosion control mat, hay or straw mulch shall be applied subsequent to the hydraulic application of seed and cellulose fiber mulch. Hay and straw mulch shall be anchored using a soil binder (tackifier). In all areas that receive hay or straw mulch that are steeper than 15%, the mulch shall be further anchored using an approved netting, in addition to a tackifier. In areas requiring the installation of an erosion control mat, including the interior sideslopes of sedimentation basin perimeter berms, grass-lined swales, and slopes 2.5H:1V or steeper, an approved erosion control mat shall be installed subsequent to the hydraulic application of seed and cellulose fiber mulch, and in lieu of hay or straw mulch, tackifier, and netting.

B. The subgrade of all areas to be covered with topsoil and seeded shall be raked and all rubbish, sticks, roots and stones larger than 3 inches shall be removed. Subgrade surfaces shall be raked or otherwise loosened immediately prior to being covered with Topsoil. Subgrade shall be inspected and approved by the Engineer before Topsoil is placed.

C. Swales shall be excavated and shaped to an even cross-section. The Contractor shall:

1. Grade soil adjacent to the swale evenly so that surface water may enter freely.
2. Apply lime, fertilizer, seed, and cellulose fiber mulch to the swale as indicated in these specifications.
3. Protect the seeded and mulched area immediately after spreading with erosion control mat in accordance with the Temporary Mulching BMP.
4. Begin laying mats from the upstream end of the swale and unroll it downgrade and not stretch the mat.

D. Topsoil shall be placed over approved areas to a depth sufficiently greater than required so that after natural settlement and light rolling, the complete work will conform to the lines, grades, and elevations indicated. Topsoil shall not be spread in water or while frozen or muddy.

E. After Topsoil has been spread, it shall be carefully prepared by scarifying or harrowing and raking. All large stiff clods, lumps, brush, roots, stumps, litter and other foreign material shall be removed from the area covered with topsoil and disposed of by the Contractor. The area shall also be free of smaller stones in excessive quantities, subject to the approval of the QAC or Project Manager. The whole surface shall then be tracked immediately after fine grading and raking has been completed. Tracking shall be performed with bulldozers operating in the direction of surface water flow. The tracks of the bulldozers shall have grousers of sufficient height to leave visible depressions in the subgrade. The depressions shall be oriented perpendicular to the direction of surface water flow to reduce erosion potential until Topsoil is placed. During the tracking, all depressions caused by settlement or tracking shall be filled with additional Topsoil and the surface shall be regraded and tracked until a smooth and even finished grade is created.

F. The Contractor shall hydroseed only on calm days. Seeding shall not be performed when the ground surface is excessively wet or otherwise untillable.

G. If lime and fertilizer are to be spread mechanically rather than in one operation with the hydroseeding, then:
   1. After the Topsoil is placed and before it is raked to true lines and rolled, lime shall be spread evenly over Topsoil surface and thoroughly incorporated with Topsoil by heavy raking to at least one-half the depth of topsoil.
   2. Fertilizer shall be uniformly spread and immediately mixed with the upper 2 inches of topsoil.

H. Seeding shall be done within ten days following soil preparation. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed, and lime, fertilizer, and cellulose fiber mulch, shall be equal in quantity to the specified rates.

I. When protection of newly graded areas is necessary at a time which is outside of the normal seeding season, as defined in Part 3.01.A of this section, the Contractor shall protect and maintain those areas by whatever means necessary, as indicated in Section 02120, in accordance with the Temporary Grass and Legume Cover BMP, or by other measures as approved by the Project Manager or Designer.

3.03 MAINTENANCE AND PROVISIONAL ACCEPTANCE

A. The Contractor shall keep all seeded areas watered and in good condition, reseeding if and when necessary, until a healthy, uniform growth is established over the entire area seeded. Watering and reseeding shall be conducted at no additional cost to the Owner. The Contractor shall also repair, at no additional cost to the Owner, any area damaged as a result of reseeding work. The Contractor shall maintain these areas in an approved condition until provisional acceptance.

B. On all slopes, the Contractor shall protect against erosion in accordance with Section 02120, Maine BMPs, and by an approved method. Any erosion which occurs shall be regraded and reseeded at the Contractor's expense until a good sod is established.

C. The QAC or Project Manager will inspect all work for provisional acceptance at the end of an eight week grass establishment and maintenance period, upon the written request of the Contractor, received at least ten days before the anticipated date of inspection.

D. A satisfactory stand will be when there are:
1. No bare spots larger than three square feet.
2. No more than ten percent of total area with bare spots larger than one square foot.
3. No more than fifteen percent of total area with bare spots larger than six square inches.

E. The Contractor shall furnish full and complete written instructions for maintenance of the seeded areas to the Project Manager at the time of provisional acceptance.

F. The inspection by the QAC or Project Manager will determine whether maintenance shall continue in any area or manner.

G. After all necessary corrective work and cleanup has been completed, and maintenance instructions have been received, the Project Manager will certify in writing the provisional acceptance of the seeded areas. The Contractor's responsibility for maintenance of seeded areas, or parts of seeded areas shall cease on receipt of provisional acceptance.

3.04 GUARANTEE PERIOD AND FINAL ACCEPTANCE

A. All seeded areas shall be guaranteed by the Contractor for not less than one full year from the time of provisional acceptance.

B. At the end of the guarantee period, inspection will be made by the QAC or Project Manager upon written request submitted by the Contractor at least ten days before the anticipated date. Seeded areas not demonstrating satisfactory stands as outlined above, as determined during the inspection, shall be renovated, reseeded, and maintained meeting all requirements as specified herein, at no additional cost to the Owner.

C. After all necessary corrective work has been completed, the Project Manager will certify in writing the final acceptance of the seeded areas.

[END OF SECTION]

SECTION 02950

CLEANUP AND SITE RESTORATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary to complete the work under this Section including operations which cannot be specified in detail as separate items but can be sufficiently described as to the kind and extent of work involved.

1.02 APPLICABLE SECTIONS

A. All Sections

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 CLEANUP

A. During the course of the work, the Contractor shall keep the site of his operations in as a clean and neat condition as is possible. The site shall include, but not necessarily be limited to, the project area, haul roads, stockpile areas, laydown areas, and borrow areas. The Contractor shall dispose of all residues continuously throughout the construction and at the completion of the work. The Contractor shall dispose of any surplus excavated material in a location approved by the Project Manager and in accordance with Sections 02130, 02140, and 02200. Lumber, equipment, temporary structures, and other refuse remaining from the construction operations shall be removed from the site by the Contractor.

B. It shall be the Contractor's responsibility to dispose of all excess residue resulting from construction operations. Excess trenching materials consisting of soil, rock, or boulders shall be disposed of by the Contractor in on-site areas designated by the Project Manager, and in accordance with Sections 02130, 02140, and 02200.

3.02 INCIDENTAL WORK

A. The Contractor shall do all incidental work not otherwise specified, but obviously necessary for the proper completion of the Contract in accordance with the Drawings and Specifications.

[END OF SECTION]

APPENDIX VI(d)

Technical Specifications – Final Closure Construction

FINAL COVER SYSTEM CONSTRUCTION PACKAGE
WMDSM – CROSSROADS LANDFILL NORRIDGEWOCK, MAINE

TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

NOTES:

1. The minimum allowable interface shear strength requirements for the final cover system, as established in the veneer stability calculation package, will be incorporated into the project specifications prior to construction of the liner systems.
2. The topsoil material properties have been modified to include requirements for minimum organic content, pH, nitrogen, potassium, phosphorous, calcium, magnesium, sulfur, based on testing by the University of Maine Cooperative Extension Soil Testing Service.

SECTION 01100

DEFINITION OF TERMS

PART 1 - GENERAL

1.01 SCOPE

A. The scope of this section is to provide definitions of the relevant terms used in these Specifications.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 DOCUMENTS

A. Contract Documents: refers to the entire package of information issued to and used by the Contractor to enter into and perform the Work. The Contract Documents may include, but are not necessarily limited to:
1. Drawings
2. Specifications
3. Quality Assurance Manual (QAM)
4. Test Pad Program
5. Erosion and Sedimentation Control Plan
6. Miscellaneous Information issued to the Contractor during the bidding process
7. Meeting Minutes
8. Addendums, Change Orders, Requests for Clarification and Requests for Information

B. Technical Specifications: refers to Division 01 through Division 16 of the Specifications to be used by the Contractor for the work. The term Technical Specifications shall apply equally to the term Specifications.

C. <u>Construction Drawings</u>: refers to the set of drawings to be used by the Contractor for the work. The term <u>Construction Drawings</u> shall apply equally to the terms <u>Drawings</u>, and <u>Plans</u>. Shop Drawings refers to drawings prepared by the Contractor (e.g., Manholes, Pump Stations, Cast-in-Place Concrete, etc.) and submitted to the Designer for review/approval. Once approved, the terms <u>Construction Drawing</u>, <u>Drawings</u>, and <u>Plans</u> become inclusive of the Shop Drawings.

D. <u>Quality Assurance Manual (QAM)</u>: refers to the document titled *Quality Assurance Manual for the Crossroads Landfill* and referenced in the project Quality Assurance Plan included in these specifications, and used by the Soil Quality Assurance Consultant and the Geosynthetic Quality Assurance Consultant to ensure appropriate levels of quality assurance monitoring and testing are achieved during the work. The term Quality Assurance Manual shall apply equally to the term <u>QAM</u>.

E. As-Built Drawings: refers to drawings produced by the Contractor and submitted to the Project Manager, Soil Quality Assurance Contractor (QAC), or Geosynthetic QAC to check the accuracy of construction layout, layer thicknesses, tolerances, and other aspects of the work.

F. Record Drawings: refers to the drawings produced by the Soil QAC, Geosynthetic QAC, and/or Construction Quality Assurance (CQA) Surveyor in partial fulfillment for certification that the work was completed in accordance with the Contract Documents.

1.04 PARTIES

A. Owner: refers to Waste Management Disposal Services of Maine, Inc (WMDSM). The term Owner shall apply equally to the terms WMDSM, Waste Management, Inc., and Waste Management.

B. Project Manager: refers to the official representative of the Owner for the work. The term Project Manager shall apply equally to the terms Construction Manager, and Owner's Representative. Responsibilities of the Project Manager include, but are not necessarily limited to:
   1. Coordinating communications.
   2. Chairing meetings and recording minutes.
   3. Monitoring schedules.
   4. Liaison with Maine Department of Environmental Protection (MEDEP).
   5. Reviewing and/or distributing submittals.
   6. Administration of Requests for Information and Field Clarifications.
   7. Administration of contracts, change orders, addenda, and pay requisites.

C. Contractor: refers to the firm responsible for performing all aspects of the work, except as designated for the Geosynthetics Installer, or specialty contractors commissioned directly by the Owner. The term Contractor shall apply equally to the terms Earthwork Contractor, and General Contractor. Responsibilities of the Contractor include, but are not necessarily limited to:
   1. Supplying all non-geosynthetic materials as set forth in the Contract Documents.
   2. Constructing all non-geosynthetic aspects of the work, except as noted in the Contract Documents.
   3. Supplying and installing all site piping, including the geotextile filter, crushed stone, and all stormwater drainage piping.

D. Geosynthetic Installer: refers to the firm responsible for supplying and installing the geosynthetic components of the liner system. The term Geosynthetic Installer shall apply equally to the term Installer. Responsibilities of the Geosynthetic Installer include, but are not necessarily limited to:
   1. Supplying all geosynthetic materials for the project, except for materials supplied directly by the Owner, or by the Contractor.
   2. Coordinating all deliveries of geosynthetic materials and ensuring submittal of all required information from the manufacturers of the geosynthetic materials except for materials supplied by the Owner.

3. Installing all geosynthetic components of the final cover system.

E. Designer: refers to the firm responsible for preparing the design, including the Drawings, Specifications, and QAM, and other select components of the Contract Documents. The term Designer shall apply equally to the term Engineer. Responsibilities of the Designer include, but are not necessarily limited to:
   1. Attending meetings as requested by the Project Manager.
   2. Addressing all Requests for Information and Requests for Clarification that arise during the work.
   3. Approving in writing any changes to the Drawings, Specifications, or QAM implemented during the work.
   4. Providing interpretation of the (intent of the) Drawings and Specifications as needed.

F. Soil Quality Assurance Consultant: refers to the firm responsible for observing, monitoring, and documenting the quality assurance activities for non-geosynthetic aspects of the Contractor's work. The term Soil Quality Assurance Consultant shall apply equally to the term Soil QAC, and as a general term for Soil Technician and CQA Engineer-of-Record. The Soil QAC shall be a firm independent from the Owner, Contractor, Geosynthetics Installer, and manufacturers of materials for this project. Responsibilities of the Soil QAC include, but are not necessarily limited to:
   1. Administering requirements set forth in the non-geosynthetic portions of the QAM.
   2. Attending meetings as requested by the Project Manager.
   3. Preparing the Certification Report and Record Drawings for non-geosynthetic components of the work.
   4. Certifying construction of the non-geosynthetic components of the work.
   5. Coordinating activities of the Soil Quality Assurance Laboratory (Soil QAL) and CQA Surveyor for non-geosynthetic components of the work.

G. Geosynthetic Quality Assurance Consultant: refers to the firm responsible for observing, monitoring, and documenting the quality assurance activities for geosynthetic aspects of the Contractor's work. The term Geosynthetic Quality Assurance Consultant shall apply equally to the term Geosynthetic QAC, and as a general term for Geosynthetic Technician, Liner Technician, and Geosynthetic CQA Engineer-of-Record. The Geosynthetic QAC shall be a firm independent from the Owner, Contractor, Geosynthetics Installer, and manufacturers of materials for this project. Responsibilities of the Geosynthetic QAC include, but are not necessarily limited to:
   1. Administering requirements set forth in the geosynthetic portions of the QAM.
   2. Attending meetings as requested by the Project manager.
   3. Preparing the Certification Report and Record Drawings for geosynthetic components of the work.
   4. Certifying construction of the geosynthetic components of the work.
   5. Coordinating activities of the Geosynthetic Quality Assurance Laboratory (Geosynthetic QAL) and CQA Surveyor for geosynthetic components of the work.

H. CQA Surveyor: refers to the firm responsible for verifying the as-built information submitted by the Contractor and providing the Soil QAC and/or Geosynthetic QAC with the information required to prepare Record Drawings. The term CQA Surveyor shall apply equally to the term Record Surveyor. Responsibilities of the CQA Surveyor do not include layout of any aspects of the work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 01160

SURVEY CONTROL

PART 1 - GENERAL

1.01 LINES, GRADES AND LEVELS

A. The Owner will provide a survey base line and/or bench marks for construction purposes, as shown on the Drawings. The Contractor shall safeguard all survey points and bench marks. Should any of these points be disturbed or destroyed, the replacement cost will be borne by the Contractor. The Contractor will be held entirely responsible for rectifying Work improperly constructed and any associated liabilities or costs to the Owner resulting from failure to maintain and protect established survey points and bench marks.

B. The Contractor shall be responsible for the layout of all lines, grades, and levels necessary for the proper construction of the Work called for by the Drawings and Specifications. Survey control shall include, but not be limited to accomplishing proper cuts and fills, appropriate slopes in drainage swales and pipes, and placing specified layer thicknesses for cover system materials. Any work deficiencies and any associated liabilities or costs to the Owner caused by improper survey layout, including lost productivity of the Soil QAC or Geosynthetic QAC, shall be rectified at the Contractor’s expense.

C. The Contractor shall employ competent and experienced personnel to provide the surveying functions. These personnel shall be directed by a Maine Licensed Land Surveyor.

D. The Contractor shall provide partially-complete or finalized as-built survey information at any stage of the work to the Project Manager, Soil QAC, or Geosynthetic QAC within 24 hours of being requested. These interim submittals may be in the form of as- built drawings as described in Section 01550, or may be in the form of tabulated coordinates of verified construction control points, as requested by the Soil QAC or Geosynthetic QAC. This information may be used to verify proper layout and layer thicknesses as the work progresses, to calculate material quantities, and to perform other activities deemed necessary by the Project Manager to check the Contractor's work.

E. The Contractor’s surveyor will follow the tolerances consistent with boundary surveys. If, during any stage of the Work, the Contractor’s survey work is deemed inaccurate or otherwise unacceptable to the Project Manager, the Owner shall have the authority to provide and direct all survey layout for the Work at the Contractor’s expense.

PART 2 -MATERIALS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 01200

PROJECT COORDINATION AND MEETINGS

PART 1 - GENERAL

1.01 PRECONSTRUCTION CONFERENCES

A. The Contractor shall not commence work until a preconstruction conference has been held at which representatives of the Contractor, Designer, Soil QAC, Geosynthetic QAC, and Owner are present. This preconstruction conference will be arranged by the Project Manager and is intended to establish lines of communication between the parties involved. The time and place of the preconstruction conference will be arranged by the Project Manager and all parties will be notified approximately two weeks in advance. Personnel from Maine Department of Environmental Protection (MEDEP) will be invited to the preconstruction conference and notified at least 7 days in advance.

1.02 PROGRESS MEETINGS

A. The Contractor shall make physical arrangements for progress meetings, to be held weekly at a minimum or as ordered by the Project Manager. The meetings will be held to review the work progress, to make necessary adjustments to schedules, to discuss submittals, changes, substitutions, and other items affecting the work. The Project Manager will preside at meetings, and will be responsible for preparing meeting minutes as deemed appropriate.

B. Attendance at the progress meetings will include the Project Manager, Soil QAC, Geosynthetic QAC, major subcontractors and suppliers as appropriate to discuss agenda topics for each meeting. Personnel from MEDEP will be notified in advance about the progress meeting schedule and will have the option to attend. The Designer will be invited to attend as deemed appropriate.

1.03 JOB SITE ADMINISTRATION

A. The Contractor shall keep a competent and authorized supervisory representative at each work location during all working hours who shall act as the agent of the Contractor. The supervisor shall be the lead point-of-contact for coordination of work and shall attend all project meetings or shall designate an alternate who is deemed acceptable to the Owner to attend.

B. The Contractor’s supervisory representative shall be a competent, English-speaking superintendent capable of reading and thoroughly understanding the Drawings and Specifications, with full authority to fulfill the Contractor's duties and responsibilities on the job. If in the opinion of the Project Manager the supervisory representative or any of his successors proves incompetent, not conscientious, or not industrious, then the Contractor shall replace him upon written request by the Project Manager.

C. The Contractor shall only employ competent workmen on the job. Whenever the Project Manager notifies the Contractor in writing that, in their opinion, any workmen on the job, whether employed by the Contractor or any subcontractors, is incompetent, unfaithful, disorderly, or otherwise unsatisfactory, such workmen shall be discharged from the contract work and shall not be employed on it, except with the written consent of the Project Manager.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 PROCEDURES

A. The Contractor shall submit electronic versions of submittals to the Project Manager. Each item shall be transmitted on a form acceptable to the Project Manager. The form shall identify the Project, Contractor, Subcontractor, Major Supplier, pertinent Drawing sheet and detail number, applicable standards (such as ASTM or Federal Specification numbers), and Specification Section and Paragraph numbers, as appropriate. Any and all deviations from the Contract Documents shall be identified in the submittals.

B. Within fourteen (14) days after execution of this Contract and prior to mobilization to the site, the Contractor shall submit to the Project Manager a Proposed Work Plan indicating the methods the Contractor proposes to complete the work. The plan shall include, but not necessarily be limited to, a description of the Contractor's proposed sequence of construction; access to and from borrow areas and the landfill; methods of filling, compaction and moisture control; traffic control at intersections of haul roads and access roads; erosion and sedimentation control; dust control; preparation and restoration of borrow areas; and mulching and hydroseeding. The Contractor shall present to the owner for review and approval a description of the procedures to be used if any handling and transporting of waste is required as part of the closure work.

C. Within fourteen (14) days after execution of the Contract Agreement, the Contractor shall submit to the Project Manager an estimated progress schedule indicating the starting and completion dates for the various stages of the work. The Contractor shall submit revised schedules reflecting changes subsequent to the previous submittal with each Application for Payment.

D. The Contractor shall comply with the progress schedule for submittals related to the progress of the Work. Following the Project Manager's review of each submittal, the Contractor shall revise and resubmit the submittal, if required, identifying changes made since the previous submittal.

1.02 CONSTRUCTION PROGRESS SCHEDULES

A. The Contractor shall submit a horizontal bar chart (Gantt chart) with separate bars for each major operation, identifying the first work day of each week. The bar chart shall show the complete sequence of construction activity, identify the work of separate stages, the projected percentage of completion for each item of Work at the time of each Application for Progress Payment, submittal dates for shop drawings, product data, and samples, and product delivery dates, including those furnished by the Owner (if any). The bar chart shall also distinguish between critical-path and noncritical-path activities.

1.03 PRODUCT DATA

A. Contractor shall submit copies of product data sheets as required in the Specifications. The Contractor shall mark each copy of product data sheets to identify applicable products, models, options and other data. The Contractor shall submit the number of copies he requires, plus four (4) copies to the Project Manager.

1.04 MANUFACTURER’S INSTRUCTIONS

A. Where required in individual Specification Sections, the Contractor shall submit the manufacturer's printed instructions for delivery, storage, assembly, installation, adjusting and finishing, in quantities specified for the product data except for materials and products supplied by the Owner. For materials and products supplied by the Owner, the Owner shall submit the manufacturer's printed instructions for delivery, storage, assembly, installation, adjusting and finishing, in quantities specified for the product data.

1.05 SAMPLES

A. Prior to installation, the Contractor shall submit samples to illustrate the functional characteristics of the product, as required in these Specifications. The Contractor shall submit the number of samples to the party set forth in the respective Specification Section or as directed by the Project Manager. For materials supplied by the Owner, the Owner shall submit samples to illustrate the functional characteristics of the product, as required in these Specifications for materials.

1.06 SUBMITTAL SCHEDULE

A. The Contractor shall complete all of the submittals listed in Table 01300-1 – Submittal List, and/or as required in any section of the Specifications, QAM, or Contract Documents not later than the specified number of calendar days. Associated shipping, work, and use of materials by Contractor shall not begin until the Project Manager's review of each respective submittal is complete and further resubmission is not required. The Contractor shall plan all the work activities to allow the Project Manager at least seven (7) days to review the submittal after initial delivery. Review of submittals should not cause a delay in the work unless the submittals are incomplete or fail to demonstrate the specified requirements. Each resubmittal shall be identified with the number of the original submittal followed by consecutive numbers starting with “01” for the first resubmittal, “02” for second, etc.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

TABLE 01300-1
TECHNICAL SPECIFICATION SUBMITTAL LIST

SPECIFICATION SECTION	SECTION TITLE/SUBMITTAL DESCRIPTION	TO BE SUBMITTED BY	SUBMITTAL DUE
1100	**DEFINITIONS**		
	None		
1160	**SURVEY**		
	None		
1200	**MEETINGS**		
	None		
01300	**SUBMITTALS**		
1.01.B	Proposed work plan	Contractor	14 days after execution of contract
1.01.C	Project progress schedule	Contractor	14 days after execution of contract
1.02.A	Gantt chart	Contractor	14 days after execution of contract
1.03.A	Product data sheets	Contractor/Owner	Throughout construction, per specific material specification section
1400	**QUALITY CONTROL**		
1.02.B	Manufacturer's certificates	Contractor/Owner	Throughout construction, per specific material specification section
1500	**CONSTRUCTION FACILITIES & TEMP. CONTROLS**		
	NONE		
1550	**PROJECT AS-BUILT DOCUMENTS**		
1.02.C	As-built documents	Contractor	Up to 12 interim construction submittals and at substantial completion
1700	**CONTRACT CLOSE-OUT**		
1.01.B	Written certified of substantial completion that the Contract Documents have been reviewed and the work is complete	Contractor	Prior to final inspection
1.01.C	Statement of accounting giving total adjusted Contract Sum, previous payments, and the sum remaining due	Contractor	Prior to substantial completion
2100	**INSTRUMENTATION**		
1.05.A	Plan regarding method and protection of geotechnical Instrumentation	Contractor	Prior to start of construction activities
2120	**TEMPORARY EROSION CONTROL**		
1.02.B	Work plan outlining methods and materials by which site specific ESCP will be implemented	Contractor	One week prior to start of construction activities
1.02.C	Copies of BMPs, test results, and/or manufacturer's data verifying proposed materials and methods are in compliance with project specifications	Contractor	Upon request of Project Manager, prior to construction activities
2130	**CLEARING GRUBBING AND STRIPPING**		
	NONE		
2140	**EXCAVATION AND STORAGE OF SILT CLAY**		
	NONE		
2200	**EARTHWORK**		
1.05.A	Geotechnical index tests of all proposed soil material types and sources	Contractor	10 days prior to placement
1.05.B	Additional test results or samples (if requested) for any source changes	Contractor	Five (5) days prior to using proposed source
2400	**GEOMEMBRANE**		
1.05.A	Quality Control Submittals: Pre-Installation	Geosynthetic Installer/Manufacturer	Prior to delivery
1.05.B	Quality Control Submittals: Installation	Geosynthetic Installer/Manufacturer	As installation proceeds
2.03.A	Manufacturer Quality Control (MQC)	Geosynthetic Installer/Manufacturer	prior to installation
1.07.B.5	Notification of delivery	Manufacturer	24 hours prior to delivery to site
2510	**GEOTEXTILES**		
1.04.A	Certification that geotextile used in liner/cover system meets specifications	Contractor/Manufacturer	Prior to delivery
1.04.B	Certification that geotextile not part of liner/closure system meets specifications	Contractor/Manufacturer	Prior to delivery to site
1.04.C	Resin information and list of material components	Contractor/Manufacturer	Upon request
1.05.A.3	Notification of delivery	Manufacturer	24 hours prior to delivery to site

SPECIFICATION SECTION	SECTION TITLE/SUBMITTAL DESCRIPTION	TO BE SUBMITTED BY	SUBMITTAL DUE
2520	**DRAINAGE GEOCOMPOSITE/GEONET**		
1.04.A	Certification that geonet component used meets the specifications	Geosynthetic Installer/Manufacturer	Prior to delivery to site
1.04.B	Certification that geotextile component meets the specifications	Geosynthetic Installer/Manufacturer	Prior to delivery to site
1.04.C	Certification that geocomposite delivered meets the specifications	Geosynthetic Installer/Manufacturer	Prior to delivery to site
1.05.C	Notification of delivery	Manufacturer	24 hours prior to delivery to site
2530	**GEOSYNTHETIC CLAY LINER**		
1.04.A	MQC results/certification that bentonite component used meets the specifications	Geosynthetic Installer/Manufacturer	Prior to delivery to site
1.04.B	MQC results/certification that geotextile component meets the specifications	Geosynthetics Installer/Manufacturer	Prior to delivery to site
1.04.C	MQC results/certification that GCL rolls delivered meets the specifications	Geosynthetics Installer/Manufacturer	Prior to delivery to site
1.05.B	Notification of delivery	Manufacturer	24 hours prior to delivery to site
2560	**SITE PIPING**		
1.03.C.1.a	Drain and appurtenances technical product data sheets	Contractor/Owner	Prior to delivery
1.03.C.1.b	Pipe and fittings shop drawings	Contractor/Owner	Upon request of Project Manager, prior to delivery
1.03.C.1.c	Certification that material used meets manufacturer's standards	Contractor/Owner	Upon request of Project Manager, prior to delivery
2570	**MANHOLES, SUMP, AND CATCH BASINS**		
1.04.A	Shop drawings for pre-cast items	Contractor/Owner	Prior to installation
1.04.B	Installation plan for elongated sump	Contractor	Prior to installation
1.04.C	Product data sheets (e.g., frames, grates, sleeves, sealants, penetrations, etc.)	Manufacturer/Contractor/Owner	Prior to installation
2780	**HDPE PIPING**		
1.04.A.1	Pipe technical product data sheets	Manufacturer/Contractor/Owner	Prior to delivery to site
1.04.A.2	Manufacturer's instructions for fusing	Manufacturer/Contractor/Owner	Prior to use
1.04.A.3	Installation plan for extrusion sleeve	Contractor	Prior to use
2.05.A	Product data sheet for electro-fusion couplings	Manufacturer/Contractor/Owner	Prior to use
2.06.A	Product data sheet for dual containment joint	Manufacturer/Contractor	Prior to use
2800	**PLACEMENT OF TOPSOIL AND HYDROSEEDING**		
1.03.B.1	Representation samples	Contractor/Owner	Upon request of Soil QAC
1.03.B.2	Certificates of compliance	Contractor/Owner	Two (2) weeks prior to application
1.03.B.3	Schedule for seeding and fertilizer	Contractor	14 days prior to work
1.03.B.4	Certified statement of the number of pounds of materials per 100 gallons of water along hydroseeder square feet coverage	Contractor	Prior to start of work
3.04.B	Request of inspection notification	Contractor	10 days prior to end of warranty period
2950	**CLEANUP AND SITE RESTORATION**		
	NONE		
	MISCELLANEOUS		
	Submittal Control Log	Contractor	Completion of work
	Emergency Contact Phone Numbers	Contractor	Completion of work
	Erosion and Sedimentation Control Plan: Form A	Contractor	Completion of work
	Erosion and Sedimentation Control Plan: Inspection Log	Contractor	Completion of work

Notes:

(1) This table is to be used as a guide by the Contractor. The Contractor is responsible to submit in accordance with the Specifications

SECTION 01400

QUALITY CONTROL

PART 1 - GENERAL

1.01 GENERAL QUALITY CONTROL

A. The Contractor shall maintain quality control over the suppliers, manufacturers, products, services, site conditions, and workmanship to produce work of specified quality.

B. The Contractor shall comply with industry standards except when more restrictive tolerances on the Drawings, Specifications, or QAM indicate more rigid standards or more precise workmanship are required.

1.02 CONTRACTOR'S OBLIGATIONS

A. The Contractor shall comply with instructions in full detail, including each step in the recommended construction or installation sequence. If instructions conflict with any Contract Document, the Contractor and/or Construction Manager shall submit a Request for Clarification (RFC) to the Designer. If an interpretation of the design is considered, a Request for Information (RFI) will be submitted to the Designer and MEDEP before proceeding.

B. Where required in the Specifications, or as requested by the Designer and/or Project Manager, the Contractor shall submit the manufacturer's certificates verifying that products meet or exceed the specified requirements.

1.03 INSPECTION AND TESTING

A. The Owner will employ and pay for services of a Soil QAC and a Geosynthetic QAC to perform construction quality assurance. These services will be performed in accordance with the requirements of the QAM to establish whether the Work is in accordance with the Drawings and Specifications. Reports of the results of all Soil QAC and Geosynthetic QAC testing and construction observation shall be maintained on site, be submitted to the Project Manager on request, and shall give observations and results of tests, indicating compliance or non-compliance with specified standards and with the Contract Documents.

B. The Contractor shall cooperate fully with all Soil QAC and Geosynthetic QAC, and furnish tools, samples of materials, and assistance, as requested.

C. The Contractor shall allow the Soil QAC and Geosynthetic QAC ample time and opportunity for testing materials used in the work. The Contractor and Project Manager shall advise the Soil QAC and Geosynthetic QAC promptly upon placing orders for materials so that arrangements may be made, if desired, for inspection before shipment from the place of manufacture. The Contractor shall at all times furnish the Soil QAC and Geosynthetic QAC and his representatives, facilities including labor, and allow proper time for inspecting and testing materials and workmanship. The Contractor must anticipate that possible delays may be caused to him in the execution of this work due to the necessity of materials being inspected and accepted for use. The Contractor shall furnish, at his own expense, all samples of materials required by the Specifications or QAM.

D. The Work shall at all times be subject to the observation of the Project Manager, Soil QAC, Geosynthetic QAC, and/or Designer. Observation or non-observation by the Project Manager, Soil QAC, Geosynthetic QAC, and/or Designer shall in no way relieve the Contractor from his contractual obligation to furnish work and material as required, and properly complete the Work in accordance with these Contract Documents. If the Project Manager, Soil QAC, and/or Geosynthetic QAC considers that the Work is not being properly accomplished, he may condemn or reject all or any part of the work and any materials or equipment incorporated in it. If any material, equipment, or work is condemned or rejected, the Contractor shall bear all expenses for removal and proper replacement of such material, equipment or work required to be provided by these Contract Documents. The expense of replacing any work done by others which is adversely affected by removal and proper replacement of improper work done by the Contractor shall be borne by the Contractor.

1.04 SUBSTANDARD WORK OR MATERIALS

A. Any defective or substandard work or materials furnished by the Contractor that is discovered before the final acceptance of the work, as established by the Certificate of Substantial Completion, or during the subsequent guarantee period, shall be removed immediately even though it had not been previously noticed and may have even been recommended for payment. Any equipment or materials condemned or rejected shall be tagged as such and shall be immediately removed from the site. Satisfactory work or materials shall be substituted for that rejected.

B. The Designer, Soil QAC, and/or Geosynthetic QAC may order tests on substandard or damaged work, equipment, or materials to determine the required functional capability for possible acceptance, if there is not other reason for rejection. The cost of such tests shall be borne by the Contractor and the nature, extent and supervision of the tests will be as determined by the Designer, Soil QAC, and/or Geosynthetic QAC. If the results of the tests indicate that the required functional capability of the work, equipment or material was not impaired, consistent with the final general appearance of same, the work, equipment or materials may be deemed acceptable. If the results of such tests reveal that the required functional capability of the questionable work or materials has been impaired, then such work or materials shall be deemed substandard and shall be replaced. The Contractor may elect to replace the substandard work, or material in lieu of performing the tests.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 CONSTRUCTION FACILITIES

A. The Contractor shall provide and pay for a weather-tight field office equipped with sturdy furniture, drawing rack and drawing display table. Clean space shall be provided for Project meetings, with table and chairs to accommodate six (6) to eight (8) persons. A separate private office with desk, chair, plan table, and two-drawer filing cabinet and telephone will be provided by the Owner for the use of the Soil QAC and/or Geosynthetic QAC.

B. The Contractor shall maintain paved site roads, unpaved facility roads, and temporary roads that serve the work areas during construction. The Contractor shall restore all site roads that served work areas to their original condition.

C. The Contractor shall maintain areas outside the limits of work free of, mud, dirt, waste materials, debris, and rubbish which are a direct result of work performed by the Contractor.

D. The Contractor shall conduct vehicle maintenance only in an area approved by the Project Manager. The Contractor shall promptly clean-up and notify the Project Manager of any spills or leakage of fluids from construction vehicles or refueling trucks.

E. The Contractor shall stage materials only in areas of the site indicated on the Drawings or pre-approved by the Project Manager.

1.02 TEMPORARY UTILITIES

A. The Owner will provide access to utilities on site including power, internet, and telephone service. The Contractor shall be responsible for connection to power, internet, and telephone service per applicable codes. The Owner will pay for electricity. The Contractor is responsible for all other utilities.

B. The Contractor shall be responsible to provide water to be used for construction activities such as dust control, hydroseeding, and water which may be necessary to facilitate compaction. This water will be available from on-site sources designated by the Owner.

C. The Contractor shall provide adequate temporary sanitary facilities for use by Contractor and Soil QAC and/or Geosynthetic QAC personnel.

1.03 TEMPORARY CONTROLS

A. The Contractor shall maintain excavations free of water, protect the site from puddling or running water, and furnish and install all required temporary erosion control measures to comply fully with the Contract Documents, including Section 02120 of these Specifications, the project Erosion and Sedimentation Control Plan, and the MEDEP's requirements.

B. The Contractor shall protect installed work, provide special protection where specified in individual specification sections, and provide temporary and removable protection for installed products.

1.04 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. The Contractor shall remove appropriate temporary above-grade or buried utilities, equipment, facilities, and materials prior to Final Completion inspection. The Contractor shall restore existing and permanent facilities used during construction to original or better condition, unless specifically approved by the Owner.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 01550

PROJECT AS-BUILT DOCUMENTS

PART 1 - GENERAL

1.01 MAINTENANCE OF AS-BUILT DOCUMENTS AND SAMPLES

A. The Contractor shall maintain at the Site for the Owner's permanent records one complete set of As-Built Documents which include a copy of the Drawings, Specifications, Addenda, Requests for Clarifications (RFCs), Requests for Information (RFIs), Change Orders, Owner Field Orders, Shop Drawings, Quality Control Field Reports, Product Data, and Samples. The Drawings are to be used as the basis for all As-Built Drawings by the Contractor.

B. The As-Built Documents shall be stored in the Contractor's field office apart from other field documents used by the Contractor for construction purposes. The Contractor shall maintain the As-Built Documents in clean, dry, legible condition and in good order. The As-Built Documents shall be made available at all times for inspection by the Project Manager, Soil QAC, Geosynthetic QAC, and Designer.

1.02 MARKING

A. The Contractor shall mark all changes on the As-Built Drawings upon construction of each item of work. The Contractor shall record information concurrently with construction progress and shall not cover any work until the required information has been recorded on the As-Built Drawings.

B. During construction, the Contractor shall submit to the Soil QAC as-built plan sheets, based on the Contractor’s survey documentation. The plan sheets shall show the work in progress and shall provide the as-built coordinates and/or elevations for/at all construction layout points shown on the Drawings. The Contractor shall submit interim plan sheets to the Soil QAC whenever requested during construction, within 24 hours of being requested. Generation and submittal of up to 12 interim as-built plan sheets shall be included in the Contractor’s price to conduct the work and shall be submitted at no additional cost to the Owner.

C. Contractor shall submit the As-Built Documents including a set of plans marked "As- Built Drawings" to the Project Manager upon substantial completion of the Work. The As-Built Documents shall include a tabulation of all as-built coordinates of and/or elevations at each layout point shown on the Drawings. The As-Built Drawings should include an as-built version of each drawing in the Construction Drawings.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 CLOSEOUT PROCEDURES

A. The Contractor shall comply with the procedures in the Standard General Conditions of the Construction Agreement for issuance of the Certificate of Substantial Completion.

B. The Contractor shall submit a written certification that the Contract Documents have been reviewed and that the Work is complete in accordance with the Contract Documents and ready for inspection.

C. The Contractor shall submit a statement of accounting giving the total adjusted Contract Sum, previous payments, and the sum remaining due.

1.02 FINAL CLEANING

A. The Contractor shall perform the final cleanup prior to final site inspection by the Project Manager. Final cleanup shall consist of removal of temporary construction; removal of waste and rubbish resulting from the Contractor’s work or the work of subcontractors/subconsultants managed by the Contractor; removal of surplus materials belonging to the Contractor and/or subcontractors/subconsultants; re-staging of surplus material belonging to the Owner and resulting from Contractor and subcontractor/subconsultant activities; and removal of the Contractor's construction facilities from the Project and from the site. Removal of temporary construction shall include temporary erosion control measures, as approved by the Project Manager. Final cleanup shall also include final grading and seeding of borrow, laydown, and stockpile areas, as called for in the Specifications, Drawings, and/or Maine BMPs.

1.03 WARRANTIES

A. Prior to the final application for payment, the Contractor shall submit applicable warranty documents from subcontractors, suppliers and manufacturers. For items of work delayed materially beyond the date of substantial completion, the Contractor shall provide an updated submittal within ten (10) days after acceptance, listing the date of acceptance as the start of the warranty period.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 02100

INSTRUMENTATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. It is of paramount importance on this Site that the Contractor protects all instrumentation from damage. Instrumentation consists of settlement plates, horizontal and vertical slope inclinometers, shape accelerometer arrays (SAA's) and associated earth stations, standpipe and vibrating wire piezometers, instrumentation signal cables, water quality monitoring wells, and/or other devices used to monitor surficial or subsurface properties at the site. Due to the nature of the site and proposed construction, instrumentation may be located within or close to the limits of work. The Contractor shall verify the location and adequately mark and protect all instrumentation within 25 feet beyond the limits of work prior to beginning site work activities. Such protective measures may consist of, but are not limited to, the temporary placement of boulders or manhole segments around the installations. Caution markings shall be clearly visible from construction equipment.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 REFERENCES

A. General information regarding the geotechnical instruments is presented on the Drawings, or in the Site Operations Manual.

1.04 JOB CONDITIONS

A. The Contractor is advised to review the information about geotechnical instrumentation provided for general location and layout information, and to coordinate the construction logistics around the existing instrumentation. The contractor shall be aware that work schedules may be affected by results of on-going monitoring of the geotechnical instrumentation, especially as related to slope stability.

1.05 SUBMITTALS

A. Prior to the start of site work activities, the Contractor shall submit a plan to the Project Manager for approval by the Designer detailing the methods that will be used to mark and protect instrumentation. The plan shall identify by list and location sketch all instrumentation located within the limits of work. The Contractor shall identify the individual(s) on the Contractor's staff permanently assigned to the job, who is/are competent and may act on behalf of the Contractor, who will coordinate with an instrumentation contractor during any concurrent instrumentation installation and/or monitoring work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall exercise care in performing work adjacent to instrumentation installations. Any disturbance of the instrumentation shall be reported immediately to the Project Manager. Damaged instrumentation shall be replaced or repaired, as directed by the Designer, at the Contractor's expense within one week of the damage occurring. All work shall be stopped within a 50-foot radius of a damaged installation, or as directed by the Designer, until the installation is repaired and accepted by the Designer. The installation shall be repaired by the Contractor or at the Contractor’s expense as coordinated with and approved by the Project Manager. All repair work will be subject to approval by the Designer.

B. The Contractor shall coordinate the construction schedule to allow adequate time for the Designer and the Owner to obtain readings from the existing instrumentation.

END OF SECTION

SECTION 02120

TEMPORARY EROSION CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Due to the nature of the work and site soils, the Contractor shall implement strict erosion and sedimentation control measures throughout the duration of the work. A preventative approach to sedimentation control shall be implemented by the Contractor in that multiple measures shall be installed and maintained to prevent sedimentation and/or erosion of exposed soils, particularly adjacent areas of completed final cover. The Contractor shall furnish all labor, materials, tools, and equipment, and perform all operations necessary to provide and maintain erosion control devices to limit erosion, control sedimentation that occurs during construction operations, and contain runoff within the work area. This shall include all stockpile, laydown, and borrow areas. Such controls shall be implemented and maintained throughout the construction until the stabilization of permanent erosion control devices.

B. The Contractor shall thoroughly review and understand the site-specific Erosion and Sedimentation Control Plan (ESCP), which is available from the owner. The Contractor shall then submit a project specific plan on how their work will comply with the applicable components of the attached ESCP.

C. Regardless of any minimum requirements set forth in this section, it is the Contractor's sole responsibility to select, implement, and maintain proper and fully adequate erosion and sediment controls at all times (24 hours a day on all days) throughout the project. Repair of any damage and all restitution for liabilities resulting from improper erosion and sediment control shall be at the Contractor's expense.

1.02 QUALITY ASSURANCE

A. Most recent version of the following Standards:
1. Project-specific Erosion and Sedimentation Control Plan (ESCP).
2. "Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices," Maine Soil and Water Conservation Commission; hereinafter referred to as the BMPs.

B. <u>Work Plan Outline:</u> Prior to the start of construction, the Contractor shall meet with the Project Manager to discuss erosion control requirements as set forth in the project-specific ESCP, and, at the request of the Project Manager, to develop a written work plan outline of the materials with which and methods by which the project ESCP will be implemented. The Contractor shall complete the work plan outline and submit it to the Project Manager for review and approval at least one week prior to the start of construction. As a minimum, the temporary erosion control structures specified herein and required in accordance with the ESCP shall be installed prior to the start of construction.

C. Submittals: Upon request, the Contractor shall provide to the Project Manager copies of BMPs, test results, and/or manufacturer's data to verify that proposed materials and methods are in compliance with these specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor shall use the following materials in construction of temporary erosion control devices in accordance with the BMPs; other materials require approval of the Owner, unless specifically allowed per the BMPs.
   1. Seed:
      a. Type and use as specified in the Temporary Grass and Legume Cover BMP.
      b. Seed mixture as approved by the Project Manager or Designer.
   2. Mulches and Mats:
      a. Type and use as specified in the Temporary Mulching BMP, inclusive of Erosion Control Mix (ECM).
      b. Materials as approved by the Project Manager or Designer.
   3. Silt Fence: The Contractor shall provide documentation, if requested, to the Soil QAC certifying that the silt fence is a woven polypropylene and/or polyester material which meets the following minimum average roll values:

FABRIC PROPERTY	TEST METHOD	FABRIC REQUIREMENT
Grab Tensile Strength (lbs.)	ASTM D-4632	100
Burst Strength (psi)	ASTM D-3787	200
Apparent Opening Size (U.S. Standard Sieve)	ASTM D-4751	30 max.

   4. Hay Bales: Rectangular shaped bales of hay weighing at least 40 pounds per bale. They shall be free of primary noxious weed seeds.
   5. Sand Bags: Heavy-duty textile bags of approximately 1 cubic foot capacity filled with sand or gravel.
   6. Crushed Stone: Type and use as specified in the Temporary Check Dams BMP.

PART 3 - EXECUTION

3.01 TEMPORARY DEVICES

A. The Contractor shall use the following devices to limit erosion and control sedimentation. Other devices may be used in accordance with the BMPs and with the approval of the Project Manager.
   1. Silt Fence Barriers: As a minimum, provide as shown on the Drawings. Type and use as specified in the Sediment Barriers BMP.

2. Temporary Check Dams: As a minimum, provide as shown on and in accordance with the Drawings. Type and use as specified in the Temporary Check Dams BMP.
3. Temporary Sumps and Sediment Traps: Type and use as specified in the Sediment Trap BMP. Sediment traps shall pond sediment-laden water until outletted via pumping. Sediment-laden runoff collected in sediment traps shall be pumped to an on-site location designated by the Owner.
4. Temporary Diversions: Provide as needed to prevent clean stormwater from outside the limits of work from entering the work area. Temporary diversions shall not result in erosion or sedimentation, or cause flooding outside the limits of work.
5. Geotextile: Use lightweight fabric (e.g., 6 oz/syd) to provide temporary erosion control.
6. Erosion Control Mix (ECM): Use bark mulch to direct and divert stormwater.

3.02 APPLICATION RATES

A. Seed: As specified in the Temporary Grass and Legume Cover BMP.

B. Mulches: As specified in the Temporary Mulching BMP.

3.03 MAINTENANCE

A. All temporary erosion control measures shall be maintained by the Contractor throughout the course of site construction activities until final acceptance of the site vegetation by the Project Manager.

B. The Contractor shall provide personnel on a round-the-clock (overnight) basis whenever necessary to monitor and maintain all temporary erosion and sediment control devices.

3.04 REMOVAL OF TEMPORARY EROSION CONTROL

A. Temporary materials and devices shall be removed by the Contractor when permanent soil stabilization has been achieved and as approved by the Project Manager. Materials in good condition may be reused on the site if approved by the Project Manager.

Materials unsuitable for reuse become the property of the Contractor and shall be disposed of at the Contractor's expense.

END OF SECTION

SECTION 02130

CLEARING, GRUBBING, AND STRIPPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Owner will clear the approximate limits of work prior to construction.

B. The work of this section includes all construction activities related to the following:
1. Clearing, removing, and disposing of all remaining trees, brush, and vegetative cover from within the limits of work or within on-site borrow areas as needed to allow construction of the work.
2. Removing and disposing of tree stumps grubbed from within the limits of work or within on-site borrow areas.
3. Stripping, screening, hauling, and stockpiling surficial organics (topsoil) from within the limits of work or within on-site borrow areas; segregating wetland and upland topsoil if required per other Contract Documents.
4. Stripping of surficial sand or granular fill deposits in designated areas to expose the underlying natural silt clay deposits.
5. Removing and salvaging and/or disposing of temporary geosynthetics, including tarps, and cover soils as needed to allow construction of the work.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 JOB CONDITIONS

A. The project may require the removal of temporary geosynthetics and/or cover soils, trees, brush, stumps, and/or topsoil in preparation of construction of permanent project facilities or for the excavation of construction materials from on-site borrow sources.

B. The Contractor shall be responsible for the implementation and maintenance of all measures identified in Section 02120 prior to and during execution of the work related to this Section.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials generated as a result of work specified in this Section may include:
1. Trees and Brush
2. Stumps
3. Topsoil, Upland and Wetland
4. Surficial Sand
5. Miscellaneous Fill

6. Temporary Geosynthetics/Tarps
7. Cover Soil

PART 3 - EXECUTION

3.01 CLEARING AND GRUBBING

A. General:
  1. The areas to be occupied by the permanent construction required under these Specifications and the surface of all the borrow pits, stockpile, and waste pile sites shall be cleared of all trees, stumps, exposed roots, brush, rubbish, debris, and other materials as determined by the Soil QAC or Project Manager. The intent of clearing and grubbing is to remove vegetation, while leaving the topsoil.
  2. No trees located more than 10 feet (horizontal distance) outside of areas mentioned above shall be cut without specific approval of the Project Manager, and all trees designated to remain shall be protected from damage by the Contractor's construction operations.
  3. The Contractor shall investigate and determine the limits of clearing required in accordance with this Section. No clearing, grubbing, or stripping shall be undertaken prior to approval of the limits of clearing by the Project Manager. The Contractor shall notify the Project Manager at least one day (minimum 24 hours) before activities are scheduled to commence.

B. Disposal:
  1. Suitable materials from clearing and grubbing operations including cut timber, down timber, dead timber, branches, stumps, and brush shall be transported to the wood grinding area on site.
  2. All other materials resulting from the clearing and grubbing operations shall be transported by the Contractor to the unsuitables stockpile area designated on the Drawings.

3.02 STRIPPING

A. General:
  1. The designated areas shall be stripped in accordance with the Specifications that follow.

B. Excavation:
  1. Designated areas shall be stripped of surficial materials until suitable subgrade or borrow materials are exposed, in accordance with Section 02200 and as determined by the Soil QAC.
  2. Unsuitable materials to be removed by stripping shall include all perishable and other materials that are unsuitable for use in the permanent construction required under these specifications. Unsuitable materials resulting from the stripping operations shall be transported by the Contractor to the unsuitables stockpile area designated on the Drawings or as directed by the Project Manager.

3. If other Contract Documents require wetland and upland topsoil to be segregated, the upland topsoil shall be screened as necessary to achieve the requirements set forth in Section 02800. Otherwise, all topsoil shall be screened as necessary to achieve the requirements set forth in Section 02800.

4. Wetland and upland topsoil shall be separately stockpiled in the locations designated on the Drawings, or as directed by the Project Manager. The Contractor shall temporarily mulch and seed stockpiles in accordance with the Specifications and Maine BMPs. Only straw mulch shall be used on segregated wetland topsoil.

C. Excavation Below Stripping:
   1. Excavation below stripping where shown on the Drawings or where directed, shall be to firm foundation materials as determined by the Soil QAC.

D. Excavation of Surficial Sands and/or Granular Fill:
   1. Excavated sands or granular fill resulting from clearing, grubbing and stripping operations shall be reused in accordance the Drawings and Specifications, or stockpiled by the Contractor in the locations designated on the Drawings or as directed by the Project Manager. The Contractor shall temporarily mulch and seed stockpiles in accordance with the Maine BMPs.

E. Removal of Temporary Geosynthetics and/or Cover Soils:
   1. Temporary geosynthetics (tarps) and/or cover soils shall be removed by the Contractor from the work area to expose the required subgrade, as directed by the Project Manager.

   2. Temporary geosynthetics (tarps) and/or cover soils removed as part of the work shall be salvaged and stored, stockpiled, and/or disposed of by the Contractor as directed by the Project Manager. These materials shall be used as daily cover over exposed waste or as temporary tarps to minimize generation of leachate, as directed/approved by the Project Manager or Owner.

   3. The Contractor shall temporarily mulch and seed any resulting stockpiles in accordance with the Maine BMPs.

END OF SECTION

SECTION 02140

EXCAVATION AND STORAGE OF SILT CLAY

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Silt clay will be excavated from on-site or off-site sources, provided the material satisfies the specifications stated in Section 02200. The work associated with this section consists of excavating and transporting silt clay from on-site sources, to stockpile areas or directly to capping areas.

1.02 APPLICABLE SECTIONS

A. All Sections

PART 2 - PRODUCTS

2.01 SILT CLAY

A. Soils to be used on-site as Silt Clay Borrow may include silt clay generated from on- site and/or off-site sources, provided the material satisfies the requirements of Section02200.

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to submitting bids, bidders may sample and test borrow materials from on-site or off-site source areas designated by the Project Manager.

B. The type of equipment and methods used by the Contractor in the excavation of silt clay materials shall not result in the mixing of the silt clay with other materials.

3.02 PREPARATION

A. Project areas from which silt clay is to be obtained shall be cleared, grubbed, and stripped in accordance with Section 02130.

3.03 EXCAVATION AND TRANSPORTATION

A. The Contractor shall, to the extent practicable, transport suitable silt clay from approved borrow sources directly to locations requiring Silt Clay Borrow material.

B. Silt clay having unacceptable water content or needing to be stockpiled for future use shall be transported to the stockpile areas designated on the Drawings or as directed by the Project Manager.

C. Stockpiled silt clay shall be placed in a configuration that promotes shedding of storm water. The surface shall be sealed by tracking with a bulldozer, smooth drum roller, or equivalent equipment approved by the Soil QAC.

D. Silt clay stockpiles shall be constructed outside the limits of each landfill unit with sideslopes no steeper than 2H:1V, and to a height no greater than 30 feet above the surrounding ground. Stockpiles within the waste-disposal areas must be preapproved by the Designer to ensure slope stability.

E. The soil stockpile area shall be constructed with temporary erosion controls in accordance with Section 02120.

3.04 DISPOSAL OF UNSUITABLE MATERIAL

A. Materials deemed unsuitable by the Soil QAC shall be transported by the Contractor to the unsuitables stockpile area designated on the Drawings, or as directed by the Project Manager.

B. Erosion control structures shall be placed around the stockpiles to control erosion, as necessary, in accordance with Section 02120. All stockpile areas shall be graded by the Contractor to drain, covered with topsoil, and seeded in accordance with the BMPs, as directed by the Project Manager.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work of this section includes construction activities related to the following, as applicable:
   1. Excavations for Pipe Trenches and Structures
   2. Intermediate Cover Soil, Protective Cover Soil, and Silt Clay Borrow Placement
   3. Backfilling of Pipe Trenches and around Structures, and General Backfilling
   4. Riprap Installation
   5. Access Roadway Construction

B. The Contractor is advised that a test pad program may be required prior to full-scale Silt Clay Borrow layer construction.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 REFERENCES

A. The latest versions of the following American Society for Testing and Materials (ASTM) standards shall be used:
   1. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
   2. ASTM C127 - Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
   3. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
   4. ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   5. ASTM D422 - Standard Test Method for Particle Size Analysis of Soils.
   6. ASTM D698 - Standard Test Methods forLaboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m^3)).
   7. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^{-3} (2,700 kN-m/m^3)).

9. ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
10. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
11. ASTM D2937 - Standard Test Method for Density of Soil In-Place by the Drive-Cylinder Method
12. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
13. ASTM D4373 - Standard Test Method for Rapid Determination of Calcium Carbonate Content of Soils
14. ASTM D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
15. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.04 QUALITY ASSURANCE

A. The latest versions of the following Standards:
   1. "Quality Assurance Manual (QAM) for Crossroads Landfill."
   2. "Standard Specification for Highways and Bridges," Maine Department of Transportation.

B. Testing and Inspection: Owner will pay for a Soil QAC and a Soil QAL during construction to verify compliance with these Specifications. Subject to the discretion of the Project Manager, the cost (labor and expenses) for all re-tests resulting from failing initial tests shall be conducted by the Soils QAC and/or Soils QAL at the Contractor's expense.

C. Inspection of Material Sources: The Soil QAC may inspect off-site sources of materials and request the Contractor to perform tests of those materials to verify compliance with these specifications. The Soil QAC may also make his own tests in accordance with the QAM.

1.05 CONTRACTOR'S SOIL SUBMITTALS

A. At least 10 days prior to commencing filling operations, the Contractor shall submit to the Soils QAC results of laboratory testing performed on representative samples of soil materials from the proposed sources. The testing shall be performed at the Contractor's expense. The test results shall demonstrate compliance of each material with the properties required in these specifications. If directed to do so by the Soils QAC, the Contractor shall also provide a sample of material from each proposed source.

B. The Contractor shall follow the same procedure set forth in paragraph 1.05A of this Specification for any required or desired change in material sources. The test results, and if requested, representative sample, shall be submitted by the Contractor to the Soils QAC at least five (5) working days prior to using soil from the proposed soil.

C. If the Contractor’s test results fully satisfy the specification requirements, the test results may be counted by the Soils QAC as the first conformance test for the subject material, as set forth in the QAM.

D. The Contractor shall submit all other documents required herein for review and acceptance, in accordance with this specification and the QAM.

1.06 JOB CONDITIONS

A. General:
1. Contractor will be working on existing waste slopes placing materials as specified in the Contract Documents. It is the Contractor’s responsibility to be thoroughly familiar with the waste and slope conditions on which the work will be performed, and to coordinate activities to ensure the stability of the slopes and the integrity of the soil and geosynthetic components of the work.

PART 2 - PRODUCTS

2.01 MATERIALS, DEFINITION

A. General:
1. Definitions: All earth materials which may contain varying amounts of the following:
   a. Rock Fragments - Pieces of rock which are generally not rounded.
   b. Boulders - Detached pieces of rock, generally rounded but may be subrounded to angular, which are larger than 12 inches in maximum dimension.
   c. Cobbles - Rounded pieces of rock which are not greater than 12 inches, but are larger than 3 inches in maximum dimension.
   d. Soils - Soils consist of sands, gravels, clay and silt. A definition of "clay" and "silt" is provided below:
      i. Clay - Plastic soil which passes a U.S. Standard No. 200 sieve and has a particle size less than 2 microns.
      ii. Silt - Soil which passes a U.S. Standard No. 200 sieve and is larger than 2 microns in particle size.
2. Glacial Till:
An unsorted, unconsolidated deposit consisting of a heterogeneous mixture of clay, silt, sand, gravel, cobbles, and boulders varying widely in size and shape.
3. Peat:
An unconsolidated deposit of semi-carbonized plant remains of a water-saturated environment, such as a bog, and of persistently high moisture content.
4. Glaciomarine:
An unconsolidated deposit of uniformly graded sands, silts, and clays. These soils generally have a high water content and experience a loss of strength when disturbed.

2.02 MATERIALS, FILL

A. General: Excavations made at the site for the construction of project facilities will generate soil materials. These soils will either be suitable or unsuitable for use as fill in the construction of earth-related portions of the project.

1. Suitable Materials: Those materials generated from on-site excavations that satisfy the property requirements for the material for which it is to be used (e.g. Silt Clay Borrow, etc.). Specified properties for suitable project materials are set forth in Paragraphs 2.02B through 2.02L. The specified properties must be met unless approved otherwise by the Designer.
2. Unsuitable Materials: Those materials generated from on-site excavations that do not satisfy the specifications for the project materials identified in Paragraphs 2.02B through 2.02L, or as identified by the Project Manager or Soil QAC. Generally, these materials will contain vegetation, organic matter, debris, or frozen materials. Disposal or stockpiling of unsuitable materials shall be in accordance with Paragraph 3.01E.

B. Sedimentation Basin Filter Sand:

1. Sedimentation Basin Filter Sand shall be furnished and placed to the lines and dimensions shown on the Drawings to provide a filter medium and a protective layer over subgrade soil in sedimentation basins. The materials to be used for the Sedimentation Basin Filter Sand shall be select pervious mixtures of sand and gravel, reasonably well graded within the following limits:

SIEVE DESIGNATION	% PASSING BY WEIGHT
4-inch	100
1-inch	65-100
No. 4	55-95
No. 10	50-90
No. 40	0-50
No. 100	0-20
No. 200	0-6

C. Protective Layer:

1. Protective Layer shall be furnished and placed to the lines and dimensions shown on the Drawings to provide a protective soil layer over the drainage geocomposite and other select locations such as under drainage benches and downchutes for construction of final cover. The Protective Layer shall have a hydraulic conductivity of greater than or equal to 1.0×10^{-4} cm/sec at 95% maximum dry density as determined by ASTM D698. Hydraulic conductivity test shall be performed at an effective stress of less than 500 psf and in accordance with ASTM D5084. The material shall contain no sharp angular stone or other material capable of penetrating the geomembrane and shall meet the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
2-inch	100
1-inch	95-100
No. 10	40-100
No. 60	20-100
No. 100	10-100
No. 200	<45

D. Intermediate Cover:

1. Intermediate Cover shall be furnished and placed over waste to the lines and dimensions shown on the drawings to provide a gas vent material and grading layer. The Intermediate Cover shall have a permeability greater than or equal to 1×10^{-4} cm/sec at 88% maximum dry density as determined by ASTM D698 Hydraulic conductivity test shall be performed at an effective stress of less than 500 psf and in accordance with ASTM D5084. The material shall conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
1-inch	100
No. 40	0-95
No. 200	0-15

Note: A temporary geomembrane, with a minimum thickness of 20 mils, must be installed over granular intermediate cover. If not, material used for intermediate cover shall meet the requirements of Section 4.C(8)(b) of Maine SWMR Chapter 401.

E. Silt Clay Borrow:

1. Silt Clay Borrow used for fill beneath landfill base areas, general and/or embankment fill, part of cover section construction, and/or anchor trench backfill shall consist of a mixture of silt clay material. Silt Clay borrow shall have a hydraulic conductivity of less than or equal to $1\text{x}10^{-5}$ cm/sec when compacted at the conditions demonstrated by the Test Pad Program. Hydraulic conductivity test shall be performed at an effective stress of less than 500 psf and in accordance with ASTM D5084. Silt Clay Borrow shall conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
1-inch	100
No. 200	71-100

F. Common Borrow (Granular and Cohesive):

1. Common Borrow shall consist of soil considered by the Designer to be suitable for embankment, flexible pipe bedding and general fill, where identified on the Drawings. Granular Common Borrow shall be utilized to the maximum extent allowed for on the Drawings. Common Borrow shall be free from frozen material, perishable rubbish, peat, and other unsuitable material, and conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT	
	Cohesive	Granular (See Notes 1 and 2)
8-inch	100	100
No. 200	>70	<35

Note 1: Granular Common Borrow shall have a maximum dry density of at least 110 pounds per cubic foot (pcf) when tested in accordance with ASTM D1557.
Note 2: Granular Common Borrow shall be a fairly well graded material (i.e., uniformity coefficient (D_{60}/D_{10}) ≥ 2.5 with a smooth and reasonably symmetrical grain size curve.)

G. Structural Fill:

1. Structural Fill to be used in access road construction, for filter berm construction, as a bedding layer for stormwater manholes and catch basins, and for structure footings, as indicated on the Drawings, shall consist of hard, durable stone with coarse to fine sand. It shall be free of ice, snow, debris, organic and other deleterious materials, and lumps of clay and conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
4-inch	100
1/2-inch	45-90
No. 4	40-80
No. 40	5-35
No. 200	0-10

H. Granular Fill:

1. Granular Fill to be used in access road construction, sedimentation basin perimeter berm construction, flexible pipe bedding, and/or as backfill around catch basins, manholes, and structure footings/walls shall be free of ice, snow, debris, organic and other deleterious materials, and lumps of clay and conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
6-inch	100
No. 10	30-95
No. 40	10-60
No. 200	2-8

I. 3/4-Inch Crushed Stone:

1. 3/4-Inch Crushed Stone to be used as bedding for rigid pipe (RCP), sedimentation basin outlet structure base pad, leachate transfer system structures, and/or to be used in downchute, swale, and sedimentation basin underdrain construction shall be hard, durable, resistant to weathering, and free from overburden, spoil, and organic materials. Shale and stone with shale seams are not acceptable. 3/4-Inch Crushed Stone shall be washed and uniformly blended according to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
1-inch	100
3/4-inch	65-100
1/2-inch	10-70
1/4-inch	0-20
No. 4	0-6
No. 200	0-2

J. 1-1/2-Inch Crushed Stone:

1. Crushed stone to be used in header trenches, sumps, cover system perimeter drain, and temporary stone check dam construction shall be hard, durable, resistant to weathering and to water action, and free from overburden, spoil, and organic materials. Shale and stone with shale seams are not acceptable. The material must be essentially non-carbonate, exhibiting less than 5 percent loss of weight when tested in accordance with ASTM D4373. Crushed stone shall be washed and uniformly blended according to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
3-inch	100
1-1/2-inch	90-100
1-inch	35-100
1/2-inch	0-30
No. 4	0-5
No. 200	0-2

K. Surface Course:

1. Surface Course to be used in access road construction shall be free of ice, snow, debris, organic and other deleterious materials, and lumps of clay and conform to the following gradation requirements:

SIEVE DESIGNATION	% PASSING BY WEIGHT
1-inch	95-100
3/4-inch	90-100
No. 4	40-65
No. 10	10-45
No. 200	2-6

L. Riprap:

1. Stone used for riprap shall be hard, durable, and angular in shape; resistant to weathering and to water action; free from overburden, spoil, and organic materials; and shall meet the gradation requirements specified in subsection 2.02.L.5. Neither breadth nor thickness of a single stone shall be less than one-third (1/3) its length. Rounded stone or boulders will not be accepted unless authorized by the Designer.
2. Shale and stone with shale seams are not acceptable. The minimum unit weight of the stone shall be one hundred and fifty five pounds per cubic foot (155 lb/ft^3) as computed by multiplying the specific gravity (bulk- saturated-surface-dry basis, per ASTM C127) times sixty-two and four tenths pounds per cubic foot

(62.4 lb/ft^3).

3. The source of the stone shall be selected at least fourteen (14) days in advance of the time when the stone will be required in the work. The acceptability of the stone will be determined by service records (i.e., certification from the source) and/or by suitable tests. If testing is required, representative samples of stone shall be taken in the presence of the Soil QAC at least fourteen (14) days in advance of the time when placing of riprap is expected to begin. The approval of some rock fragments from a particular quarry site shall not be construed as constituting the approval of all rock fragments taken from the quarry.
4. In the absence of service records, resistance to disintegration from the type of exposure to which the stone will be subjected shall be determined by the Contractor using the following tests:
   a. The abrasion test in the Los Angeles machine (ASTM C535). The stone shall have a percentage loss of not more than forty (40) after five-hundred (500) revolutions.
   b. The sulfate soundness test (ASTM C88). Stones shall have a loss not exceeding ten percent (10%) after five (5) cycles.
5. Riprap (D_{50} as indicated on the Drawings) shall meet the following gradation requirements:

SIEVE	% PASSING BY WEIGHT			
DESIGNATION	D_{50} = 4 in.	D_{50} = 6 in.	D_{50} = 8 in.	D_{50} = 12 in.
18-inch				100
12-inch			100	40-70
9-inch		100		
8-inch			40-70	
6-inch	100	40-70	20-40	20-40
4-inch	40-70			
3-inch		0-20	0-20	0-20
2-inch		0-10	0-10	
1-1/2-inch	0-20			
3/4-inch	0-10			

6. Control of riprap gradation will be by visual inspection by the Soil QAC. If necessary, the Contractor shall provide two (2) samples of rock, at least five tons (5) each, meeting the specified gradation. One of the samples shall be provided at the construction site and may be a part of the finished riprap covering. The other sample shall be stockpiled at the quarry or distribution source for the riprap. These samples shall be used as a reference for judging the gradation of the riprap supplied.
7. Any difference of opinion between the Soil QAC and the Contractor shall be resolved by dumping and checking the gradation of two (2) random truckloads of stone. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 EXCAVATIONS

A. General:
  1. Refer to Section 02130 for preparation of the site prior to excavations required as part of the construction of the project facilities.
  2. No additional allowance above the prices bid in the schedule for excavation will be made on account of any of the material being wet or frozen.
  3. Common excavation includes all material, including peat, silt clay, glacial till, and sand.

B. Open Excavation and Trench Excavations:
  1. Excavations shall be made to the full dimensions required and shall be finished to the prescribed lines and grades.
  2. Any and all excess excavation for the convenience of the Contractor or over excavation performed by the Contractor for any purpose or reason, except as pre-approved in writing by the Project Manager, and whether or not due to the fault of the Contractor, shall be at the expense of the Contractor. Where required to complete the work, all such excess excavation and over excavation shall be refilled with materials furnished and placed at the expense of the Contractor.
  3. The Contractor shall inform the Soil QAC and the Project Manager of all substantial over excavation operations prior to commencing any such work, so that any associated stability issues may be identified. The Contractor shall be prepared to alter their operations to enhance stability.
  4. All excavation to subgrade for liner system construction, embankment construction, pipe installation, and structure foundations shall be performed in the dry, with adequate dewatering procedures implemented.
  5. All necessary precautions shall be taken to ensure that the material below and beyond the established excavation lines remains in the soundest possible condition.

C. Subgrade Preparation - General:
  1. Prior to fill placement, the subgrade shall be firm, dry, and free from debris, ice, and snow. Fill shall not be placed over frozen soil unless otherwise approved by the Designer.
  2. Subgrade preparation shall be followed as closely as possible by fill placement. Deterioration of the subgrade between excavation and initial fill placement shall be the responsibility of the Contractor and shall be repaired at the Contractor's expense.
  3. All subgrades must be inspected and approved by the Soil QAC in accordance with the QAM prior to fill placement. Sufficient time shall be given to the Soil QAC to inspect and perform any necessary tests (e.g., proof rolling, field moisture-density tests) on the subgrade as set forth in Paragraph 3.07 of this section, as well as to visually inspect proof rolling activities.

D. Refilling Unauthorized Excavation:
  1. <u>Trenches:</u> The Contractor shall use materials selected by the Designer based on the location of the excavation.

2. Other Excavations: The Contractor shall use compacted Silt Clay Borrow within landfill boundaries, or other materials selected by the Designer outside landfill units.

E. Disposition of Excavated Materials:
1. Suitable materials generated from excavations shall be used, to the maximum extent shown on the Drawings, to construct the earthwork components of the project.
2. Suitable materials are those materials meeting the property requirements set forth in Paragraph 2.02 of this Section.
3. Excavated materials which are unsuitable for, or are in excess of, the project earthwork requirements shall be stored in the stockpile areas designated on the Drawings or as directed by the Project Manager.
4. The Contractor's operations in excavations shall yield as much suitable material for construction as practicable. The Contractor shall excavate unsuitable materials separately from the suitable materials to be stored, and the unsuitable materials shall be segregated by loads during the excavation operations. The suitable materials shall be placed in the designated final locations directly from the excavation, or shall be placed in temporary stockpiles and later placed in the designated locations.
5. Excavated materials which, after drainage or drying, are suitable for embankments and general fill construction but which, when excavated, are too wet for immediate compaction in the embankment, shall be placed temporarily in stockpiles or processing areas approved by the Project Manager until the moisture content is reduced to the limits stated in Subsection 3.04.
6. Excavated materials which are suitable for reuse shall be placed and compacted as soon as practicable following excavation. During winter-like working conditions (freezing temperatures), the Contractor's operations shall be coordinated and the appropriate equipment used to ensure the reuse of excavated materials is maximized to the extent practicable. Frozen materials shall not be allowed for reuse unless allowed to thaw and properly adjusted for moisture content. If material is placed while still frozen, the Contractor shall remove and handle as an unsuitable material at no additional expense to the Owner.

3.02 STABILITY OF EXCAVATIONS

A. General:
1. Sideslopes of excavations and means for access/egress shall comply with OSHA, other Federal, and State Regulations and Local Codes. The Contractor shall shore and brace in accordance with Paragraph 3.02B where sloping is not feasible.
2. Maintain sides and slopes of excavations in safe conditions until completion of backfilling.

B. Shoring and Bracing:
1. The Contractor shall provide materials for shoring and bracing to comply with all OSHA, other Federal, and State regulations and local codes.
2. The Contractor shall maintain shoring and bracing in excavations regardless of the time period excavations remain open. The Contractor shall carry down shoring

and bracing as excavation progresses.

3. The design, supporting calculations, and proposed construction procedure for bracing systems shall be prepared and stamped by a Professional Engineer registered in the State of Maine and submitted to the Designer for review at least one week prior to commencing excavation.

3.03 DEWATERING

A. General:
1. The Contractor shall perform all work in the dry, and shall prevent surface water and groundwater from flowing into excavations and from flooding any portion of the project site or surrounding area.
2. To the extent practicable, the Contractor shall not allow water to accumulate in excavations. The Contractor shall provide and maintain sumps, pumps, and dewatering system components as necessary to convey water out of and/or away from excavations.
3. The Contractor shall be responsible for dewatering the liner or cover system anchor trench throughout all stages of the Work.
4. The Contractor shall convey all water (that has not been in contact with waste) removed from excavations or diverted from the work area to the sedimentation ponds (Erosion Control Structures) as indicated on the Drawings or as directed by the Project Manager. The Contractor shall establish and maintain temporary drainage ditches and other diversions outside excavation limits, and provide temporary erosion control measures in accordance with Section 02120, and the Erosion and Sedimentation Control Plan. Excavation of temporary drainage ditches or construction of other diversions shall be subject to the prior approval of the Project Manager and/or Designer. The Contractor shall not use trench excavations as temporary drainage ditches, unless approved otherwise by the Designer.
5. Failure to keep excavations dry could result in softening of the exposed subgrade, rendering it unsuitable to support proposed facilities. Softened soils, caused as a result of inadequate dewatering, shall be removed and replaced with compacted material or otherwise repaired as directed by the Soil QAC and/or the Designer at the Contractor's expense.

3.04 FILL MATERIAL PLACEMENT

A. Silt Clay Borrow. The Contractor will be required to demonstrate that the equipment proposed to place, spread, moisture-condition, and compact the silt-clay borrow layer of the cover system will meet the project requirements. Unless waived by the Project Manager, this shall be accomplished by a test pad program, as outlined in the Test Pad Work Plan to be provided by the Project Manager if needed.

1. <u>Material</u>: Silt clay to be used in areas where Silt Clay Borrow is required shall consist of a mixture of silt clay taken from on-site excavations or obtained from off-site sources.
2. <u>Moisture Control:</u> The workability of silt clay is acutely sensitive to moisture content. The water content of Silt Clay Borrow used as fill shall be controlled by the Contractor to stay in the range of 0 percent dry of the laboratory-determined

optimum water content to 4 percent wet of optimum water content. Silt clay not meeting this range of water contents shall be removed or reworked until the moisture content is within these limits, unless approved otherwise by the Designer.

3. Compaction Criteria: Silt Clay Borrow shall be compacted to at least 95% of maximum dry density as determined by ASTM D698. The Contractor shall adjust the moisture content of the Silt Clay Borrow as necessary to achieve the required degree of compaction.
4. Placement: Silt Clay Borrow shall be placed in continuous, approximately horizontal layers. The contractor shall place a single lift of silt-clay having sufficient loose thickness such that the layer is a minimum of 12 inches thick after compaction. In areas that will require hand compaction, the loose-lift thickness shall be such that the compacted thickness is a maximum of 6 inches thick after compaction. The Silt Clay material shall not be placed on surfaces that are muddy, frozen, or contain frost or ice.

   The distribution and gradation of the Silt Clay Borrow throughout earthwork components shall be such that the fills will be free from lenses, pockets, streaks, or layers of material differing substantially in texture, gradation, or moisture from the surrounding material. The combined excavation, separation, and placement operations shall be such that the materials, when compacted, will be blended sufficiently to secure the best practicable distribution of the material.

   If, in the opinion of the Soil QAC, the surface of the prepared foundation or the compacted surface of any layer of earthfill is too dry or smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or worked with harrow, scarifier, or other suitable equipment, in an approved manner to a sufficient depth, to provide a satisfactory bonding surface before the next succeeding layer of fill material is placed. If, in the opinion of the Soil QAC, the compacted surface of any layer of in-place fill is too wet for proper compaction of the layer of earthfill material to be placed thereon, it shall be removed, allowed to dry or be worked with a harrow, scarifier, or other suitable equipment to reduce the moisture content to the specified amount; and then it shall be recompacted before the next succeeding layer of earthfill material is placed. If, in the opinion of the Soil QAC, (a portion of) any layer of fill freezes prior to the placement of the succeeding lift of earthfill material, the frozen material shall be removed and handled as unsuitable material, or allowed to thaw and then adjusted to meet the required moisture content criteria.
5. Compaction: When each layer of material has been conditioned to have the specified moisture, it shall be compacted using as many passes of a pad-foot compactor to achieve no less than 95% of the standard proctor maximum dry density. Based on previous test pads at the site, this is anticipated to be at least 4 passes of the compaction equipment selected in accordance with Paragraph 3.04.A.6. The passage of compaction equipment in either direction (forward or backward) is considered a single “pass.” When compacted, the density shall be essentially uniform throughout the layer. Compacted earth material having a moisture content or dry density that does not meet the criteria specified shall be reworked and recompacted, as directed by the Soil QAC, to obtain the specified moisture content and dry density.
6. Compaction Equipment: Compaction of the silt clay to be used at the site shall be by equipment capable of producing a kneading action for the full depth of each

lift. A padfoot, sheepsfoot, or tamping feet roller shall be used, unless approved otherwise by the Designer. Using loaded dump trucks will not be considered a satisfactory compaction method.

7. Smooth Roll Surface: At the completion of each work day, the Contractor shall "seal" the surface by compacting the surface with several coverages of a smooth drum roller. This procedure will encourage runoff from storms, thus limiting development of excessively moist or wet lenses of soil within the fill. The sealed surface shall be roughened prior to placing the next lift of silt clay to promote a bond between lifts.
8. Placement and Compaction of Silt Clay Borrow in Areas of Difficult Access: Where compaction of silt clay by means of the rollers specified for use is impracticable or undesirable, the fill shall be placed in accordance with the applicable provisions of this Subsection except placement may require layers thinner than those specified for roller compaction of earthfill to obtain the desired compaction with the equipment used.

B. Common Borrow (Granular/Cohesive)

1. Material: Common Borrow may consist of suitable silt clay, glacial till, sand and gravel, or other inorganic soils meeting the requirements of Subsection 2.02.F, taken from on-site excavations or obtained from off-site sources.
2. Placement: Common Borrow shall be placed in continuous, approximately horizontal layers, not more than 12 inches in loose depth for material compacted by heavy construction equipment; and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Fill material shall not be placed on surfaces that are muddy, frozen, or contain frost or ice.
   Cohesive Common Borrow, and Silt Clay Borrow material that is used as Cohesive Common Borrow, shall be placed in accordance with the requirements specified in Paragraph 3.04.A.4.
3. Compaction Criteria and Moisture Control: Cohesive Common Borrow shall be compacted to at least 95% of maximum dry density as determined by ASTM D698, unless otherwise specified herein. Moisture content of silt clay shall be controlled in accordance with the requirements specified in Paragraph 3.04.A.2.
   Granular Common Borrow shall be compacted to at least 95% of its maximum dry density as determined by ASTM D1557, unless otherwise specified herein. The Contractor shall adjust the moisture content of the Granular Common Borrow soils as necessary to achieve the required degree of compaction.

C. Sedimentation Basin Filter Sand, Protective Layer, and Intermediate Cover

1. Sedimentation Basin Filter Sand, Sand Protection Layer, and Granular Intermediate Cover shall be furnished and placed to the limits shown on the Drawings.
2. The Sedimentation Basin Filter Sand, Sand Protection Layer, and Granular Intermediate Cover shall have a final thickness not less than that shown on the Drawings and shall be placed in one continuous lift.
3. Protective Layer shall be placed to at least 85% of its maximum dry density as determined by ASTM D 698.
4. Intermediate Cover shall be placed and tracked in with a dozer or compactor to achieve a relatively uniform layer having the minimum thickness called for on the Drawings.

D. Surface Course, Structural Fill, and Granular Fill for Roadways
   1. Roadway Surface Course, Structural Fill, and Granular Fill shall be compacted using vibratory equipment to at least 95% of the material's maximum dry density as determined by ASTM D1557. Placement of these materials shall be in layers not exceeding 12 inches in loose lift thickness. The Contractor shall adjust the moisture content of the Roadway Surface Course, Structural Fill, and Granular Fill as necessary to achieve the required degree of compaction.

E. Structural Fill for Bedding for Structures and for Basin Filter Berms, and Granular Fill for Basin Berms and Bedding for Flexible Pipes
   1. Structural Fill bedding for structures shall be placed in continuous, approximately horizontal layers, not more than 12 inches in loose depth for material compacted by heavy construction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Structural Fill bedding shall be compacted to at least 95 percent of the material's maximum dry density as determined by ASTM D1557.
   2. Structural Fill for basin filter berms shall be furnished and placed to the limits and grades shown on the Drawings.
   3. Granular Fill for basin berms and bedding for flexible pipe shall be placed in continuous, approximately horizontal layers, not more than 12 inches in loose depth for material compacted by heavy construction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. Granular Fill in basin berms and for flexible pipe bedding shall be compacted to at least 95 percent of the material's maximum dry density as determined by ASTM D1557.

F. ¾-Inch Crushed Stone
   1. ¾-Inch Crushed Stone for structure bedding as indicated on the Drawings, shall be placed in one continuous lift and wrapped in geotextile fabric, as specified on the Drawings.

G. Riprap
   1. Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing or damaging underlying material. Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.
   2. The larger stone shall be well distributed, and the entire mass of stone shall conform to the gradation specified in Paragraph 2.02.L. All material comprising riprap protection shall be so placed and distributed so that there will be no large accumulations of either the larger or smaller sizes of stone.
   3. A fairly compact riprap protection, in which all sizes of material are placed in their proper proportions, should be produced. Hand-placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.
   4. Unless otherwise authorized by the Project Manager, the riprap protection shall be placed in conjunction with the dressing and preparation of the drainage swales with only sufficient lag in construction of the riprap protection as may be necessary to allow

for proper construction of the portion of the drainage swale protected. The Contractor shall maintain the riprap protection until accepted.

5. The riprap shall extend to firm undisturbed soil. A well-established cover of grass with a thick root mat should be provided at the lateral and upper limits of the riprap, unless approved otherwise by the Designer.
6. The perimeter of all riprap areas shall be blended into surrounding contours.

3.05 PIPE BEDDING AND TRENCH BACKFILL

A. General:

1. The Contractor shall prepare subgrade to the lines and grades shown on the Drawings, allowing for a 6-inch minimum thickness of pipe bedding material. It is noted that the pipe and trench work addressed in this section does not pertain to trenching and piping installed for gas collection/transfer systems within the landfill.
2. The Contractor shall place and compact Granular Fill to the design elevations of flexible pipe or ¾-Inch Crushed Stone to the design elevations of rigid (RCP) pipe, as shown on the Drawings. Within a MSE berm, the MSE berm soil may be used as pipe trench backfill. The ¾-Inch Crushed Stone and pipe shall be wrapped in a minimum of 7 oz/sy nonwoven geotextile, where Granular Fill bedding is underlain by soft silt clay soils, the Granular Fill and pipe shall be wrapped in a minimum of 7 oz/sy nonwoven geotextile. The geotextile wrap is not required in well-compacted silt-clay fill or in stiff brown silt-clay soils.
3. The Contractor shall place the specified pipe.
4. The Contractor shall complete placement of the backfill specified on the Drawings, limiting the loose lift thickness to 6 inches. Where no specific backfill material is indicated on the Drawings, Granular Fill shall be utilized.
5. Trench backfill materials shall be compacted to the following minimum percentages of the maximum dry density:

	DEGREE OF COMPACTION	
	Granular Material (ASTM D-1557) (see Note 1)	Silt Clay Material (ASTM D-698) (see Note 2)
Trenches through unpaved areas	92%	95%
Trenches beneath or adjacent to roads, paved or gravel surface, within top 2 feet beneath road subgrade	95%	98%
Trenches beneath or adjacent to roads, paved or gravel surface, below top 2 feet beneath road subgrade	92%	95%

Note 1: Granular Materials include: Structural Fill, Granular Fill, and Surface Course
Note 2: Silt Clay Materials include: Silt Clay Borrow
Note 3: For trenches within MSE berms, the backfill shall be compacted to at least 95 percent of the maximum dry density as determined by ASTM D698.

B. The Contractor shall be responsible for placing and compacting backfill in the liner or cover system anchor trench, in accordance with Paragraph 3.05.A of this Section. All anchor trench work shall be performed in a manner that does not damage the geosynthetic components of the liner or cover system.

3.06 BACKFILL AROUND STRUCTURES

A. General:
1. The Contractor shall place the specified soil material in layers to required elevations shown on the Drawings and listed below.
2. The Contractor shall backfill and compact to minimize settlement of the material and provide adequate support for structure walls, and/or the surface treatment or structure to be placed on the material.

B. Placement:
1. The Contractor shall place material in approximately horizontal layers beginning at the lowest area to be filled. The Contractor shall place backfill and fill materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers. The Contractor shall not place backfill or fill material on surfaces that are wet, frozen, or contain frost or ice.
2. The Contractor shall place backfill and fill materials evenly adjacent to structures, to required elevations. The Contractor shall take care to prevent wedging action of backfill against structures by carrying material uniformly around structures to approximately the same elevation in each lift.

C. Compaction:
1. The Contractor shall use methods that produce the required degree of compaction throughout the entire depth of material placed without damage to new or existing facilities. The Contractor shall adjust the moisture content of soil as required, and remove and replace material that is too wet to compact to the required density.
2. Granular backfill materials (i.e., Structural Fill, Granular Fill, or Surface Course) used as backfill around structures shall be compacted to at least 92% of the maximum dry density as determined by ASTM D1557, unless otherwise indicated on the Drawings or in the Specifications. Silt clay backfill materials (i.e., Silt Clay Borrow) used as backfill around structures shall be compacted to at least 95% of the maximum dry density as determined by ASTM D698, unless otherwise indicated on the Drawings or in the Specifications.

3.07 TESTING

A. General:
1. The Soil QAC will measure the actual in-place moisture and density of fill materials using field tests. Costs for initial tests will be paid by Owner.
2. The Contractor shall perform, at no additional cost to the Owner, additional work to obtain proper compaction if in-place moisture or density results do not meet the specifications.
3. The Soil QAC will observe construction and perform testing at the minimum frequencies set forth in the QAM, and at locations that he will select. The results of these tests will be made available to the Contractor on a timely basis so the contractor can take such actions as are required to remedy indicated deficiencies.
4. Removal of non-conforming drainage sand could damage components of the liner

system. For this reason, conformance testing of these materials (i.e. grain size distribution, etc.) will be performed on samples obtained by the Soil QAC at either the borrow pit or from on-site stockpiles. Placement of these materials shall not commence until satisfactory test results are received and approval to place the fill material is given to the Contractor by the Soil QAC.

5. Delivery and compaction of fill materials shall be made during the presence of the Soil QAC and shall be subject to testing to determine compliance with material, placement, and compaction specifications. The Soil QAC's presence does not include supervision or direction of the actual work by the Contractor, his employees, or agents. Neither the presence of the Soil QAC, nor any observations and testing performed by him, shall excuse the Contractor from defects discovered in his work.

B. Tests: Tests used to monitor the quality of materials related to this Earthwork Section include but are not limited to ASTM D422, ASTM D1556, ASTM D698 or D1557, ASTM D2216, ASTM D2487, ASTM D4318, ASTM D4373, ASTM D5084, ASTM D6938.

3.08 GRADING

A. Grading: The Contractor shall uniformly grade areas within limits of grading including adjacent transition areas. The Contractor shall smooth finish surfaces within the following specified tolerances:

1. Roadside Areas: Finish areas to receive topsoil to within 0.20 feet above or below required subgrade elevations.
2. Fills and Embankments: Finish areas to receive topsoil within 0.20 feet above or below required subgrade elevation, and finish areas to receive the liner system or structures or road sections within 0.10 feet above or below required subgrade elevation.
3. Capped Areas: Grading in areas to receive final cover components shall be performed to within +/- 0.1 feet, provided all required tolerances set forth in the other sections of theses specifications are met.

B. Compaction: After grading, the Contractor shall compact the surface to the percentage of maximum density specified for each area and fill material, unless approved otherwise by the Designer.

3.09 MAINTENANCE

A. Protection of Graded Areas: The Contractor shall protect newly graded areas from traffic or erosion, and keep free of trash and debris. The Contractor shall repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, the Contractor shall scarify the surface, re-shape, and compact to the required moisture and density at no additional cost to the Owner.

3.10 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. The Contractor shall dispose of excess and waste materials in accordance with Sections 02130 and 02140.

END OF SECTION

SECTION 02400

GEOMEMBRANE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Supply and install geomembrane for landfill final cover system.

1.02 APPLICABLE SECTION

A. All Sections

1.03 REFERENCES

A. The latest versions of the following American Society for Testing and Materials (ASTM) standards shall be used:

1. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
2. ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
3. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
4. ASTM D1204 - Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature. Modifications: 100 °C for 1 hour.
5. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer (Condition 190/2.16).
6. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
7. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics.
8. ASTM D5397 - Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
9. ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
10. ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
11. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
12. ASTM D5199 - Standard Test Method for Measuring Nominal Thickness of Geosynthetics.
13. ASTM D5397 - Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
14. ASTM D5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembrane.

15. ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
16. ASTM D5641 - Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
17. ASTM D5820 - Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
18. ASTM D6392 - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced using Thermo- Fusion Methods.
19. ASTM D6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
20. ASTMD7466 - Standard Test Method for Measuring Asperity Height of Textured Geomembranes.

1.04 QUALITY ASSURANCE PROGRAM

A. The Contractor and Geosynthetic Installer shall agree to participate in and conform with all items and requirements of the QAM.

B. The Contractor and Geosynthetic Installer shall attend the pre-construction meeting.

1.05 QUALITY CONTROL SUBMITTALS

A. Pre-installation: The Geosynthetic Installer shall submit the following to the Geosynthetic QAC for approval, prior to delivery of geomembrane to the site.
1. Resin origin (supplier's name and production plant) and identification (brand name and number)
2. Copies of dated quality control certificates issued by resin supplier.
3. Results of tests conducted by geomembrane manufacturer to verify that resin used to manufacture geomembrane meets the specifications in Paragraph 2.01A.
4. Statement that the amount of reclaimed polymer added to resin during manufacturing was done with appropriate cleanliness and did not exceed 10 percent by weight.
5. List of materials that comprise the geomembrane, expressed in the following categories as percent by weight: high density and low-density polyethylene, carbon black, and other additives.
6. Manufacturer's specification that includes properties listed in Paragraph 2.01A measured using the appropriate test methods.
7. Written certification that minimum values given in geomembrane manufacturer's specification are guaranteed by geomembrane manufacturer.
8. Quality control certificates, signed by a responsible entity employed by geomembrane manufacturer. Each quality control certificate shall include applicable roll identification numbers, testing procedures, and results of quality control tests required by Paragraph 2.03A.
9. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.

10. Resume of the Geosynthetic Installer's Superintendent to be assigned to this project, including dates and duration of employment.
11. A panel layout drawing showing the proposed installation layout identifying field seams as well as any variance or additional details that deviate from the project plans or specifications. The layout shall be adequate for use as a construction plan and shall include dimensions, details, and the estimated quantity of geomembrane required for the project.
12. The proposed installation schedule.
13. A list of personnel performing field seaming operations along with pertinent experience information.

B. Installation: The Geosynthetic Installer shall submit the following to the Geosynthetic QAC as installation proceeds:
1. Quality control documentation recorded during installation.
2. Subgrade surface acceptance certificates, signed by the Geosynthetic Installer, for each area that will be covered directly by geomembrane. Submit prior to geomembrane deployment. Deployment of geomembrane will be considered acceptance of subgrade if certificate is not submitted.

1.06 SAMPLES

A. Geomembrane sampling shall be conducted in accordance with the QAM for the following:
1. Conformance Testing (Paragraph 3.01 A of this Section)
2. Destructive Seam Testing (Paragraph 3.04 D of this Section)

1.07 DELIVERY, STORAGE, AND HANDLING

A. The Geosynthetic Installer shall inform the Project Manager a minimum of 48 hours before any delivery for material furnished by the Installer.

B. Packing and Shipping
1. Labels on each roll delivered to site shall identify the following:
   a. Manufacturer's name
   b. Product Identification
   c. Thickness
   d. Lot Number
   e. Batch Number
   f. Roll number
   g. Roll dimensions
2. The Geosynthetic Supplier shall ensure that geomembrane rolls are properly loaded and secured to prevent damage during transit.
3. The Geosynthetic Installer shall protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions.
4. The entity supplying geosynthetics shall ensure personnel responsible for loading, transport, and unloading of geomembrane are fully aware of the consequences of damage to geomembrane, and familiar with handling and transport constraints imposed by manufacturer.

5. The entity supplying geosynthetics is responsible for providing all equipment and personnel necessary to promptly unload geosynthetic materials upon delivery to the site. The materials shall be stockpiled by a responsible party in accordance with the requirements of these specifications, in the areas designated on the Drawings or as directed by the Project Manager. The entity supplying geosynthetics shall provide the entity that is responsible for unloading material with no less than 24 hours' notice prior to all deliveries, and shall be present during unloading.

C. Acceptance at Site

1. The Geosynthetic Installer and the Contractor shall assist the Geosynthetic QAC in inventory and inspection for defects and damage, of all geomembrane rolls upon delivery.
2. Damage resulting from handling and transport of geomembranes shall be repaired at no cost to the Owner. If irreparable, in the opinion of the Geosynthetic QAC, damaged materials shall be replaced at no cost to the Owner.

D. Storage and Protection

1. The Owner will provide on-site storage area for geomembrane rolls from the time of delivery until installed.
2. The Geosynthetic Installer and the Contractor shall store and protect geomembrane from dirt, water, and other sources of damage.
3. The Geosynthetic Installer and the Contractor shall preserve integrity and readability of geomembrane roll labels.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Unless approved otherwise by the Designer, the geomembrane shall be manufactured using high density polyethylene (HDPE) resin (R1) with the following properties:

PROPERTY	VALUE	METHOD
Density	0.932 g/cc min.	ASTM D1505
Melt Index	1.0g/10 minutes max.	ASTM D1238
Carbon Black Content	2 to 3 percent	ASTM D1603 or 4218

B. Unless approved otherwise by the Designer, geomembrane type GM2 - 40 mil Double-sided Textured, HDPE Geomembrane shall meet or exceed the following properties:

PROPERTY	METHOD*	VALUE
Thickness	ASTM D5994	38 mils min. average
Thickness	ASTM D5994	34 mils min. reading
Density (geomembrane)	ASTM D1505/D792	0.94 g/cc min. average
Tensile Properties: (each direction) 1. Yield strength 2. Break strength 3. Elongation at yield 4. Elongation at break	ASTM D6693	 84 ppi min. average 60 ppi min average 12% min average 100% min average
Tear Strength	ASTM D1004	28 lb min average
Puncture Resistance	ASTM D4833	60 lbs min average
Carbon Black Content	ASTM D1603 or 4218	2.0% to 3.0%
Carbon Black Dispersion	ASTM D5596	Category 1 or 2
Stress Crack Resistance	ASTM D5397	500 hrs min. with no failures
Asperity (Note 1)	ASTM D7466	20 mils min.

Note 1: The geomembrane must be tested in accordance with the *Interface and Internal Shear Resistance Testing Program* and validated by project specific cover system veneer stability analyses.

C. Geomembrane shall be manufactured from new polyethylene resin, with no more than 10% reworked resin allowed. The use of geomembrane recycled during the manufacturing process shall be permitted if done with appropriate cleanliness.

D. Geomembrane manufactured from non-complying resin shall be rejected.

E. Resin shall be designed and manufactured specifically for use in geomembranes.

F. The geomembrane shall have the following characteristics:
   1. Contain a maximum of 1 percent by weight of additives, fillers or extenders (not including carbon black).
   2. Contain between 2 percent and 3 percent by weight of carbon black for ultraviolet light resistance. This shall be added to the otherwise pure polyethylene resin as part of resin manufacturing or roll manufacturing process.
   3. Contain no pinholes, bubbles, or other surface features that compromise geomembrane integrity. The geomembrane shall be free of blisters, nondispersed raw materials, or other signs of contamination by foreign matter.

2.02 SEAMING AND TESTING EQUIPMENT

A. Welding: The Geosynthetic Installer shall:
   1. Maintain on-site a minimum of two spare operable seaming apparatus, unless otherwise agreed upon at pre-construction meeting.
   2. Use seaming equipment that does not damage geomembrane.
   3. Protect geomembrane from damage in trafficked areas.
   4. Use extrusion welding apparatus equipped with gauges giving temperature of extrudate at nozzle of apparatus, or utilize hand-held gauges to measure extrudate temperatures.
   5. Use fusion-welding apparatus that are self-propelled devices equipped with the following:
      a. A gauge indicating temperature of heating element.
      b. A method of monitoring relative pressure applied to geomembrane.
      c. A gauge indicating the speed of welding apparatus.

B. Vacuum testing equipment shall consist of the following:
   1. Vacuum box assembly consisting of: rigid housing, transparent and clear viewing window, soft neoprene gasket attached to bottom of housing, porthole or valve assembly, and vacuum gauge.
   2. Pump assembly equipped with pressure controller and pipe connections.
   3. Pressure/vacuum rubber hose with fittings and connections.
   4. Bucket of soapy solution.
   5. Wide paint brush, or other means of applying soapy solution.

C. Air pressure testing equipment shall consist of the following:
   1. Air pump (manual or motor driven), equipped with a pressure gauge, capable of generating, sustaining, and measuring pressure between 0 and 30 psi, and mounted on a cushion to protect geomembrane.
   2. Rubber hose with fittings and connections.
   3. Sharp hollow needle, or other approved pressure feed device.
   4. An air pressure monitoring device capable of measuring pressure between 0 and 30 psi.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:
   1. Geomembranes shall be tested by geomembrane manufacturer for quality control to demonstrate that material meets these specifications.
   2. Geomembrane manufacturer shall continuously monitor during manufacturing process for inclusions, bubbles, or other defects. Geomembranes which exhibit defects shall not be delivered to the site.
   3. Geomembrane manufacturer shall monitor thickness continuously during manufacturing process. No geomembrane shall be acceptable for installation which fails to meet specified values.
   4. The Geomembrane Manufacturer shall, at a minimum, perform the following tests:
      a. Density, ASTM D1505/D792;
      b. Carbon black content, ASTM D1603 or 4218;
      c. Carbon black dispersion, ASTM D5596;
      d. Thickness, ASTM D5199 (smooth) or ASTM D5994 (textured);
      e. Tensile properties, ASTM D6693;
      f. Puncture resistance, ASTM D4833; and
      g. Asperity, ASTM D7466 (textured materials only).

      The Geomembrane Manufacturer shall perform these tests on geomembrane, at a minimum of once every 50,000 ft^2. Samples not satisfying specifications shall result in rejection of the rolls represented by the tests. At the geomembrane manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify non-complying rolls and to qualify individual rolls.

5. The Geomembrane Manufacturer shall perform stress rack resistance testing ASTM D5397 on geomembrane at a minimum of once every resin lot. Unless approved otherwise by the Geosynthetic QAC, a resin lot will be defined as equivalent to one rail car or 180,000 lbs.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Conformance Testing
   1. The Geosynthetic QAC will collect samples of geomembrane to be installed, for conformance testing, as outlined in the QAM. The Geosynthetic Installer may request retesting of failed conformance tests, as outlined in the QAM. The entity responsible for supplying geomembrane shall bear the cost of retesting if results lead to material rejection. The Geosynthetic QAC shall bear cost of retesting if original conformance tests are found to be in error.

3.02 PREPARATION

A. Surface Preparation
   1. Within 12 hours prior to deployment on any given work day, the Geosynthetic Installer shall inspect the subgrade in the area of deployment for that day. Prior to deploying geomembrane the Geosynthetic Installer shall sign subgrade acceptance forms and submit them to the Geosynthetic QAC.
   2. After prepared surface has been accepted, the Geosynthetic Installer shall inform the Geosynthetic QAC of any change in supporting soil (i.e., subgrade) condition that may require repair work. The Contractor shall maintain an acceptable prepared soil surface.
   3. The Geosynthetic Installer shall not place geomembrane onto an area that has become softened by precipitation or cracked due to desiccation. The Geosynthetic Installer shall frequently evaluate softening and desiccation cracking and inform the Geosynthetic QAC and Soil QAC of conditions that are inadequate for deployment.
   4. The Contractor shall, at no additional cost to the Owner, repair damage to the subgrade caused by installation activities unless damage is caused by the Geosynthetic Installer and is negligent in nature. Damage to subgrade caused by the Geosynthetic Installer and negligent in nature will be the responsibility, and at the cost of, the Geosynthetic Installer.

3.03 INSTALLATION

A. Panel Nomenclature
   1. A field panel is defined as a unit of geomembrane which is to be seamed in the field, that is, a field panel is a roll or a portion of roll cut in the field.
   2. The Geosynthetic Installer shall identify each field panel with an identification code (number or letter-number). This identification code shall be agreed upon by the Geosynthetic QAC.

B. Protection. The Geosynthetic Installer shall:
   1. Not use equipment which damages geomembrane during handling or trafficking, or by excessive heat, leakage of hydrocarbons or other means. The use of any vehicular equipment by the Geosynthetic Installer to deploy cover system components is subject to the approval of the Geosynthetic QAC. Such equipment may include low-ground-pressure rubber tire vehicles, if the Geosynthetic QAC deems the use of such equipment allowable for the conditions and methods proposed by the Geosynthetic Installer. In all cases, operation of such approved vehicles directly on the geosynthetic components of the cover system shall be exclusively for deployment purposes only.
   2. Not permit personnel to smoke or wear shoes that can damage the geomembrane while working on geomembrane. Personnel shall not bring glass bottles on geomembrane.
   3. Unroll panels in a manner which does not cause excessive scratches or crimps in geomembrane and does not damage supporting soil.
   4. Place panels in a manner which minimizes wrinkles, especially differential wrinkles between adjacent panels, while providing sufficient material to prevent bridging. In the event of bridging, repairs may include compensation panels, etc., which shall be approved by the Geosynthetic QAC.
   5. Prevent wind uplift by providing adequate temporary loading or anchoring (for example, sandbags, tires) that shall not damage geomembrane. In case of high winds, provide continuous loading along panel edges.
   6. Protect geomembrane in areas where excessive traffic is expected with geotextiles or extra geomembrane.

C. Field Panel Deployment. The Geosynthetic Installer shall:
   1. Install field panels at locations that, unless approved otherwise by the Geosynthetic QAC, are in general accordance with the Geosynthetic Installer's proposed panel layout plan.
   2. Replace torn, twisted or crimped field panels, or portions, at no cost to Owner. Repair less serious damage according to Paragraph 3.03 H of this Section. The Geosynthetic QAC shall determine if material is to be repaired or replaced.
   3. Remove from work area damaged panels or portions of damaged panels which have been rejected.
   4. Not proceed with deployment at an air temperature below 32 degrees Fahrenheit or above 104 degrees Fahrenheit unless otherwise authorized by the Geosynthetic QAC.
   5. Not deploy during precipitation, in the presence of excessive moisture such as fog or dew, in an area of ponded water or during excessive winds.
   6. Not undertake deployment if weather conditions will preclude material seaming on same day as deployment.
   7. Not deploy more geomembrane field panels in one day than can be seamed during that day.

D. Seam Layout. The Geosynthetic Installer shall:
   1. Orient seems in general accordance with the proposed Panel Layout Drawing, unless approved otherwise by the Geosynthetic QAC.
   2. Orient seams parallel to line of maximum slope, such as oriented along, not across,

the slope. Horizontal seams on slopes steeper than 20H:1V will not be allowed without written approval by Designer.

3. Place panels such that no horizontal seams are closer than 5 feet up from toe of slopes. Horizontal seams where the cover geomembrane is welded to the liner geomembrane are allowed within 5 ft of the toe of slope.
4. Not locate seams in areas of potential stress concentrations.
5. Maximize lengths of field panels and minimize number of field seams, where practicable.

E. Temporary Bonding. The Geosynthetic Installer shall:

1. Be allowed to use hot air devices (Leister) to temporarily bond geomembrane panels that are to be extrusion welded.
2. Apply minimal amount of heat to lightly tack geomembrane panels together, and control temperature of hot air at nozzle of any temporary welding apparatus to prevent damage to geomembrane.
3. Not use solvent or adhesive.

F. Seaming Methods. Approved processes for field seaming are extrusion fillet welding and fusion welding. Proposed alternate processes shall be documented and submitted to the Geosynthetic QAC for review. Alternate seaming procedures shall be used only after being approved in writing by the Geosynthetic QAC, the Designer, and the Project Manager.

1. The Geosynthetic Installer shall produce seams (both fusion and extrusion) meeting the following requirements:
   a. For HDPE Geomembrane:

PROPERTY	SPECIFIED VALUE(1)	TEST METHOD
Bonded Seam Shear Strength	90% of PMTYS(2) (3)	ASTM D6392
Peel Adhesion	60% of PMTYS(2)(3)	ASTM D6392

(1) Criteria in Paragraph 3.04D.6 must be met.
(2) Parent Material Tensile Yield Strength (PMTYS) determined in accordance with Paragraph 3.03 F.1.b or Paragraph 3.03 F.1.c.
(3) In addition to the minimum passing values, passing seams shall not separate more than 10 percent of the width into the weld and shall exhibit the following location of breaks:
Fusion Welded Seams – BRK, SE1, SE2, and AD-BRK Extrusion
Welded Seams – SE1, SE2, SE3, BRK1, and BRK2
Observation of Film Tear Bond (FTB) is acceptable in the field.

   b. The parent material tensile yield strength (PMTYS) for each type of geomembrane shall be defined as the lower of two representative samples taken from material anticipated to be installed that day and shall be obtained from two separate rolls.
   c. The parent material yield strength shall be determined as follows:
   One 1" x 5" coupon will be cut from each sheet (both sides of seam) which makes up the "test seam" and "test sample" with the long dimension of the coupon perpendicular to the alignment of the seam.
   For the laboratory testing required for destructive samples the testing laboratory will be required to record and document two test coupons for PMTYS.

2. The Geosynthetic Installer shall align geomembrane panels to have an overlap

of 3 inches for extrusion welding and 5 inches for fusion welding, providing sufficient overlap to allow peel tests to be performed on seam.

3. The Geosynthetic Installer shall use double-fusion welding as the primary method of seaming adjacent field panels, and:
   a. For cross seam tees, associated with fusion welding, extrusion weld to a minimum distance of 4 inches on each side of tee, following trimming the flap associated with the fusion weld.
   b. Place electric generators on a smooth base such that no damage occurs to geomembrane. Any fuel spills shall be cleaned up and reported to Geosynthetic QAC and the Project Manager.
   c. Place a protective layer, such as insulating plate or fabric, beneath hot welding apparatus after usage.
   d. When subgrade conditions dictate, use a movable protective layer such as extra piece of geomembrane, directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent dust or debris from collecting around pressure rollers.
4. The Geosynthetic Installer shall use conventional fillet extrusion welding as a secondary method for seaming between adjacent panels and as a primary method of welding for detail and repair work. The Geosynthetic Installer shall:
   a. Purge heat-degraded extrudate from barrel of extruder under the following conditions:
      i. Prior to beginning a seam.
      ii. Whenever extruder has been inactive.
   b. Place electric generator on a smooth base so no damage occurs to geomembrane.
   c. Place a smooth insulating plate or fabric beneath hot welding apparatus after usage.
   d. Use clean and dry welding rods or extrudate pellets.
   e. Complete seaming process, without damaging geomembrane, within one hour of grinding operation. Remove sufficient material to smooth textured surface.
   f. Eliminate exposed grinding marks adjacent to an extrusion weld, specifically not allowing exposed grinding marks to extend outside the finished seam area.
   g. Perform grinding such that it does not exceed 10% of parent material thickness and is perpendicular to seam where practical. The edge of the upper sheet should be beveled during grinding.
   h. Thoroughly clean existing geomembrane at tie-in locations prior to grinding operations to the satisfaction of the GQAC. Failed extrusion welded seams due to poor cleanliness will be repaired in accordance with Project Specifications at no cost to the Owner.

G. Seaming Procedures
1. General Seaming Conditions shall be as follows:
   a. Ambient temperature between 32 and 104 degrees Fahrenheit;
   b. Dry conditions such as no precipitation nor other excessive moisture, such as fog or dew; and
   c. No excessive winds.
2. General Seaming Procedures. The Geosynthetic Installer shall:
   a. If required, provide a firm substrate by using an extra piece of geomembrane,

or similar hard surface directly under seam overlap to achieve proper support for seaming apparatus.

b. Align seams with the fewest possible number of wrinkles and fishmouths.
c. Provide adequate illumination if seaming operations are carried out at night.
d. Extend seams to outside edge of panels placed in anchor trench.
e. Not field seam without master seamer being present.
f. Prior to seaming, ensure that seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind.
g. Cut fishmouths or wrinkles along ridge of wrinkle in order to achieve a flat overlap. Seam the cut fishmouths or wrinkles and patch portions where overlap is inadequate. Use oval or round patch of same geomembrane extending a minimum of 6 inches beyond the cut in all directions.

3. Cold Weather Seaming Procedures. The Geosynthetic Installer shall meet the additional following conditions if seaming is conducted when ambient temperature is below 32 degrees Fahrenheit. Ambient temperature will be determined by the Geosynthetic QAC by measuring the air temperature at a height of 18 to 36 inches above the cover system.
   a. The Geosynthetic QAC shall determine geomembrane surface temperatures at intervals of at least once per 100 feet of seam length or at start and end of seam if less than 100 feet to determine if preheating is required. For extrusion welding, preheating is required if surface temperature of geomembrane is below 32 degrees Fahrenheit.
   b. Preheating may be waived based on recommendation from the Geosynthetic QAC, if demonstrated that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
   c. If preheating is required, Geosynthetic QAC shall observe all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been subjected to excessive heating.
   d. The Geosynthetic QAC shall confirm that surface temperatures are not lowered below minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for seam area at no cost to Owner.
   e. Preheating devices used shall be pre-approved by the Geosynthetic QAC prior to use.
   f. Additional destructive seam tests (as described in Paragraph 3.04 D of this section) shall be performed as directed by the Geosynthetic QAC.
   g. Sheet grinding may be performed before preheating, if required.
   h. Trial seaming, as described in Paragraph 3.04 B of this Section, shall be conducted under the same ambient temperature and preheating conditions as the actual seams. New trial seams shall be conducted if ambient temperature drops by more than 10° Fahrenheit from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature drop.
4. Warm Weather Procedures. The Geosynthetic Installer shall meet the following conditions, in addition to general seaming procedures, if seaming is conducted when ambient temperature is above 104° Fahrenheit.
   a. At ambient temperatures above 104° Fahrenheit no seaming of geomembrane

shall be permitted unless demonstrated to the Geosynthetic QAC's satisfaction that geomembrane seam quality will not be compromised.

b. New trial seams shall be conducted if ambient temperature rises by more than 10^{o} Fahrenheit from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature rise.

c. Additional destructive seam tests (as described in Paragraph 3.04 D) shall be performed as directed by the Geosynthetic QAC.

H. Repair Procedures:

1. The Geosynthetic Installer shall repair portions of geomembrane exhibiting a flaw, or failing a destructive or nondestructive test.
2. Final decision as to appropriate repair procedure shall be as approved by the Geosynthetic QAC.
3. Repair Alternatives:
   a. Patching: A piece of same geomembrane extrusion welded into place. Use to repair large holes, tears, nondispersed raw materials, and contamination by foreign matter.
   b. Spot welding or seaming: A bead of molten extrudate placed on flaw. Use to repair small tears, pinholes, or other minor, localized flaws.
   c. Capping: A strip of same geomembrane extrusion welded into place over an inadequate seam. Use to repair large lengths of failed seams.
   d. Removal and replacement: Remove bad seam and replace with a strip of same geomembrane welded into place. Use to repair large lengths of failed seams.
   e. It is noted that extrusion welding the overlap flap of a fusion weld shall NOT be considered an acceptable repair technique for this project.
4. For any repair method, the Geosynthetic Installer shall:
   a. Grind surfaces of geomembrane which are to be repaired using extrusion methods, in accordance with Section 3.03.F.4.
   b. Ensure surfaces are clean and dry at time of repair.
   c. Ensure seaming equipment used in repairing procedures meets specification requirements.
   d. Extend patches or caps at least 6 inches beyond edge of defect. Round corners of patches with a radius of at least 3 inches.
5. The Geosynthetic Installer shall not place overlying layers over locations which have been repaired until appropriate passing nondestructive and destructive (laboratory) test results are obtained, and the Geosynthetic QAC has approved the repairs.

I. Anchor Trench. The Geosynthetic Installer shall:

1. Verify anchor trenches are constructed to lines and grades shown on design drawings, prior to geomembrane placement.
2. Verify slightly rounded corners are in anchor trench to avoid sharp bends in geomembrane.
3. Remove all construction-related debris from anchor trench.
4. Ensure an excessive amount of loose soil does not underlie geomembrane in anchor trench.
5. Coordinate activities with the Contractor to ensure that the anchor trench will be

adequately drained to prevent ponding or softening of adjacent soils while trench is open. Dewatering the anchor trench is the responsibility of the Contractor.

6. Coordinate activities with the Contractor so anchor trench can be backfilled and compacted after geomembrane installation is completed.

3.04 FIELD QUALITY CONTROL

A. Visual Inspection. The Geosynthetic Installer shall:
   1. Allow the Geosynthetic QAC to examine seam and non-seam areas of geomembrane for identification of defects, holes, blisters, nondispersed raw materials, and any sign of contamination by foreign matter.
   2. Clean and wash geomembrane surface if the Geosynthetic QAC determines that the amount of dust or mud inhibits examination.
   3. Not seam any geomembrane panels that have not been examined for flaws by the Geosynthetic QAC.
   4. Nondestructively test each suspect location as in seam and non-seam areas using methods described in Paragraph 3.04 C of this section as appropriate.
B. Trial Seams. The Geosynthetic Installer shall:
   1. Make trial seams on fragment pieces of same geomembrane cover system to verify that conditions are adequate for production seaming.
   2. Make trial seams at beginning of each seaming period and at the beginning of each five-hour period for each seaming apparatus used that day. Each seamer shall make at least one trial each day when that seamer welds. Additional trial welds will be required by the Geosynthetic QAC when a seaming apparatus is shut-off, power is interrupted, temperature settings are adjusted and/or weather conditions change.
   3. Make trial seams under same field conditions as actual seams.
   4. Make trial seams only under observation of the Geosynthetic QAC.
   5. Make trial seam overlap as indicated in Paragraph 3.03 F of this section.
   6. Make trial seam sample at least 5 feet long by 1-foot wide (after seaming) with seam centered lengthwise.
   7. Cut five specimens (for 3 peel and 2 shear) from a sample with a 1-inch wide die. These specimen locations shall be selected randomly along trial seam sample by the Geosynthetic QAC. Test specimens in peel (both tracks), and shear using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per minute, and shall be calibrated, with a certificate of calibration less than one-year old kept with the tensiometer. Specimens must pass the criteria set forth in Paragraph 3.04 D.5 of this section. Allow the Geosynthetic QAC to document results.
   8. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the Geosynthetic Installer shall not use seaming apparatus and seamer until the deficiencies are corrected and two consecutive successful trial welds are achieved.

C. Nondestructive Seam Testing
   1. General. The Geosynthetic Installer shall:
      a. Nondestructively test field seams over their full length using a vacuum test (for extrusion seams), air pressure (for double-fusion seams) or other method

as approved by the Geosynthetic QAC.

b. Perform nondestructive testing and document test results as seaming work progresses, not at the completion of all field seaming.

2. The following procedure shall be used by the Geosynthetic Installer for Vacuum Testing of all extrusion seams. If additional instruction is required, refer to ASTM D5641.
   a. Energize vacuum pump and reduce tank pressure to approximately 5 psi (10 inch of mercury) gauge pressure.
   b. Wet strip of geomembrane approximately 12 inch by 48 inch with soapy solution. The Geosynthetic Installer shall demonstrate to the Geosynthetic QAC the sudsing characteristics of the solution.
   c. Place box over wetted area.
   d. Close bleed valve and open vacuum valve.
   e. Ensure that a leak-tight seal is created.
   f. For a period of not less than 15 seconds, apply vacuum and examine geomembrane through viewing window for presence of soap bubbles.
   g. If no bubbles appear within 15 seconds, close vacuum valve and open bleed valve, move box over to next adjoining area with a minimum 3 inch overlap and repeat process.
   h. Mark and repair areas where soap bubbles appear in accordance with Paragraph 3.03 H of this section.
3. The following procedure shall be used by the Geosynthetic Installer for Air Pressure Testing of all Double-Track Fusion Seams. If additional is required, refer to ASTM D5820.
   a. Temporarily seal both ends of seam to be tested using locking pliers or other method as approved by the Geosynthetic QAC.
   b. Insert needle or other approved pressure feed device into air channel created by fusion weld.
   c. Place a protective layer between air pump and geomembrane.
   d. Pressurize air channel to a pressure of approximately 30 psi. Close valve and allow pressure to stabilize for approximately 2 minute. Ensure after 2 minute stabilization period the pressure is within 24 to 30 psi.
   e. Observe the air pressure 5 minutes after the initial 2 minute stabilization period ends. If pressure loss exceeds a Maximum Permissible Pressure Differential of 2 psi for 40-mil or the pressure does not stabilize, locate faulty area and repair in accordance with Paragraph 3.03 H.
   f. Cut opposite end of tested seam area once testing is completed to verify continuity of air channel. If air does not escape, locate blockage and retest unpressurized area. Repair cut end of air channel in accordance with Paragraph 3.03 H of this section.
   g. Remove needle or other approved pressure feed device and seal hole in the annulus.
4. Inaccessible Seams. The Geosynthetic Installer shall:
   a. Cap-strip seams that cannot be nondestructively tested using material composed of the same type and thickness geomembrane as the geomembrane to be capped.
   b. Examine cap-stripping operations with the Geosynthetic QAC for uniformity

and completeness.

D. Destructive Seam Testing
1. General:
    a. The destructive seam testing program shall be implemented as seaming progresses; not at the completion of all field work.
    b. A failed destructive seam sample shall result if grips of testing machine cannot be closed on sample test flap (available flap is ½-inch long or less) due to excessive temporary welding.
2. Location and Frequency:
    a. Test at a minimum frequency of one test location per 1,000 linear ft of seam length. This minimum frequency is to be determined as an average taken throughout the entire facility.
    b. Test locations shall be determined during seaming, with samples obtained at locations selected by the Geosynthetic QAC.
    c. The Geosynthetic Installer will not be informed in advance of the locations where seam samples will be taken.
    d. The Owner reserves the right to increase the frequency of testing in accordance with performance results of samples previously tested.
3. Sampling Procedures. The Geosynthetic Installer shall:
    a. Cut samples at locations chosen by the Geosynthetic QAC.
    b. Repair holes in geomembrane resulting from destructive seam sampling immediately in accordance with repair procedures described in Paragraph 3.03.H of this section.
    c. Nondestructively test continuity of new seams in the repaired area according to Paragraph 3.04.C of this section.
4. Sample Dimensions: The Geosynthetic Installer shall take the following two types of samples at each sampling location. Final determination of sample sizes shall be agreed upon at the preconstruction meeting. Sample sizes shall be as small as possible, but shall be adequate for the required/anticipated test program.
    a. Take two samples for field testing. Cut each of these samples with a 1-inch wide die, with seam centered parallel to width. The distance between these two samples shall be 42 inches. If both samples pass the field test described in Paragraph 3.04.D.5 of this section, take a sample for laboratory testing as described in Paragraph b below.
    b. The sample for laboratory testing shall be located between the samples cut for field testing. Cut sample for laboratory testing 42 inches along the seam by 14 inches wide across the seam. Cut this sample into three equal parts, distributed as follows:
        i. One portion to the Geosynthetic Installer for optional laboratory testing.
        ii. One portion to the Geosynthetic QAC to be sent to the Geosynthetic Quality Assurance Laboratory (QAL) for testing.
        iii. One portion to the Project Manager for archive storage until acceptance of project record documents.
5. Field Testing. The Geosynthetic Installer shall:
    a. Test the three 1-inch-wide strips described in Paragraph 3.04.D.4 for peel (both tracks) and two 1-inch-wide strips for shear strength. Use a

tensiometer as described in Paragraph b below to conduct these tests. These tests shall not fail according to criteria in Paragraph 3.03.F.1 of this section.

b. Use a tensiometer capable of maintaining a constant jaw separation rate of two inches per minute. The tensiometer shall be calibrated, and a certificate of calibration less than one year old kept with the tensiometer.
c. Test field samples only under the Geosynthetic QAC's observation.
d. If test sample passes in accordance with this Section, the seam qualifies for laboratory testing.
e. If any field test sample fails to pass, then follow procedures outlined in Paragraph 3.04.D.7 of this section.
f. Final judgment regarding seam acceptability, based on failure criteria in these specifications, rests with Geosynthetic QAC.

6. The following procedure shall be applied to determine pass or fail criteria for each scan tested destructively at laboratory.
   a. Paragraph 3.03.F.1 of this section shall be used to determine pass/fail criteria.
   b. Four out of five samples shall pass as following:
      i. Extrusion Weld: Bonded seam strength and peel adhesion.
      ii. Fusion Weld: Bonded seam strength and peel adhesion for both tracks (double track).
   c. The fifth sample's values must exceed 50 percent of the first four samples' criteria.
   d. Locus of break shall be reported.
7. Destructive Test Failure Procedures. The Geosynthetic Installer shall apply the following procedures when a sample fails destructive testing, whether that test is conducted by the Geosynthetic QAL or by the Geosynthetic Installer using a field tensiometer.
   a. The Geosynthetic Installer has following options:
      i. Repair seam between any two passing destructive test locations.
      ii. Trace welding path to an intermediate point 10 feet minimum from point of failed test in each direction) and take a small sample with a 1-inch-wide die for an additional field test at each location. If these additional samples pass the test, take full laboratory samples. If these laboratory samples pass the tests, repair seam between these locations. If either sample fails, repeat process to establish zone in which seam should be repaired.
   b. Acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet of repaired seam, a sample taken from zone in which seam has been repaired shall pass destructive testing. The Geosynthetic Installer shall make repairs in accordance with Paragraph 3.03.H.
   c. When a sample fails, the Geosynthetic QAC may require additional testing of seams that were welded by the same welder and/or welding apparatus during the same time shift.

E. Repair Verification. The Geosynthetic Installer shall:
   1. Nondestructively test each repair using methods described in Paragraph 3.04.C as appropriate. Results shall be documented by the Geosynthetic QAC. Passing nondestructive test results indicate an adequate repair.
   2. Repairs more than 150 feet long require destructive test sampling, in accordance

with Paragraph 3.04.D of this section. Failed destructive or nondestructive tests indicate that the repair shall be redone and retested until passing nondestructive and destructive test results are obtained.

F. Large Wrinkles - A wrinkle is considered to be large when geomembrane can be folded over onto itself.
   1. When seaming of geomembrane cover system is completed, and prior to placing overlying materials, the Geosynthetic Installer shall accompany the Geosynthetic QAC in identifying all excessive geomembrane wrinkles.
   2. The Geosynthetic Installer shall cut and reseam all wrinkles identified by Geosynthetic QAC. Testing seam produced while repairing wrinkles in accordance with Paragraph 3.03.H. When practicable, wrinkle repairs should be made during coldest part of installation period.

3.05 COMPLETION

A. Upon completion of the installation, the Geosynthetic Installer shall submit:
   1. The warranty obtained from the Manufacturer.
   2. The installation warranty.

END OF SECTION

SECTION 02510

GEOTEXTILES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools and equipment and perform all operations necessary to furnish, deploy, and install geotextiles in the areas indicated on the Drawings, except for placing Geotextile Fabric components of the cover sections, which will be performed by the Geosynthetic Installer.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 REFERENCES

A. ASTM D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.
B. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus. Modification: Utilize ASTM D4632 to evaluate effect of exposure on geotextile.
C. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
D. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
E. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
F. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
G. ASTM D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
H. GRI Test Method GT12(a) - Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials.

1.04 QUALITY CONTROL SUBMITTALS

A. Prior to delivery of geotextile for installation within the landfill cover system, the Geosynthetic Installer shall submit the following information to the Geosynthetic QAC:
   1. Written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles using a metal detector and found the geotextile to be needle-free.
   2. Written quality control certificates, signed by a responsible party employed by the Manufacturer and stating that the product will meet the minimum values given in the specification are guaranteed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for:

a. Mass per unit area (ASTM D5261)
b. Grab strength (ASTM D4632)
c. Trapezoidal tear strength (ASTM D4533)
d. Puncture strength (ASTM D4833 or D6241)

These quality control tests shall be performed in accordance with the test methods for at least 100,000 ft^2 of geotextile produced within each lot.

B. For Geotextile that is not part of the cover system, the Contractor or Geosynthetic Installer shall submit to the Geosynthetic QAC samples of the proposed geotextiles, and certification that the geotextiles meet the required specifications, prior to delivery of materials to the site.

C. The following shall be maintained by the geotextile Manufacturer or Geosynthetic Installer and will be available upon request:
1. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.
2. Reports on tests conducted by the Manufacturer to verify that resin used to manufacture the geotextile meets the Manufacturer's resin specifications.
3. A list of the materials which comprise the geotextile, expressed in the following categories as percent by weight: base polymer, carbon black, other additives.

1.05 MATERIALS SHIPPING, STORAGE, AND HANDLING

A. Shipping:
1. During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, moisture, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall not be removed until shortly before deployment.
2. Geotextile rolls shall be marked or tagged with the following information:
   a. Manufacturer's name;
   b. Product identification;
   c. Roll number; and
   d. Roll dimensions.
3. The Contractor is responsible for providing all equipment and personnel to promptly unload geosynthetic materials upon delivery to the site. The materials shall be stockpiled by the Contractor in accordance with the requirements of these specifications, in the areas designated on the Drawings or as directed by the Project Manager. The Geosynthetic Installer shall provide the Contractor with no less than 24 hours' notice prior to all deliveries, and shall be present during unloading unless the Geosynthetic Installer has not yet been mobilized to the site.

B. Storage and Handling:
1. The Contractor and Geosynthetic Installer shall be responsible for the handling, storage and care of geotextiles from the time of delivery to the site until final acceptance of the completed work by the Project Manager. The Contractor and Geosynthetic Installer shall be liable for all damages to the materials during such time.

PART 2 - PRODUCTS

2.01 GENERAL

A. The geotextiles provided shall meet or exceed the property values specified herein. Geotextiles shall be comprised of polymeric yarns or fibers or weld or drawn strands oriented into a stable network which will retain its structure during handling, placement, and long-term service. The geotextile must be certified as exhibiting no less than 70% strength at 500 hours when tested using ASTM D4355.

B. Synthetic fabrics shall be non-biodegradable. The Contractor shall follow the manufacturer's recommendations regarding handling and installation of such materials.

2.02 GEOTEXTILE FABRIC

A. Nonwoven Geotextile Fabric, Types NW7, NW10, NW12, and NW16 shall be non-woven, polypropylene or polyester material which meets the following minimum average roll values in accordance with GRI GT12(a). It is noted that GRI GT12(a) does not cover Type NW7. Polyester materials shall not be used as the geotextile fabric wrapped around 1-1/2-inch Crushed Stone surrounding primary andsecondary leachate collection pipes, surface water management system pipes, and leachate recirculation pipes. Polyester materials may be used for site drainage construction, or as a component of the geocomposite drainage layer, as set forth in Section 02520, Paragraph 2.05A.

FABRIC PROPERTY	TES METHOD	FABRIC REQUIREMENT			
		Type NW7	Type NW10	Type NW12	Type NW16
Mass per unit area (oz/yd^2)	ASTM D5261	7	10	12	16
Grab Tensile Strength (lbs, machine direction)	ASTM D4632	200	230	300	370
Grab Tensile Elongation (%, machine direction)	ASTM D4632	50	50	50	50
Trapezoidal Tear Strength_(lbs)	ASTM D4533	75	95	115	145
Apparent Opening Size (U.S. Standard Sieve)	ASTM D4751	70 max.	100 max.	100 max.	100 max.
Puncture Strength[1] (lbs)	ASTM D6241	540	700	800	900

Notes:
1. In accordance with GRI GT12(a), and at the discretion of the Engineer, test method ASTM D4833 may be performed in lieu of ASTM D6241 for Puncture Strength. For ASTM D4833, the minimum values, in lbs, for puncture strength are 110 (NW7), 120 (NW10), 140 (NW12) and 170 (NW16).

B. Woven Geotextile Fabric, Type W6 shall be a woven polypropylene and/or polyester material which meets the following minimum average roll values:

FABRIC PROPERTY	TEST METHOD	FABRIC REQUIREMENT
Grab Tensile Strength (lbs)	ASTM D4632	300
Grab Elongation (%)	ASTM D4632	10
Burst Strength (psi)	ASTM D3787	600
Trapezoidal Tear (lbs)	ASTM D4533	120
Apparent Opening Size (U.S. Standard Sieve)	ASTM D4751	40 max.
Puncture Strength (lbs)	ASTM D6241	120

PART 3 - EXECUTION

3.01 INSTALLATION

A. Geotextile Fabric shall be installed in accordance with the manufacturer's recommendations, and as shown on the Drawings and specified herein. The Contractor and Geosynthetic Installer shall be trained and experienced in field handling, storing, deploying, installing, and protecting geotextiles.

B. The Contractor or Geosynthetic Installer shall ensure that geotextiles are not damaged during handling. The geotextile shall be deployed as described below, unless approved otherwise by the Designer.
   1. On slopes, the geotextile shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.
   2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Sandbags shall be installed during deployment and shall remain until replaced with cover material.
   3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.
   4. The Geosynthetic Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.
   5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

C. Geotextiles shall be overlapped a minimum of 3 inches prior to seaming. No horizontal seams (oriented perpendicular to the fall line) shall be allowed on sideslopes, except as part of a patch. When horizontal seams are necessary, seams shall be offset in adjacent panels and shall be “shingled” downhill. On slopes steeper than 10:1 (horizontal: vertical), all geotextiles shall be continuously sewn. Dry, clean material may also be fusion heat bonded. Spot sewing is not allowed. On slopes flatter than 10:1, geotextiles shall be continuously sewn, or thermally bonded with the approval of the Designer. Sewing shall be done using polypropylene thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. The color of the sewing thread shall contrast the background color or the geotextile. Sewing shall be done using a single-stitch “prayer” seam. Stitch density shall be at least four stitches per inch.

D. Unless indicated otherwise on the Drawings, geotextile shall be overlapped a minimum of 12 inches wherever continuous stitching is not required.

E. Folds or excessive wrinkling of deployed geotextile shall be removed to the extent practicable. The Contractor or Geosynthetic Installer shall exercise care not to entrap stones, excessive dust, or foreign objects in the geotextile. Large stones and foreign objects shall be removed. Exposed geotextile shall be adequately weighted, using sand bags or equivalent. Geotextile placed on sideslopes shall be securely anchored in the anchor trench prior to deployment.

F. Any holes or tears in the geotextile shall be repaired using the following procedures, unless approved otherwise by the Designer.
   1. On sideslopes, a patch made from the same geotextile shall be thermally bonded or sewn into place in accordance with the project specifications.
   2. On non-sideslope areas, a patch made from the same geotextile shall be thermally bonded or sewn into place with a minimum of 12-inch overlap in all directions. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.
   3. All holes and tears in the geotextile that is not part of the cover system shall be repaired as directed by the Geosynthetic QAC.

G. All soil materials located on top of a geotextile shall be deployed in such a manner as to ensure:
   1. The geotextile and underlying materials are not damaged.
   2. Minimal slippage of the geotextile on underlying layers occurs.
   3. No excess tensile stresses occur in the geotextile.

END OF SECTION

SECTION 02520

DRAINAGE GEOCOMPOSITE/GEONET

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Geosynthetic Installer shall furnish all labor, materials, tools and equipment and perform all operations necessary to furnish, deploy, and install Drainage Geocomposite (Geocomposite Drainage Layer) in the areas indicated on the Drawings or as required by the Designer or Owner. The Owner may supply the drainage geocomposite.

B. Except where related to specific material requirements, all references to "Drainage Geocomposite" herein shall also apply to “Geonet Drainage layer”, “Drainage Geonet” and “Geonet.” The term “Drainage Geocomposite” shall apply equally to the term “geocomposite.”

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 REFERENCES

A. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

B. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer (condition 190/2.16).

C. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

D. ASTM D1603 - Standard Test Method for Carbon Black in Olefin Plastics.

E. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus.

F. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

G. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

H. ASTM D4632 - Standard Test Method for Breaking Load and Elongation of Geotextile (Grab Method).

I. ASTM D4716 - Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.

J. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

K. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

L. ASTM D5199 - Standard Test Method for Measuring Nominal Thickness of Geosynthetics.

M. ASTM D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.

N. ASTM D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

O. ASTM D7005 - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.

1.04 QUALITY CONTROL SUBMITTALS

A. Prior to delivery of drainage geocomposite to the site, the Geosynthetic Installer or Owner shall submit the following information to the Geosynthetic QAC for the geonet component of the geocomposite.

1. Copies of dated quality control certificates issued by the HDPE geonet resin supplier.
2. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
3. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control tests. At a minimum, results shall be given for:
   a. Density (ASTM D1505 or D792);
   b. Mass per unit area (ASTM D5261);
   c. Thickness (ASTM D5199); and
   d. Carbon black content (ASTM D1603 or D4218).

   Quality control tests shall be performed in accordance with the test methods for every 50,000 ft2 of geonet produced within each lot.
4. The following shall be maintained by the geonet Manufacturer and will be available upon request:
   a. The origin (supplier's name and production plant) and identification (brand name and number) of the resin.
   b. Results of tests conducted by the Manufacturer to verify that the resin used to manufacture the geonet meets the project specifications.
   c. A list of the materials which comprise the geonet, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.

B. Prior to delivery of drainage geocomposite to the site, the Geosynthetic Installer or Owner shall submit the following information to the Geosynthetic QAC for the geotextile component of the geocomposite:

1. Written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles using a metal detector and found the geotextile to be needle-free.
2. Written quality control certificates, signed by a responsible party employed by the Manufacturer and stating that the product will meet the minimum values given in the specification are guaranteed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for:
   a. Mass per unit area (ASTM D5261);
   b. Grab strength (ASTM D4632);
   c. Trapezoidal tear strength (ASTM D4533);

d. Apparent opening size (ASTM D4751);
e. Permittivity (ASTM D4491); and
f. Puncture strength (ASTM D6241).

These quality control tests shall be performed in accordance with the test methods for at least 90,000 ft^2 of geotextile produced within each lot.

3. The following shall be maintained by the geotextile Manufacturer and will be available upon request:
   a. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.
   b. Reports on tests conducted by the Manufacturer to verify that resin used to manufacture the geotextile meets the Manufacturer's resin specifications.
   c. A list of the materials which comprise the geotextile, expressed in the following categories as percent by weight: base polymer, carbon black, other additives.
   d. A statement from the Geotextile Manufacturer that the geotextiles will retain their structure during handling, placement, and long-term service; and be capable of withstanding direct exposure to sunlight for a minimum of 15 days with no measurable deterioration and 30 days with 70 percent retention of mechanical properties.

C. Prior to delivery of drainage geocomposite to the site, the Geosynthetic Installer or Owner shall submit the following information to the Geosynthetic QAC for the assembled geocomposite:
1. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
2. Quality control certificates for the geocomposite, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for:
   a. Geotextile-geonet adhesion (ASTM D7005)
   b. Transmissivity (ASTM D4716)
3. Quality control tests shall be performed in accordance with the test methods for at least every 50,000 ft^2 of geocomposite produced, except for transmissivity that shall be at a rate of one test per 250,000 ft^2.
4. A sample of the drainage composite shall be provided to pre-qualify the material. ASTM D4176 will be used as the pre-qualification test to verify only the hydraulic transmissivity. One specimen will be required to be run through 100 hours duration at the maximum confining pressure.

1.05 MATERIAL SHIPPING, STORAGE, AND HANDLING

A. The Geosynthetic Installer shall be responsible for the shipping, handling, storage, and care of the Drainage Geocomposite from the time material is delivered to the site until final acceptance of the completed work by the Owner. The Geosynthetic Installer shall be liable for all damages to the materials during such time.

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

C. The Contractor is responsible for providing all equipment and personnel necessary to promptly unload geosynthetic materials upon delivery to the site. The materials shall be stockpiled by the Contractor in accordance with the requirements of these specifications, in the areas designated on the Drawings or as directed by the Project Manager. The Geosynthetic Installer shall provide the Contractor with no less than 24 hours' notice prior to all deliveries, and shall be present during unloading unless the Geosynthetic Installer has not yet been mobilized to the site.

PART 2 - PRODUCTS

2.01 MATERIAL PROPERTIES

A. The components of the single-sided and double-sided drainage geocomposite shall meet or exceed the properties set forth in this section of the specifications unless approved otherwise by the Designer.

2.02 GEONET

A. The transmissivity of Drainage Geonet shall be such that the transmissivity of the drainage geocomposite meet the requirements of Part 2.03 and 2.04 of this specification

2.03 SINGLE-SIDED DRAINAGE GEOCOMPOSITE

A. The transmissivity of the Single-Sided Drainage Geocomposite, measured using water at 68 degrees F with a gradient of 0.05 under a compressive stress of 250 psf between 40-mil textured HDPE geomembrane (below) and protective cover sand (above), shall exceed 1.3×10^{-2} square feet per second (ft^2/sec) (1.2×10^{-3} m^2/s) as measured according to ASTM D4716. Seating time of the loads shall be in accordance with ASTM D4716.

B. The geocomposite shall be uniformly bonded across the entire roll width, as follows:
1. The allowable width of unbonded material along the roll edge shall not exceed 6 inches.
2. For bonded areas, the average geonet/geotextile adhesion shall meet or exceed 1.0 pounds per inch (ppi) according to ASTM D7005 with the modifications below:
    a. 4 of 5 individual test results shall meet or exceed 1.0 ppi.
    b. For test results internal to the roll width (more than 12 inches from an edge) all individual tests shall meet or exceed 0.5 ppi.
    c. For test results adjacent to (within 6-inches of) the unbonded seam edge, all individual test results shall meet or exceed 0.7 ppi.
3. MCQ testing frequency for ply adhesion shall be one test per 20,000 ft2, and a minimum of one test per lot/batch.

2.04 DOUBLE-SIDED DRAINAGE GEOCOMPOSITE

A. The transmissivity of the Double-Sided Drainage Geocomposite for use in cover systems, measured using water at 68 degrees F for the minimum and maximum gradients representative of site conditions under a compressive stress of 250 psf between 40-mil textured HDPE geomembrane (below) and protective cover soil (above). Results of testing shall exceed 4.5×10^{-3} m^2/sec for a 11H:1V and 9.7×10^{-4} m^2/sec for a 3H:1V slope as measured according to ASTM D4716. Seating time of the loads shall be in accordance with ASTM D4716. Results of transmissivity testing shall be verified as acceptable based on design calculations.

B. The geocomposite shall be uniformly bonded across the entire roll width, as follows:
   1. The allowable width of unbonded material along the roll edge shall not exceed 6 inches.
   2. For bonded areas, the average geonet/geotextile adhesion shall meet or exceed 1.0 pounds per inch (ppi) according to ASTM D7005 with the modifications below:
      a. 4 of 5 individual test results shall meet or exceed 1.0 ppi.
      b. For test results internal to the roll width (more than 12 inches from an edge) all individual tests shall meet or exceed 0.5 ppi.
      c. For test results adjacent to (within 6-inches of) the unbonded seam edge, all individual test results shall meet or exceed 0.7 ppi.
   3. MCQ testing frequency for ply adhesion shall be one test per 20,000 ft2, and a minimum of one test per lot/batch.

2.05 GEONET ALONE OR AS A COMPONENT OF GEOCOMPOSITES

A. The geonet portion of either Single-Sided or Double-Sided Drainage Geocomposite shall be manufactured of HDPE which has a carbon black content of 2 to 3 percent by weight according to ASTM D1603.

B. In addition to the properties specified above, Geonet and the geonet portion of the Drainage Geocomposite shall meet or exceed the specifications tabulated below.

Property	Units	Value	Test
HDPE Polymer Specific Gravity	-	0.93 minimum	ASTM D1505/D792
HDPE Polymer Melt Index	g/10 min	1.1 maximum	ASTM D1238
Thickness	mils	250 MARV (1)	ASTM D5199
Carbon Content	%	2.0 – 3.0	ASTM D1603

(1) Minimum Average Roll Value (MARV)

2.06 GEOTEXTILE COMPONENT(S) OF GEOCOMPOSITE

A. The geotextile portion of either Single-Sided or Double-Sided Drainage Geocomposite shall consist of non-woven polyester or polypropylene material and shall be heat- bonded to both sides of the HDPE drainage net. No burn through the geotextiles shall be permitted. The geotextile shall meet the following minimum average roll values:

FABRIC PROPERTY	TEST METHOD	FABRIC REQUIREMENT
Mass per Unit Area (oz/yd^2)	ASTM D5261	8.0
Grab Tensile Strength (lbs)	ASTM D4632	200

Grab Tensile Elongation (%)	ASTM D4632	50
Trapezoidal Tear Strength (lbs)	ASTM D4533	75
Puncture Strength (lbs)	ASTM 4833/D6241	110/540
Permittivity (sec^{-1})	ASTM D4491	1.3
Apparent Opening Size (U.S. Standard Sieve)	ASTM D4751	80 max.
UV Exposure (%)	ASTM D4355	70
Adhesion (lbs/in)	ASTM D7005 (modified)	1

2.07 TIES

A. Ties used to secure adjacent sheets of Drainage Geocomposite shall be strings, plastic fasteners, or polymer braid. Metallic ties will not be allowed. Ties shall be yellow or white to facilitate inspection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Geocomposite shall be installed by the Geosynthetic Installer in accordance with the manufacturer’s recommendations, and as shown on the Drawings and specified herein. The Geosynthetic Installer shall be trained and experienced in field handling, storing, and installing Drainage Geocomposite.

B. The use of any vehicular equipment by the Geosynthetic Installer to deploy cover system components is subject to the approval of the Geosynthetic QAC. Such equipment may include low-ground-pressure rubber tire vehicles, if the Geosynthetic QAC deems the use of such equipment allowable for the conditions and methods proposed by the Geosynthetic Installer. In all cases, operation of such approved vehicles directly on the geosynthetic components of the cover system shall be exclusively for deployment purposes only.

C. The Contractor or Geosynthetic Installer shall handle all geocomposite in such a manner as to ensure they are not damaged, and the following shall be complied with

1. After unwrapping the roll from its opaque cover, the exposed geotextile portion shall not be left exposed for a period more than 30 days unless a longer exposure period is approved by the Engineer. Approval may be based on a formal demonstration from the Geotextile Manufacturer that the geotextile is stabilized against ultraviolet degradation for a period more than 30 days.
2. On slopes, the geocomposite shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.
3. In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Sandbags shall be installed during deployment and shall remain until replaced with cover material.
4. Unless otherwise specified, single-sided geocomposite shall not be welded to the geomembrane.
5. Geocomposites shall be cut using a hook blade or other tool approved by the Geosynthetic QAC. If in place, special care shall be taken to protect underlying

geosynthetics from damage which could be caused by the cutting of the geocomposite. Care shall be taken not to leave the tools in the geocomposite.

6. The Geosynthetic Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
7. Gecomposites may not be dragged over textured geomembrane.
8. During placement of geocomposite, care shall be taken not to entrap in or beneath the geocomposite, stones, or dirt that could damage the geomembrane, cause clogging, or hamper subsequent seaming. If dirt or excess dust is entrapped in the geonet of single-sided geocomposite, it should be washed clean prior to placement of the next material on top of it. In this regard, care shall be taken with the handling of sandbags, to prevent puncturing the sandbag.
9. The Contractor and the Geosynthetic Installer shall perform a visual examination of the geotextile component of the geocomposite over the entire surface, after installation, to ensure that no potentially harmful foreign objects are present.

D. In general, horizontal seams shall be minimized on sideslopes. Seams on sideslopes shall be along, not across, the slope, except as part of a patch. If horizontal seams are required on sideslopes, seams shall be offset in adjacent panels, shall allow only one seam on the slope per deployment run, shall be shingled downhill, and shall be located on the lower 1/3 of the slope. For all geocomposite seams, the following requirements shall be met, unless approved otherwise by the Designer:

1. Adjacent geocomposite shall be overlapped so that the geonet overlaps by at least 3 inches and geotextile overlap by at least 2 inches.
2. If double-sided geocomposite, overlap bottom geotextile.
3. The geonet overlaps shall be tied with plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
4. Tying shall be every 5 feet along the slope, every 6 inches in the anchor trench, and every 6 inches along end-to-end seams on the base of the landfill.
5. If more than one layer of geocomposite is installed, joints shall be staggered.
6. Once geonet is tied, the top layer of geotextile of the geocomposite shall be seamed. On slopes steeper than 10:1 (Horizontal:Vertical), all geotextiles shall be continuously sewn. Spot sewing is not allowed. On bottoms and slopes flatter than 10:1, geotextiles shall be sewn (preferred), or thermally bonded with the written approval of the Designer. The Geosynthetic Installer shall pay particular attention to seams to ensure that no earth cover material could be inadvertently inserted beneath the geotextile.
7. Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using a single-stitch “prayer” seam.

E. Folds or excessive wrinkling of deployed Drainage Geocomposite shall be removed to the extent practicable. The Contractor and Geosynthetic Installer shall exercise care not to entrap stones, excessive dust, or foreign objects in the Drainage Geocomposite. Large stones and foreign objects shall be removed. Exposed Drainage Geocomposite shall be adequately weighted, using sand bags or equivalent. Drainage Geocomposite placed on side slopes shall be securely anchored in the anchor trench prior to deployment.

F. Defects and Repairs: If geonet is undamaged but the geotextile is damaged, the Geosynthetic Installer shall repair the damaged area as follows:
   1. Remove damaged geotextile.
   2. Cut patch of new geotextile to provide minimum 12-inch overlap in all directions.
   3. Thermally bond geotextile patch to existing geocomposite.

G. If the geonet is damaged, the Geosynthetic Installer shall repair the damaged area as follows:
   1. Remove damaged geonet.
   2. Cut patch of new material to replace damaged geonet. Remove damaged portion.
   3. Secure patch to original geonet by tying every 6 inch. Use tying devices as indicated in Paragraph 2.07.
   4. Place geotextile patch overlapping damaged area by minimum of 12 inches in all directions.
   5. Thermally bond geotextile patch to existing geocomposite.

H. The Geosynthetic Installer shall replace geocomposite if judged by Geosynthetic QAC to be large defect, or larger than 3 by 3 feet.

3.02 PLACEMENT OF SOIL MATERIALS

A. The Contractor shall place all soil materials over geocomposite such that:

   1. the geocomposite and underlying materials are not damaged;
   2. minimal slippage occurs between the geocomposite layer and underlying layers; and
   3. excess tensile stresses are not produced in the geocomposite.

B. Equipment shall not be driven directly on the geocomposite drainage layer. Placement of the cover material shall occur as soon as practicable and shall occur from the base of the slope upwards. Unless otherwise specified by Designer, all equipment operating on soil material overlying the geocomposite drainage layer shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	Thickness of Overlying Compacted Fill (ft.)
5	1.0
10	1.5
20	2.0
>20	3.0

3.03 INTERFACE WITH OTHER PRODUCTS

A. The Contractor shall ensure the following when deploying soil materials over geocomposite:

1. Geocomposite and underlying lining materials are not damaged.
2. Minimal slippage of geocomposite on underlying layers occurs.
3. No excess tensile stresses occur in geocomposite.

END OF SECTION

SECTION 02530

GEOSYNTHETIC CLAY LINER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Geosynthetic Installer shall furnish all labor, materials, tools and equipment, and perform all operations necessary to furnish, deploy, and install Geosynthetic Clay Liner (GCL) in the areas indicated on the Drawings and as specified herein.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 REFERENCES

A. Latest version of American Society for Testing Materials (ASTM):
1. ASTM D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
2. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
3. ASTMD4643 - Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating.
4. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
5. ASTMD5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
6. ASTM D5887 - Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
7. ASTM D5890 - Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
8. ASTM D5891 -Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
9. ASTM D5993 - Standard Test Methods for Measuring Mass Per Unit Area of Geosynthetic Clay Liners.
10. ASTM D6496 - Standard Test Method for Determining Average Bonding Peel Strength Between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.

1.04 QUALITY CONTROL SUBMITTALS

A. Prior to delivery of GCL to the site, the Geosynthetic Installer or Owner shall submit the following information to the Geosynthetic QAC for the bentonite component of the GCL:

1. Copies of dated quality control information issued by the bentonite supplier.
2. Results of quality control conducted by the GCL Manufacturer verifying that the bentonite supplied meets the GCL Manufacturer's specifications and the property requirements set forth in the project specifications. The following quality control tests shall be performed on the bentonite:
   a. Swell Index (ASTM D5890)
   b. Fluid Loss (ASTM D5891)
   c. Moisture Content (ASTM D2216/D4643)

   These tests shall be performed at a frequency of 100,000 lbs. within each lot of sodium bentonite.
3. Written certification that the minimum values given in the project specifications are guaranteed by the Manufacturer.

B. Prior to the delivery of GCL to the site, the Geosynthetic Installer or Owner shall submit to the Geosynthetic QAC a certification statement certifying that the geotextile carrier components of the GCL meet or exceed the property requirements set forth in the project specifications. Copies of dated quality control information from the geotextile manufacturer shall be submitted by the Geosynthetic Installer if requested by the Geosynthetic QAC.

C. Prior to delivery of GCL to the site, the Geosynthetic Installer or Owner shall submit the following information to the Geosynthetic QAC for the assembled GCL product:
1. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results for the GCL as a unit shall be given for:
   a. Moisture Content (ASTM D2216/D4643)
   b. Index Flux (ASTM D5887)
   c. Mass per unit area (ASTM D5993)
   d. Peel adhesion (ASTM D4632 (mod) or D6496)
   e. Grab strength (ASTM D4632)
2. Moisture content, mass per unit area, peel adhesion, and grab strength control tests shall be performed in accordance with the test methods for at least every 50,000 ft^2 within each lot. Index flux tests shall be performed for at least every 250,000 ft^2 or within each lot of GCL produced.

1.05 MATERIAL SHIPPING, STORAGE, AND HANDLING

A. The Geosynthetic Installer shall be responsible for the shipping, handling, storage, and care of the GCL from the time material is delivered to the site until final acceptance of the completed work by the Owner. The Geosynthetic Installer shall be liable for all damages to the materials during such time.

B. The Geosynthetic Installer shall inform the Project Manager a minimum 24 hours before any delivery for materials supplied by the Installer. During shipment and storage, the GCL shall be protected from ultraviolet light exposure, moisture, excessive humidity, puncture, cutting, or any other damaging conditions. GCL rolls shall be shipped and stored in relatively opaque and watertight wrappings. GCL rolls shall be stored away from wet ground and covered with a watertight tarp or under a roof to protect the stored rolls from hydration. The roll wrappings shall not be removed until shortly before deployment.

C. Roll Identification. The Geosynthetic Installer shall:
   1. Provide GCL rolls wrapped in relatively impermeable and opaque protective covers and marked or tagged with the following information:
      a. Manufacturer's name;
      b. Product identification;
      c. Shipping lot;
      d. Roll number;
      e. Roll dimensions; and
      f. Roll weight.
   2. Indicate special handling marked on GCL itself, e.g., "This Side Up.”

D. The Geosynthetic Installer shall handle GCL to ensure panels are not damaged.

E. The Geosynthetic Installer shall store GCL in dry place under roof or other protective cover, protect from moisture by placing on skids, pallets, or dry ground.

F. The Geosynthetic Installer shall remove and replace damaged GCL at no additional cost to Owner.

G. The Contractor is responsible for providing all equipment and personnel necessary to promptly unload geosynthetic materials upon delivery to the site. The materials shall be stockpiled by the Contractor in accordance with the requirements of these specifications, in the areas designated on the Drawings or as directed by the Project Manager. The Geosynthetic Installer or Owner shall provide the Contractor with no less than 24 hours notice prior to all deliveries, and shall be present during unloading unless the Geosynthetic Installer has not yet been mobilized to the site.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Bentomat DN CETCO Lining Technologies.
B. Bentofix NSL, Bentofix Technologies, Inc.
C. Or equal, as approved by the Designer and the Project Manager.

2.02 GENERAL

A. Except when specifically authorized, do not furnish special run or value added products.

B. GCL:
   1. Flexible, layered liner consisting of continuous layer of sodium bentonite sandwiched between a woven geotextile carrier layer and a non-woven geotextile carrier layer, and reinforced with needle-punched fibers. The

reinforcement fibers shall be glued or heat-burnished to the fabric.

2. GCL shall be of type to maintain integrity during installation, placement, and covering procedures.

2.03 GCL PROPERTIES

A. Unless approved otherwise by the Designer, the woven geotextile carrier component of the GCL shall have a MARV mass per unit area of 3.1 oz/yd^2 when measured using ASTM D5261.

B. Unless approved otherwise by the Designer, the non-woven geotextile carrier component of the GCL shall have a MARV mass per unit area of 6.0 oz/yd^2 when measured using ASTM D5261.

C. Unless approved otherwise by the Designer, the bentonite component of the GCL shall meet or exceed the following properties:

PROPERTY	TEST METHOD	VALUE
Sodium Bentonite Content		90% minimum
Swell Index	ASTM D5890	20 ml/2 g of weight
Fluid Loss	ASTM D5891	18 ml maximum
Moisture Content	ASTM D2216/D4643	30% maximum

D. Unless approved otherwise by the Designer, the assembled GCL product shall meet or exceed the following properties:

PROPERTY	TEST METHOD	VALUE
Index Flux	ASTM D5887	1x10^{-8} m^3/m^2/s maximum
Bentonite Mass per Unit Area	ASTM D5993	0.75 lb/sf minimum @ 0% ω
Grab Tensile	ASTM D4632	90 lb (typical)
Puncture Resistance	ASTM D4833	90 lb (typical)
Peel	ASTM D4632 (mod) or D6496	15 lb or 2.5 ppi (typical)

E. Bentonite adhesive shall be non-toxic and water soluble.

PART 3 - EXECUTION

3.01 EXPERIENCE

A. The Geosynthetic Installer shall be trained and experienced in field handling, storing, deploying, and installing GCL.

3.02 INSTALLATION

A. Subgrade Preparation. The Contractor shall:
1. Ensure subgrade is a smooth, compacted, uniform surface.
2. Prepare the subgrade to be free of protruding rocks greater than 1 inch in diameter.
3. Provide grading to allow surface water to be directed away from installation area.

B. Protection. The Contractor and the Geosynthetic Installer shall:

1. Not use equipment which damages GCL or other liner components during handling or trafficking, or by excessive heat, leakage of hydrocarbons, or other means. The use of any vehicular equipment by the Geosynthetic Installer to deploy liner components is subject to the approval of the Geosynthetic QAC. Such equipment may include low-ground-pressure rubber tire vehicles, if the Geosynthetic QAC deems the use of such equipment allowable for the conditions and methods proposed by the Geosynthetic Installer. In all cases, operation of such approved vehicles directly on the geosynthetic components of the cover system shall be exclusively for deployment purposes only.
2. Not permit personnel to smoke or wear shoes that can damage the GCL while working. Personnel shall not bring glass bottles on the GCL.
3. Unroll panels in a manner which does not cause tears or crimps in the GCL and does not damage supporting soil.
4. Place panels in a manner which minimizes wrinkles, especially differential wrinkles between adjacent panels, while providing sufficient material to prevent bridging.
5. Prevent wind uplift by providing adequate temporary loading or anchoring (for example, sandbags) that shall not damage the GCL.

C. Installation. The Geosynthetic Installer shall:
1. Thoroughly inspect and approve of the subgrade immediately prior to deploying the GCL.
2. Place non-woven side up.
3. Position the GCL by pulling roll suspended by inserting heavy duty steel pipe with spreader bar (to prevent damage to mat edge).
4. Lay the GCL on sideslopes perpendicular to base excavation.
5. Lay the GCL on base so upstream panel overlaps over (i.e., is shingled over) downstream panel.
6. Ensure the GCL overlap is free of dirt to provide seal. Apply granular or powdered bentonite along each seam at a rate of approximately ¼ pound per lineal foot.
7. Provide 6-inch minimum overlap at each side and 12 inches at each end.
8. Not install the GCL in any form of precipitation.
9. Notify the Geosynthetic QAC before covering the GCL, and not cover until Geosynthetic QAC has given approval.
10. Deploy no more GCL material during one working day than can be covered by the end of that day with seamed geomembrane. Geomembrane should extend approximately 2 feet beyond the leading edge of the GCL to ensure coverage. The leading edge of the geomembrane shall be adequately sandbagged to prevent uplift.

D. In the event of rain, the Geosynthetic Installer shall immediately cover exposed GCL with plastic sheeting or other methods to prevent damage and swelling.

E. Any portion of the GCL exhibiting flaws shall be repaired. Prior to acceptance of the installed GCL, the Geosynthetic Installer shall locate and repair all damaged areas of the liner as specified in this section. Defects or damage can be identified by rips, tears, premature hydration of the GCL or delamination of the geotextiles, or other features identified by the Geosynthetic QAC. All repairs shall be performed by the Geosynthetic Installer at no additional cost to the Owner, as follows:

1. Rips or tears in the GCL shall have another piece of material meeting the project specifications inserted under the GCL panel. The material shall extend beyond the entire damaged area a minimum 24-inch overlap in all directions.
2. Where damaged areas exceed 10% of the roll width on liner sideslopes, the GCL roll shall be removed and replaced with an undamaged GCL panel.

F. Contractor shall ensure a confining load (e.g., Protective Layer) is installed on the lower 30-ft of the slope within 7 days of GCL deployment. Confining load shall be installed over the entire slope within 15 days of GCL deployment. Subsequent deployment of overlying geosynthetic layers (i.e., geomembrane) will not be considered adequate confinement.

END OF SECTION

SECTION 02560

SITE PIPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, and equipment and perform all operations necessary for stormwater drainage pipe construction. The Owner may opt to supply materials. Pipe culverts and pipe drains shall consist of sections of pipe of the kinds and sizes shown on the Drawings and as specified, laid on the specified bedding overlying a firm foundation in a trench in accordance with these specifications. In addition to this work, the Contractor may also be responsible for the installation of the associated gas piping, details and specifications of which are provided separately.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 REFERENCES

A. Latest version of American Association of State Highway and Transportation Officials (AASHTO) and American Society for Testing and Materials (ASTM) standards:
1. AASHTO M170 –Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
2. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
3. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.

1.04 QUALITY ASSURANCE

A. Lines and Grades:
1. Pipes shall be laid true to the lines and grades shown on the Drawings and within the tolerances specified in Paragraphs 3.05.A and B or as directed by the Designer. A variation exceeding the allowable tolerances will be deemed sufficient reason to cause the work to be rejected. Work so rejected shall be corrected by the Contractor at his own expense in a manner acceptable to the Designer.
2. The Contractor shall demonstrate his proposed methods of maintaining the grade and alignment of pipe during construction for the Soil QAC before the start of construction, and prior to backfilling operations.
3. The Contractor shall furnish all labor, materials, and tools to establish and maintain all lines and grades. Bench marks and reference points as required for control of the work shall be located by the Contract or along the job site.

Transferring line and grade from those references shall be the responsibility of the Contractor.

B. Source Quality Control:
   1. Submittals:
      a. The Contractor shall submit to the Project Manager a listing of manufacturer's technical product data for all manufactured products to be used for pipe, drains and appurtenances. Inferior performance on prior projects of a similar nature shall be grounds for rejecting a supplier's products.
      b. Upon the request of the Project Manager, the Contractor shall submit for approval shop drawings of pipes and fittings prior to ordering and receiving these materials.
      c. Upon the request of the Project Manager, the Contractor shall submit certificates of compliance with specified standards and tests from the manufacturer.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Inspection of Material and Delivery Point:
   1. When material is supplied by the Contractor and when delivered to the site, and prior to unloading, the Contractor shall inspect all pipe, and accessories for loss, damage, or lack of specified identification and markings.
   2. Any defective or improper material shall be immediately returned to the supplier at no additional expense to the Owner prior to being unloaded.

B. Handling:
   1. In shipping, storing, and installing, pipe shall be kept in a sound, undamaged condition. It shall at all times be handled with care and rigid pipe (RCP) shall not be dropped, dumped, or bumped against any other object. Any material(s) damaged shall be marked and immediately removed from the job site and replaced at the Contractor's expense.

C. Storing:
   1. Pipe shall be stored off the ground on sticking or pallets. Pipe shall be stacked with spigot ends projecting from the stack in opposite directions from alternate rows, as applicable.

D. Defective Materials
   1. All materials found at any time during the progress of the work to have cracks, flaws, or other defects will be rejected and marked and the Contractor shall promptly remove such defective material from the work site.

PART 2 - PRODUCTS

2.01 MATERIAL PROPERTIES

A. The Contractor shall supply all pipe materials and accessories meeting or exceeding the specified properties listed in this Section, unless either approved otherwise by the Designer or if materials are supplied by the Owner. Alternative materials, including all pipe, fittings and accessories (e.g., cast-in-place concrete seepage cutoff collars for ADS Pipe or PE Drain Pipe) shall be pre-approved by the Designer prior to being used.

2.02 REINFORCED CONCRETE PIPE (RCP)

A. Reinforced Concrete Pipe shall conform to the requirements of AASHTO M 170, for Class IV pipe.

B. Reinforced Concrete Pipe shall conform to AASHTO M 170, Section 4.1.1. Test requirements shall be as provided in AASHTO M 170 Section 9.3.1 and 9.5 with the further provision that the pipe will withstand an additional ten percent of the D-load specified or brought to destruction. Permissible variation in pipe tolerances shall conform to AASHTO M 170, Section 10.

MINIMUM STRENGTH REQUIREMENTS		
D-LOAD TO PRODUCE THE ULTIMATE LOAD = CLASS	D-LOAD TO PRODUCE A 0.01-INCH CRACK	AASHTO DESIGNATION CLASS
1500 D	1000	II
2000 D	1350	III
3000 D	2000	IV
3750 D	3000	V
4000 D	----	----

C. Workmanship and finish shall conform to AASHTO M 170, Section 11. Pipe shall be subject to rejection on account of failure to conform to any of the specification requirements of AASHTO M 170, Section 14. Individual sections of pipe may be rejected because of the following reasons:

1. Fracture or cracks passing through the wall, except for a single end crack that does not exceed the depth of a joint.
2. Defects that indicate imperfect proportioning, mixing, and molding.
3. Surface defects indicating honey-combed or open texture.
4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.
5. Any continuous crack having a surface width of 0.01-inch or greater, regardless of position in the wall of the pipe.

D. Markings on pipe shall conform to AASHTO M 170, Section 15 with the following information clearly marked on each section of pipe.

1. The pipe class and type wall.
2. The date of manufacture.
3. The name or trademark of the manufacturer.
4. Identification of plant.

2.03 REINFORCED CONCRETE PIPE JOINTS

A. Each pipe shall be constructed with a bell and spigot joint, capable of acting as an expansion joint and withstanding deflections caused by normal earth settlement and extremes of temperature. Each unit shall have an interior surface free of roughness, projections, indentations, offsets, or irregularities.

B. Pipe joints shall be of the round neoprene gasket type, in which the gasket is in compression, confined within the concrete groove of the spigot, and the smooth surface of the bell, permitting both longitudinal and angular movement. The bell and the spigot end of the pipe shall be formed by machine rings to ensure accuracy. The critical diameters of the joint surface, which influence the compression of the gasket, shall have a tolerance not to exceed 1/16 inch.

C. The neoprene gasket shall be confined in the annular space formed by a groove in the spigot end of the pipe and the interior surface of the bell, so movement of the pipe or hydrostatic pressure cannot displace the rubber gasket.

D. The neoprene gasket and joint shall be designed and manufactured so the completed joint will withstand an internal water pressure inside the pipe of 20 pounds per square inch (psi) or applicable ASTM Specification without showing any joint leakage or displacement of the gasket.

E. The gaskets used to seal the joints shall be made of neoprene of such composition and texture to ensure a watertight and permanent seal, and shall be the product of a manufacturer having at least five years experience in the manufacture of neoprene gaskets for pipe joints. The gaskets shall be continuous round rings of flexible joint rubber, of material resistant to common ingredients of surface water runoff and groundwater, and which will endure permanently under the conditions likely to be imposed by this service. The gasket shall conform to the requirements of ASTM Standard Specifications for joints, for circular concrete sewer and culvert pipe, using flexible watertight rubber type gaskets, designation ASTM C-443.

2.04 CORRUGATED PE DRAIN PIPE

A. PE Drain Pipe and fittings shall be non-perforated, corrugated, flexible polyethylene pipe manufactured with a smooth interior surface; shall conform to applicable ASTM and AASHTO standards; and shall be of the diameter shown on the Drawings. PE Drain Pipe shall be ADS N-12 pipe, or approved equivalent.

B. Fittings for PE Drain Pipe, including anti-seep collars, shall be produced by the same manufacturer that produces the PE Drain Pipe, and for use with the PE Drain Pipe material. Neoprene gaskets shall be utilized with couplings to provide a soil-tight joint.

PART 3 - EXECUTION

3.01 GENERAL

A. All pipes, appurtenances and accessories shall be installed true to lines, grades and locations indicated on the Drawings and in accordance with Paragraphs 3.05.A and.

B. Any deviations must be approved by the Designer before installation, and/or before final backfilling in accordance with Paragraph 3.04.G.

3.02 EXCAVATION, BACKFILL AND COMPACTION

A. Trench excavation, pipe bedding placement and compaction, and trench backfilling and compaction shall be as specified in Section 02200.

3.03 PIPE BEDDING CONDITIONS

A. All pipes laid in open trench excavations shall be bedded in and uniformly supported over their full length on beddings of the types specified herein and shown on the Drawings. Flat-bottomed trenches shall be excavated in accordance with the specifications for excavation and backfill, prior to preparing the specified foundation. All work shall be performed in a dry trench.

B. Pipe bedding for rigid pipe (RCP) shall be 6 inches of 3/4-inch Crushed Stone wrapped in Type NW7 Geotextile Fabric. Pipe bedding for flexible pipe, shall be a minimum of 6 inches of compacted Granular Fill. The Granular fill shall be underlain by Type NW7 Geotextile Fabric where subgrade soils are silt clay, or as indicated on the Drawings.

3.04 INSTALLATION OF PIPE AND FITTINGS

A. After the pipe trench and bedding has been brought to the proper grade, as herein before specified, the pipe and other relevant features shall be laid. Unless otherwise approved by the Designer, pipe laying shall only be done in the presence of the Soil QAC and the Contractor shall give ample notice of scheduled pipe laying operations to the Soil QAC.

B. All pipe and fittings shall be carefully lowered into the trench by hand or by the proper equipment. Pipe becoming damaged during or following installation shall be marked by the Contractor or Soil QAC and removed from the site as required herein.

C. Pipes shall be laid true to grades shown on the Drawings or as directed by the Designer. Each section of pipe shall rest upon the pipe bed for the full length of its barrel. Blocking will not be permitted. Any pipe that has its grades or joints disturbed after laying shall be taken up and relaid.

D. The pipe ends shall be thoroughly cleaned before the joint is made. All connections shall be made in accordance with instructions supplied by the manufacturer.

E. Joints between dissimilar pipes shall be made in accordance with the recommendations of the manufacturer of one or the other of the pipes.

F. Reinforced Concrete Pipe shall be laid with socket or collar ends of the pipe upgrade unless otherwise authorized by the Designer.

G. Before backfilling shall be done, the Contractor's surveyor and the Soil QAC shall ascertain as-built grade and alignment, and check the integrity of the pipe. In cases of poor grade or alignment, misplaced pipe, or other defects, such defects shall be remedied by the Contractor at no additional expense to the Owner. Where discrepancies between design and as-built grades and/or alignment occur, backfilling shall be limited to work necessary to maintain erosion and sedimentation control, and/or the integrity of the installation until such time that the discrepancies are resolved to the satisfaction of the Designer and Owner.

3.05 TOLERANCES

A. Installed piping shall flow in the direction intended per the Drawings and shall be free from sags or changes in slopes, unless required per the Drawings.

B. In the absence of specific requirements set forth on the Drawings, as-built slope shall be within 10 percent of design slope (i.e., +/- 0.001 ft/ft for a design slope of 0.01 ft/ft or +/- 0.1% for a design slope of 1%) and as-built invert in and out elevations shall be within 0.10 feet of design invert elevations.

END OF SECTION

SECTION 02570

MANHOLES, SUMPS, AND CATCHBASINS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, and equipment to install manholes, sump, and catchbasins, and to modify existing manholes, as shown on the Drawings. The Owner may supply products. This section includes:
1. Pre-cast stormwater manholes and catchbasins, including sedimentation basin outlet structure
2. Leachate transfer piping structures
3. Frames, covers, and grates
4. Cast-in-place reinforced concrete base pads

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 QUALITY ASSURANCE

A. General: Provide complete manhole and pump station structures capable of supporting AASHTO H20 loading and burial depth indicated on the Drawings.

B. Precast Manhole Components: ASTM C478.1.03

1.04 SUBMITTALS

A. ShopDrawings: Submit for precast items. Show components to be used, elevations of top, base and pipe inverts, location of pipe penetrations, steps, etc.

B. InstallationPlan: Submit for procedures to install elongated sump include details of providing excavation supports, if required.

C. Product Data: Submit manufacturer's product data and installation instructions for frames, covers, grates; precast items and components; manhole sleeves; and joint sealants for precast sections.

PART 2 - PRODUCTS

2.01 STRUCTURES

A. The Contractor shall supply manholes, pump station, catchbasins, and all accessories meeting or exceeding the specified properties listed in this Section and as indicated on the Drawings, unless approved otherwise by the Designer or otherwise supplied by the Owner.

1. Base Section. Precast monolithic construction with steps or formed-in-place reinforced concrete base pads as shown on the Drawings.
2. Barrel Sections. Precast with steps.
3. Top Sections. Precast eccentric cone with steps for stormwater manholes and catchbasins, precast flat top slabs for leachate transfer piping structures, unless otherwise indicated on the Drawings.
4. Steps: Aluminum alloy 6061-T6 or polypropylene reinforced with steel rod. Meet OSHA requirements, minimum width of 16 inches. Coat aluminum to be cast into concrete with bituminous paint.
5. Joints Between Precast Sections: Watertight, shiplap type, seal with two rings of 1-inch-diameter butyl rubber sealant or equivalent materials recommended by the manufacturer and approved by the Designer.

2.02 STRUCTURE AND PIPE CONNECTIONS

A. HDPE Pipe to Manhole Connections. All wall penetrations shall have a watertight seal. Pipe to wall penetration closures shall be Link-Seal as manufactured by Thunderline Corporation, or other product pre-approved by the Designer.

B. RCP to Stormwater Manhole or Catchbasin Connections. Flexible sleeves equivalent to CP series manufactured by Interpace Corp., sized to fit diameter and type of pipe without gaskets, or as indicated on the Drawings.

C. Flexible Pipe to Stormwater Manhole or Catchbasin Connections. The annular space between the structure wall penetration and the pipe shall be sealed with grout to produce a watertight connection capable of withstanding normal settlement and other relative movement between the pipe and structure.

2.03 FRAMES, GRATES, AND COVERS

A. General: The Contractor shall supply frames, grates, covers, and all accessories meeting or exceeding the specified properties listed in this section, unless approved otherwise by the Designer.
   1. Coatings for All Frames, Grates, and Covers. Two coats of coal tar pitch varnish applied after sandblasting to provide a smooth, tough, non-brittle, non-scaling finish. Repair damage to coatings to the satisfaction of the Engineer.
   2. Cast Iron. ASTM A48 Class 30.

B. Manhole Frames and Covers:
   1. General: As required by the Drawings.
   2. Standard Frames and Covers: Bolted and gasketed for leachate transfer piping structures.

C. Catchbasin Frames and Grates:
   1. General. As required by the Drawings.
   2. Standard Frames and Covers. Equivalent to Model R-3807 median drain frame and two-piece grate assembly by Neenah Foundry.

2.04 MISCELLANEOUS

A. Dampproofing: The Contractor shall provide bituminous coating equal to Dehydrate No. 4 Dampproof by W.R. Grace or Bitumastic Super Service Black by Koppers Co. for field application, or equivalent as approved by the Designer.

B. Waterproofing: For pre-cast structures the Contractor shall provide an exterior waterproofing coating equal to PPS 922 Superseal and an interior coating equal to Sherwin Williams Hi-mil Shear-Tar Epoxy.

PART 3 - EXECUTION

3.01 INSTALLATION OF STRUCTURES

A. Placement. Place bases on compacted bedding material in accordance with Section 02200 and as shown on the Drawings, so manhole structure is plumb and pipe inverts are at proper elevations. Place barrel and top sections in the appropriate height combinations. Adjust height of cover to accommodate road grades as well as allow positive drainage away from cover. Plug all lifting holes inside and out with non-shrink mortar.

B. Joints. Follow requirement set forth in Paragraph 2.01.A.5 or, if approved by Designer, follow manufacturer's instructions for sealing joints between precast sections. Point joints with non-shrinking mortar.

C. FrameandCovers. Set flush with the grades in road areas, or 18 to 24 inches above finish grade in unpaved areas. Provide adequate temporary covers to prevent accidental entry until final placement of frame and cover is made.

3.02 QUALITY CONTROL AND TOLERANCES

A. Before backfilling shall be done, the Contractor’s surveyor and the Soil QAC shall ascertain as-built grades, and check the integrity of the structures. In cases of poor grades or other defects, such defects shall be remedied by the Contractor at no additional expense to the Owner. Where discrepancies between design and as-built grades occur, backfilling shall be limited to work necessary to maintain erosion and sedimentation control, or the integrity of the installation until such time that the discrepancies are resolved to the satisfaction of the Designer and Project Manager.

B. Manhole and catchbasin structures shall be free from soil and any other deleterious material prior to acceptance for operation. Vacuuming or alternate acceptable methods of cleaning the interior of the structures shall be at the Contractor’s expense.

C. In the absence of specific requirements set forth on the Drawings, as-built rim, invert in, and invert out elevations shall be within 0.10 feet of design rim and invert elevations for stormwater structures and within 0.05 feet of design invert elevations for leachate transfer piping structures, and shall be such that the piping systems flow in the intended direction without sags.

END OF SECTION

SECTION 02780

HDPE PIPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work of this section includes providing the following:
   1. Double-walled, high-density polyethylene (HDPE) pipe and fittings for leachate transfer system carrier and containment piping outside the lined areas.
   2. Single-walled, perforated and solid, HDPE pipe and fittings for surface water, leachate collection, or recirculation headers and cleanouts; primary sump pipes and sideslope risers; and bubbler tube risers within the limits of the lined areas.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 REFERENCES

A. Latest versions of American Society for Testing and Materials (ASTM):

   1. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
   2. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   3. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
   4. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
   5. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
   6. ASTM D2122 - Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings.
   7. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings
   8. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
   9. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
   10. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

1.04 SUBMITTALS

A. The Contractor shall submit the following information to the Project Manager, if requested and if products are supplied by the Contractor:
   1. Manufacturer's test specification data listing resin type, cell classification, stock

density, melt flow, flexural modulus, tensile strength, coloration, and pipe dimensions:
a. Average outside diameter
b. Average inside diameter; and
c. Minimum and average wall thickness.
2. Manufacturer's instructions for fusing joints.
3. Installation plan for installation of extrusion welded sleeves, if used. On dual containment pipes, which are fixed, an electro fusion weld on the inner pipe may be used with an extrusion-welded sleeve used on the exterior of the pipe. The Contractor shall provide details of the proposed material and welding procedures of the sleeve. The plan shall provide dimensions of gap, the SDR of the sleeve and details of the beveled edges.

1.05 QUALITY ASSURANCE

A. Source Quality Control:
1. If manufacturer's test data is inadequate or unavailable, Owner reserves right to reject or require additional tests to satisfy material requirements. Costs of these tests shall be borne by Contractor.

B. Work shall comply with appropriate codes and standards of the following organization for handling, heat fusion, and underground installation of low pressure polyethylene pipe.
1. Plastic Pipe Institute (PPI).

C. Lines and Grades:
1. Pipes shall be laid true to the lines and grades shown on the Drawings and within the tolerances specified in Paragraphs 3.04.B. or as directed by the Designer. A variation exceeding the allowable tolerances will be deemed sufficient reason to cause the work to be rejected. Work so rejected shall be corrected by the Contractor at his own expense in a manner acceptable to the Designer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Pipe Storage. The Contractor shall:
1. Store or stack pipe to prevent damage from marring, crushing or puncture. Limit maximum stacking height to 6 feet.
2. Store in accordance with manufacturer's recommendations.

B. Pipe Handling. The Contractor shall:
1. Protect pipe from excessive heat or harmful chemicals.
2. Protect pipe from excessive gouging or surface abrasion as a result of handling or dragging.

PART 2 - PRODUCTS

2.01 GENERAL
A. The Contractor shall supply all materials and accessories meeting or exceeding the specified properties listed in this section, unless approved otherwise by the Designer.

2.02 PHYSICAL PROPERTIES OF PIPE RESIN

Property	Test Method	Value
Density (g/cc)	ASTM D1505	≥ 0.941 – 0.955
Melt Flow	ASTM D1238	Condition E < 0.15
Flexural Modulus (psi)	ASTM D790	110,000 to < 160,000
Tensile Strength at Yield (psi)	ASTM D638	3000 to < 3,500
ESCR[1]	ASTM D1693	> 5000 hours with zero failures (Condition C)
Hydrostatic Design Basis (psi)	ASTM D2837	1600 @ 23°C

1. Environmental Stress Crack Resistance (ESCR)

2.03 PIPE

A. Manufacturers:
   1. ISCO or approved equal.

B. Extra high molecular weight, high-density polyethylene pipe (Type 3408 resin).

C. ASTM D3350 (345464C previously ASTM D – Type III, Class C, Category 5, P34).

D. ASTM D3350, minimum cell classification value 345434C.

E. Required Standard Dimension Ratio (SDR) for stated use:
   1. Use SDR-32.5 for: 8" carrier pipe, force main and gravity drain, outside limits of lined area.
   2. Use SDR-17 for: 14" containment pipe, force main and gravity drain, outside limits of lined area.
   3. Use SDR-17 for: 8" and 18" risers within limits of lined area.
   4. Use SDR-17 for: 4, 6, and 8 perforated or solid leachate recirculation piping.
   5. Use SDR-13.5 for: 8” perforated leachate collection, cleanout and underdrain collection piping.

F. Markings at intervals of 5 feet or less:
   1. Manufacturer's name or trademark.
   2. Nominal pipe size.
   3. Type of plastic pipe (i.e., PE 3408).
   4. Standard dimension ratio.
   5. ASTM D2513.
   6. Extrusion date, period of manufacture or lot, or batch number.

G. Dimensions:
   1. Conform to standard dimensions and tolerances of ASTM D2513.

H. Size:
   1. As specified herein or indicated on the Drawings.

2.04 FITTINGS

A. Fittings from polyethylene compound having cell classification equal to or exceeding compound used in pipe to ensure compatibility of polyethylene resins.

B. Provide factory-fabricated, dual containment fittings except as indicated below.

C. Be of same manufacture as pipe being provided. Owner may allow substitution for approved material with use of flanged joint sections.

D. Dimensions of fittings conforming to standard dimensions and tolerances in accordance with ASTM D3261. Wall thickness of fittings shall be at least one SDR smaller than pipe to which it is fused.

E. Markings:
   1. Manufacturer's name or trademark.
   2. Nominal size.
   3. Type of plastic pipe (i.e., PE 3408).
   4. Standard dimension ratio.
   5. ASTM D2513.
   6. Extrusion date, lot number or batch number.

F. Seal space between containment pipe and manhole penetrations with Link-Seal as manufactured by Thunderline Corporation or approved equivalent.

2.05 ELECTRO-FUSION OR OVER-SLEEVE COUPLINGS

A. Manufactured specifically for joining HDPE pipe specified to be coupled; conform to pipe standard dimension ratio and size. Submit manufacturer's data to Geosynthetic QAC for approval prior to use.

B. Field fabricate extrusion welded sleeves for use on outer fixed dual containment pipe must be approved by the Designer prior to use.

2.06 DUAL CONTAINMENT JOINT

A. Manufactured specifically for joining dual containment system HDPE pipe; conform to pipe standard dimension ratio and size. Submit manufacturer's data to Project Manager for approval prior to use.

2.07 PIPE BOOT

A. Provide flexible pipe-to-sump connector of EPDM rubber, sized to fit cleanout laterals, where indicated on the Drawings. Pipe boot shall include a stainless steel pipe clamp and a stainless steel expander ring.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications or following:
   1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2 inches in length at either end of pipe which could be cut off and discarded. Pipes within one shipment shall be rejected if defects exist in more than 5% of shipment or delivery.

2. Cracks sufficient to impair strength, durability or service ability of pipe.
3. Defects indicating improper proportioning, mixing, and molding.
4. Damaged ends, where such damage prevents making satisfactory joint.
5. Damage due to handling.

B. Acceptance of fittings, stubs or other specially fabricated pipe sections shall be based on visual inspection at job site and documentation of conformance to these Specifications.

C. Before backfilling shall be done, the Contractor's surveyor and the Soil QAC and/or Geosynthetic QAC shall ascertain as-built grade and alignment, and check the integrity of the pipe. In cases of poor grade or alignment, misplaced pipe, or other defects, such defects shall be remedied by the Contractor at no additional expense to the Owner. Where discrepancies between design and as-built grades and/or alignment occur, backfilling shall be limited to work necessary to maintain erosion and sedimentation control, and/or the integrity of the installation until such time that the discrepancies are resolved to the satisfaction of the Designer and Soil QAC and/or Geosynthetic QAC.

3.02 INSTALLATION

A. The Contractor shall perform trench excavation, and bedding and backfill placement and compaction activities in accordance with Section 02200.

B. Heat Fusion of Pipe: The Contractor shall:
1. Weld in accordance with manufacturer's recommendation for butt fusion methods. Provide qualified fusion operators.
2. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures.
3. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations. Solvents shall not be used unless approved by the Designer and the Project Manager.
4. Not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade.
5. Not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
6. Before and after butt fusing pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris or animals from pipe.
7. Cover at end of each working day open ends of fused pipe. Cap to prevent entry by animals or debris.
8. Use compatible fusion techniques when polyethylenes of different melt indexes are fused together. Refer to manufacturer's specifications for compatible fusion.

C. Flange Jointing: The Contractor shall:
1. Use on flanged pipe connection sections.
2. Galvanized steel backing rings shall be used for joining flanged pipe.
3. Butt fuse fabricated flange adapters to pipe.
4. Observe following precautions in connection of flange joints:

a. Align flanges or flange/valve connections to provide tight seal. Gaskets are required for flange/valve connections.
b. Place U.S. Standard round washers as may be required on some flanges in accordance with manufacturer's recommendations. Bolts shall be lubricated in accordance with manufacturer's recommendations.
c. Tighten flange bolts in sequence and accordance with manufacturer's recommendations. Do not over-torque bolts.

5. Pull bolt down by degrees to uniform torque in accordance with manufacturer's recommendations.
6. Protect flange and bolt connections installed underground with Tapecoat mastic and tape.

D. Electro-Fusing:
1. Electro-fusion joints shall be provided in accordance with manufacturer's recommendations.

E. Pipe Placement: The Contractor shall:
1. Survey equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Dewatering: Conform to Section 02200.
3. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion; but not to exceed 500 feet for dual containment and 1,000 feet for leachate collection pipe.
5. Cap pipe sections longer than single joint (usually 40 feet) on both ends during placement except during fusing operations.
6. Remove any coarse aggregate (3 inches or greater) or debris from within 12 inches of the installed pipe before backfilling.
7. Notify the Soil QAC prior to installing pipe into trench and allow time for inspection.
   a. Correct irregularities found during inspection.
8. Complete tie-ins within trench whenever possible to prevent overstressed connections.
9. Allow pipe sufficient time to adjust to trench temperature prior to segment tie-ins, backfilling activity, and testing.
10. Install fittings at locations shown on details included on Drawings.
11. As applicable and to reduce branch saddle stress, install saddles at slope equal to and continuous with connecting piping.
12. Place in trench to allow for minimum 12-in./100 ft. for thermal contraction and expansion.

3.03 ACCEPTANCE

A. Installed pipe shall be cleaned by blowing out any debris and temporarily capped on a daily basis. Prior to start-up, installed pipe shall be televised at Contractor's expense. Soil QAC shall be present during televising. The Contractor shall provide video tape to Owner upon acceptance. Any dirt or debris in pipeline shall be removed at Contractor's expense, and pipeline re-televised to demonstrate pipe cleanliness.

B. Installed piping shall flow in the direction intended per the Drawings and shall be free from sags or changes in slopes, unless required per the Drawings. In the absence of specific requirements set forth on the Drawings, as-built slope shall be within 10 percent of design slope (i.e., +/- 0.001 ft/ft for a design slope of 0.01 ft/ft or +/- 0.1% for a design slope of 1%) and as-built invert in and out elevations shall be within 0.05 feet of design invert elevations.

END OF SECTION

SECTION 02800

PLACEMENT OF TOPSOIL AND HYDROSEEDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required to place topsoil, finish grade, apply lime and fertilizer, hydraulically apply seed, mulch, anchor and protect seeded areas, and maintain all seeded areas as specified herein. The Owner may supply topsoil.

1.02 APPLICABLE SECTIONS

A. All Sections

1.03 QUALITY ASSURANCE

A. Latest version of the following standards:
   1. "Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices," Maine Soil and Water Conservation Commission; hereinafter referred to as the BMPs.
   2. "Quality Assurance Manual (QAM) for the Crossroads Landfill".
   3. "Standard Specification for Highways and Bridges," Maine Department of Transportation; hereinafter referred to as MEDOT Std. Specs.

B. Submittals:
   1. Samples of all materials shall be submitted by the Contractor for inspection and acceptance upon request of the Soil QAC or Project Manager.
   2. Certificates of Compliance, as described in Part 2, shall be submitted by the Contractor to the Soil QAC at least two weeks prior to application of any materials or seed.
   3. Schedules for seeding and fertilizing must be submitted by the Contractor to the Project Manager for approval at least 14 days prior to the work.
   4. Prior to the start of work, the Soil QAC shall be furnished with a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the hydroseeder.
   5. The Contractor shall send samples to University of Maine Cooperative Extension for soil nutrient testing. Soil test results from University of Maine Cooperative Extension soil testing service shall include results for pH, nitrogen, potassium, phosphorous, calcium, magnesium, sulfur, organic matter for recommended amendments and recommended amendments, if necessary. Recommended amendments shall be specific for the region in which Norridgewock is located.

PART 2 - PRODUCTS

2.01 GENERAL

A. The Contractor shall supply all materials and accessories meeting or exceeding the specified properties listed in this section, unless approved otherwise by the Designer.

2.02 MATERIALS

A. Topsoil shall be fertile, natural soil capable of sustaining vigorous plant growth, typical of the locality, free from large stones, roots, sticks, clay, weeds, and sod, and obtained from naturally well drained areas. Topsoil shall be a granular loamy mixture containing only a small percentage of silt- and clay-sized particles, and having a maximum stone size of 3 inches. Topsoil shall contain a minimum of 4 percent organic material by weight determined in accordance with ASTM D2974. Amendments may be used to achieve the minimum organic content. Topsoil shall not be excessively acid or alkaline nor contain toxic material harmful to plant growth. The pH of Topsoil shall be in the range of 6 to 8 determined in accordance with ASTM D4972. Topsoil stockpiled under other Sections may be used, but the Contractor shall furnish additional topsoil as required.

B. Fertilizer shall be a complete commercial fertilizer, 10-20-20 grade for grass areas. It shall be delivered to the site in the original unopened containers, each showing the manufacturer's guaranteed analysis. Fertilizer shall be stored so that when used it shall be dry and free flowing. Fertilizer quantity and type shall be adjusted as recommended by University of Maine Cooperative Extension and approved by the Engineer.

C. Lime shall be ground limestone equivalent to fifty (50%) percent calcium plus magnesium oxide. Lime quantity shall be adjusted as recommended by University of Maine Cooperative Extension and approved by the Engineer.

D. Grass seed shall be from the same or previous year's crop; each variety of seed shall have a percentage of germination not less than eighty (80), a percentage of purity of not less than eighty-five (85) and shall have not more than one (1%) percent weed content. The seed mixture shall conform to the requirements specified in the MEDOT Std. Specs., 717.03 Method Number 2 or other seed mix approved by the Designer.
   1. Red Fescue 35% +/- 4%
   2. Sheep Fescue 35% +/- 4%
   3. Red Top 5% +/- 2%
   4. White Clover 6% +/-2%
   5. Annual Rye 19% +/-2%

E. The seed shall be furnished and delivered premixed in the specified proportions. A manufacturer's certificate of compliance to the specified mix shall be submitted by the manufacturer for each seed type. These certificates shall include the guaranteed percentages of purity, weed content, and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates to the Project Manager.

F. Cellulose fiber mulch shall be specially processed cellulose homogeneous fiber containing no growth- or germination-inhibiting factors. Processed cellulose fiber shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a slurry when sprayed on the ground. The material shall allow homogeneous absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

G. Hay or straw mulch (mulch) shall consist of cured hay or straw free from primary noxious weed seeds, twigs, debris and rough or woody materials. Mulch shall be free from rot or mold and shall be acceptable to the Project Manager and the Designer. Mulch shall be utilized on all newly-graded subgrade and topsoil areas that cannot be seeded within 10 days.

H. Soil binder (tackifier) shall be an approved synthetic, spray-on emulsion manufactured for the purpose of mixing with water and applying to hay or straw mulch as a binder.

I. Erosion control mats and (mulch anchoring) netting shall consist of twisted kraft paper, yarn, jutes, excelsior, wood fiber mats, glass fiber, plastic film, or other commercially available netting and erosion control mats. Type and use shall be in accordance with the Temporary Mulching BMP.

PART 3 - EXECUTION

3.01 APPLICATION

A. Seeding and initial fertilizing are recommended to be performed between April 1 and September 15. Seed bed preparation and hydroseeding shall be completed in accordance with the Permanent Grass and Legume Cover BMP and the Temporary Mulching BMP.

B. In the event that the construction schedule precludes planting of permanent vegetation during the recommended period, temporary seeding and stabilization procedures shall be in accordance with the Temporary Grass and Legume Cover and Temporary Mulching BMPs, and Section 02120 of these specifications. Regardless of the time of seeding, the Contractor shall be responsible for each seeded area until it is accepted as hereinafter specified.

C. Unless otherwise shown on the Drawings, topsoil shall be placed to a minimum depth of 4 inches after rolling.

D. For all areas to be seeded:

1. Lime shall be applied at the rate of one-hundred-forty (140) pounds per 1,000 square feet unless specific analysis of topsoil indicates a different application rate is appropriate, subject to approval of the Engineer. In addition, lime shall be incorporated into the upper two inches of fill after final grading and before topsoil

placement, if the pH of the fill is below 6.0. The necessity of liming and the application rate shall be based on analyses of the fill material.

2. Fertilizer (10-20-20) shall be applied at the rate of twenty (20) pounds per 1,000 square feet.
3. Seed shall be applied at the rate of 3 pounds per 1000 square feet.
4. Cellulose fiber mulch shall be applied at the rate of fifty (50) pounds per 1,000 square feet.
5. Hay or straw mulch shall be applied at a rate of eighty (80) pounds per 1,000 square feet.

E. The application of fertilizer and lime may be performed hydraulically in one operation with hydroseeding. If lime is applied in this manner, the Contractor shall be responsible for cleaning all structures and paved areas of unwanted deposits.

F. Where hay or straw mulch will be applied over newly seeded areas, cellulose fiber mulch may be applied hydraulically in one operation with the soil binder (tackifier), rather than with the seeding operation.

3.02 INSTALLATION

A. The following steps, at a minimum, shall be completed by the Contractor in all areas to receive permanent grass cover and shall be completed in the order specified: seed bed preparation and hydraulic application of seed and cellulose fiber mulch. Lime and fertilizer may be applied mechanically prior to the seeding operation or may be applied hydraulically as part of the seeding operation, as specified herein. Except in areas to receive erosion control mat, hay or straw mulch shall be applied subsequent to the hydraulic application of seed and cellulose fiber mulch. Hay and straw mulch shall be anchored using a soil binder (tackifier). In all areas that receive hay or straw mulch that are steeper than 15%, the mulch shall be further anchored using an approved netting, in addition to a tackifier. In areas requiring the installation of an erosion control mat, including the interior sideslopes of sedimentation basin perimeter berms, grass-lined swales, and slopes 2.5H:1V or steeper, an approved erosion control mat shall be installed subsequent to the hydraulic application of seed and cellulose fiber mulch, and in lieu of hay or straw mulch, tackifier, and netting.

B. The subgrade of all areas to be covered with topsoil and seeded shall be raked and all rubbish, sticks, roots and stones larger than 3 inches shall be removed. Subgrade surfaces shall be raked or otherwise loosened immediately prior to being covered with topsoil. Subgrade shall be inspected and approved by the Engineer before topsoil is placed.

C. Swales shall be excavated and shaped to an even cross-section. Grade soil adjacent to the swale evenly so that surface water may enter freely. Apply lime, fertilizer, seed, and cellulose fiber mulch to the swale as indicated in these specifications. Protect the seeded and mulched area immediately after spreading with erosion control mat in accordance with the Temporary Mulching BMP. Begin laying mats from the upstream end of the swale and unroll it downgrade. Do not stretch the mat.

D. Topsoil shall be placed over approved areas to a depth sufficiently greater than required so that after natural settlement and light rolling, the complete work will conform to the lines, grades, and elevations indicated. Topsoil shall not be spread in water or while frozen or muddy.

E. After topsoil has been spread, it shall be carefully prepared by scarifying or harrowing and raking. All large stiff clods, lumps, brush, roots, stumps, litter and other foreign material shall be removed from the area covered with topsoil and disposed of by the Contractor. The area shall also be free of smaller stones in excessive quantities, subject to the approval of the Soil QAC or Project Manager. The whole surface shall then be tracked immediately after fine grading and raking has been completed. Tracking shall be performed with bulldozers operating in the direction of surface water flow. The tracks of the bulldozers shall have grousers of sufficient height to leave visible depressions in the subgrade. The depressions shall be oriented perpendicular to the direction of surface water flow to reduce erosion potential until topsoil is placed. During the tracking, all depressions caused by settlement or tracking shall be filled with additional topsoil and the surface shall be regraded and tracked until a smooth and even finished grade is created.

F. The Contractor shall hydroseed only on calm days. Seeding shall not be performed when the ground surface is excessively wet or otherwise untillable.

G. If lime and fertilizer are to be spread mechanically rather than in one operation with the hydroseeding, then:
   1. After the topsoil is placed and before it is raked to true lines and rolled, lime shall be spread evenly over topsoil surface and thoroughly incorporated with topsoil by heavy raking to at least one-half the depth of topsoil.
   2. Fertilizer shall be uniformly spread and immediately mixed with the upper 2 inches of topsoil.

H. Seeding shall be done within ten (10) days following soil preparation. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed over an area, the grass seed, and lime, fertilizer, and cellulose fiber mulch, shall be equal in quantity to the specified rates.

I. When protection of newly graded areas is necessary at a time which is outside of the normal seeding season, as defined in Paragraph 3.01.A of this Section, the Contractor shall protect and maintain those areas by whatever means necessary, as indicated in Section 02120, in accordance with the Temporary Grass and Legume Cover BMP, or by other measures as approved by the Project Manager or Designer.

3.03 MAINTENANCE AND PROVISIONAL ACCEPTANCE

A. The Contractor shall keep all seeded areas watered and in good condition, reseeding if and when necessary, until a healthy, uniform growth is established over the entire area seeded. Watering and reseeding shall be at no additional cost to the Owner. The Contractor also repair, at no additional cost to the Owner, any area damaged as a result of reseeding work. The Contractor shall maintain these areas in an approved condition until provisional acceptance.

B. On all slopes, the Contractor shall protect against erosion in accordance with Section 02120, Maine BMPs, and by an approved method. Any erosion which occurs shall be regraded and reseeded at the Contractor's expense until a good sod is established.

C. The Soil QAC or Project Manager will inspect all work for provisional acceptance at the end of an eight (8) week grass establishment and maintenance period, upon the written request of the Contractor, received at least ten (10) days before the anticipated date of inspection.

D. A satisfactory stand will be when there are:
   1. No bare spots larger than three (3) square feet.
   2. No more than ten (10%) percent of total area with bare spots larger than one (1) square foot.
   3. No more than fifteen (15%) percent of total area with bare spots larger than 6 inches square.

E. The Contractor shall furnish full and complete written instructions for maintenance of the seeded areas to the Project Manager at the time of provisional acceptance.

F. The inspection by the Soil QAC or Project Manager will determine whether maintenance shall continue in any area or manner.

G. After all necessary corrective work and cleanup has been completed, and maintenance instructions have been received, the Project Manager will certify in writing the provisional acceptance of the seeded areas. The Contractor's responsibility for maintenance of seeded areas, or parts of seeded areas shall cease on receipt of provisional acceptance.

3.04 GUARANTEE PERIOD AND FINAL ACCEPTANCE

A. All seeded areas shall be guaranteed by the Contractor for not less than one (1) full year from the time of provisional acceptance.

B. At the end of the guarantee period, inspection will be made by the Soil QAC or Project Manager upon written request submitted by the Contractor at least ten (10) days before the anticipated date. Seeded areas not demonstrating satisfactory stands as outlined above, as determined during the inspection, shall be renovated, reseeded, and maintained meeting all requirements as specified herein, at no additional cost to the Owner.

C. After all necessary corrective work has been completed, the Project Manager will certify in writing the final acceptance of the seeded areas.

END OF SECTION

SECTION 02950

CLEANUP AND SITE RESTORATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals necessary to complete the work under this Section including operations which cannot be specified in detail as separate items, but can be sufficiently described as to the kind and extent of work involved.

1.02 APPLICABLE SECTIONS

A. All Sections

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 CLEANUP

A. During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as is possible. The Contractor shall dispose of all residue continuously throughout the construction and at the conclusion of the work. The Contractor shall dispose of any surplus excavated material in a location approved by the Project Manager, and in accordance with Sections 02130, 02140, and 02200. Lumber, equipment, temporary structures, and other refuse remaining from the construction operations shall be removed from the site. The Contractor shall leave the entire site of the work in a neat and orderly condition. The site shall include, but not necessarily be limited to, the project area, haul roads, stockpile areas, laydown areas, and borrow areas.

B. It shall be the Contractor's responsibility to dispose of all excess residue resulting from construction operations. Excess trenching materials consisting of soil, rock, or boulders shall be disposed of by the Contractor in on-site areas designated by the Project Manager, and in accordance with Sections 02130, 02140, and 02200.

3.02 INCIDENTAL WORK

A. The Contractor shall do all incidental work not otherwise specified, but obviously necessary for the proper completion of the Contract in accordance with the Drawings and Specifications.

END OF SECTION