94-01

CONSTRUCTION QUALITY ASSURANCE PLAN
PHASE I CONSTRUCTION - LANDFILL #3

WEYERHAEUSER COMPANY
PLYMOUTH, NORTH CAROLINA

Revision 1
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RMT Project No. 467.49

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Section 1
INTRODUCTION

1.1 Project Background

This report presents the Construction Quality Assurance (CQA) Plan for specific components of the composite liner and final cover for the Weyerhaeuser Company - Plymouth Landfill. The liner and cover area cover approximately 62 acres and will be developed on Weyerhaeuser property located in Plymouth, North Carolina.

This plan addresses CQA requirements for modified liner and cover components of the landfill. Design-related aspects of the components mentioned above are addressed in the Construction Plan Application. This CQA Plan is a "working" document, which will be updated as necessary to reflect changes in specific materials used, in installation practices, or in tests and test methods.

1.2 Purpose and Scope

The purpose of this CQA Plan is to provide procedures that will confirm that the landfill liner and cover are constructed and documented consistent with the Construction Plan Application approved by NC DEHNR, and the Construction Drawings and Specifications.

The scope of this report includes general CQA requirements concerning roles, responsibilities, and qualifications of parties involved; the preconstruction meeting; and general inspection and documentation procedures. Specific CQA requirements for each liner component address construction procedures and observation, field and laboratory testing frequency and methods, and acceptance criteria. Geomembrane testing and acceptance criteria are based on the National Sanitation Foundation Standard Number 54 (NSF 54) Flexible Membrane Liners, and the Geosynthetics Research Institute (GRI).

The general CQA requirements (Sections 2, 3, and 4) pertain to all liner components. The following report sections pertain to the landfill components as shown:

Report Section	Landfill Component
Section 5 - Compacted Select Clay Fill	• Clay soil liner
Section 6 - Granular Soils	• Leachate drainage blanket • Pipe bedding material
Section 7 - Geotextiles	• Leachate collection bedding cushion • Component of Geocomposites
Section 8 - Geomembranes	• Geomembrane liner (landfill base and cap) • Geomembrane liner (leachate storage tank)
Section 9 - Geonets	• Component of Geocomposite
Section 10 - Geosynthetic Clay Liner	• GCL liner (landfill base)
Section 11 - Geocomposite	• Leachate storage tank
Section 12 - Select Ash Fill	• Protection layer (landfill base) • Levelling course (final cover)
Section 13 - Piping	• Leachate collection and transfer piping • Gas Collection piping

END OF SECTION

Section 2
CQA ROLES, RESPONSIBILITIES, AND QUALIFICATIONS

2.1 CQA Officer

The CQA Officer shall supervise and be responsible for all inspections, testing, and related construction documentation as described in this CQA Plan. The CQA Officer will be responsible for preparation of the construction documentation report to certify substantial compliance with the engineering design. The CQA Officer shall be a North Carolina Registered Professional Engineer.

The CQA Officer may delegate daily inspection, testing, and sampling duties to a qualified technician with experience in the assigned aspect of construction who will serve as the Resident Project Representative (RPR). Although these duties may be delegated, the CQA Officer will retain the responsibility for these activities.

When an RPR is designated, the CQA Officer shall visit the construction site biweekly (every 2 weeks) at a minimum during active periods of construction to personally observe the construction and documentation procedures. Also, at a minimum, the CQA Officer shall personally observe, on at least one occasion, each of the major elements of construction including the clay soil liner, geomembrane liner, and the leachate drainage layer. The CQA Officer shall be readily available for consultation, as needed.

2.2 Resident Project Representative (RPR)

The RPR will carry out daily inspection, testing, and sampling duties under the direct supervision of the CQA Officer. The RPR shall be a qualified technician with experience in the assigned aspect of construction. The RPR will observe and document construction and installation procedures. The RPR will prepare daily summary and inspection reports and transmit these routinely to the CQA Officer. The RPR will immediately notify the CQA Officer of problems or deviations from the CQA Plan or design plans and specifications. Reporting, documentation, and resolution of problems and deficiencies shall be carried out as described in Section 4.3. The RPR will not have authority to approve design or specification changes without the consent of the CQA Officer.

2.3 Soils Testing Laboratory

The Soils Testing Laboratory retained will be experienced in landfill construction soils testing in accordance with the American Society of Testing and Materials (ASTM) Standards and other applicable standards. The selected laboratory will be required to be responsive to the project needs by providing test results within reasonable time frames. This shall include providing verbal communication on the status of ongoing tests and immediate communication of test results as needed to facilitate ongoing construction. Such information may include hydraulic conductivity test data, proctor values, and borrow source characterization data. Final laboratory reports will be certified by the soils testing laboratory and submitted to the CQA Officer.

2.4 Geosynthetics Testing Laboratory

The Geosynthetics Testing Laboratory will have experience in testing geosynthetics in accordance with standards developed by ASTM, National Sanitation Foundation (NSF), Geosynthetic Research Institute (GRI), and other applicable test standards. The selected laboratory will be required to be responsive to the project needs by providing test results within reasonable time frames. Final laboratory reports will be certified by the geosynthetics testing laboratory and submitted to the CQA Officer.

2.5 Construction Contractor

The Construction Contractor's role will be performed by a construction firm retained by the Owner to furnish earthwork and piping construction. The Construction Contractor will be experienced in solid waste landfill construction, knowledgeable about clay liner construction techniques, and familiar with geosynthetic construction.

2.6 Geosynthetic Installers

The Geosynthetic Installers are the companies hired by the Contractor to install the geosynthetic components referenced in this manual and to perform the nondestructive seam testing of the geomembranes required by this plan. The term "Installer" is used throughout this plan when reference is made to the tasks and responsibilities of a Geosynthetic Installer.

The Installer will be trained and qualified to install the various geosynthetic components covered by this plan. The Installer of the geomembranes will be approved and/or licensed by the Manufacturer. A copy of the approval letter or license will be submitted by the Installer to the CQA Officer.

Prior to confirmation of any contractual agreements, the Contractor shall obtain from the Installer of the geomembrane the following written information, which must be approved by the CQA Officer:

1. Corporate background and information
2. Installation capabilities
   a. Information on equipment and personnel
   b. Daily anticipated production
   c. Quality control manual for installation
   d. Samples of field seams and certified test results
3. A list of at least 10 completed facilities, totalling a minimum of 2,000,000 ft^2 for which the Installer has completed the installation of a polyethylene geomembrane.

For each installation, the following information will be provided:

1. Name and purpose of facility, its location, and date of installation
2. Name of owner, project manager, designer, manufacturer, and fabricator (if any)
3. Name and qualifications of the supervisor(s) of the Installer's crew(s)
4. Thickness of the geomembrane and the surface area of the installed geomembrane
5. Type of seaming and type of seaming apparatus used

All personnel performing geomembrane seaming operations will be qualified by experience or by successfully passing seaming tests for the seaming methods to be used. At least one seamer will have experience seaming a minimum of 1,000,000 ft^2 of polyethylene geomembrane using the same type of seaming apparatus in use at the site. The most experienced seamer, the "master seamer," will provide direct supervision, as required, over less experienced seamers. No field seaming will take place without an experienced seamer (meeting the seaming criteria stated above) being present.

The Contractor shall require the Installer to provide a list of proposed seaming personnel and their professional records. This document will be reviewed by the CQA Officer. Any proposed seaming personnel deemed insufficiently experienced will not be accepted by the CQA Officer or will be asked to

pass a seaming test. Any changes in the list of seaming personnel shall be brought to the attention of the CQA Officer.

The Installer will designate one representative as the Superintendent, who will represent the Installer at all site meetings and be responsible for acting as the Installer's spokesperson on site. This superintendent should be pre-qualified for this role, on the basis of experience, management ability, and authority. The appointment must be approved by the CQA Officer.

END OF SECTION

Section 3
PRECONSTRUCTION

3.1 Preconstruction Submittal

Prior to construction of each landfill area (*i.e.*, Phases I through VI cover, Phase II through VI liner), a preconstruction submittal shall be prepared and submitted to the NC DEHNR. The preconstruction submittal will include, at a minimum, the following information:

1. Identification of the fabricator and contractors selected for geomembrane source and installation

2. Final version of the CQA Plan, incorporating input from the selected contractors and project experience, and documenting qualifications of the third party construction quality assurance organization and testing laboratory

3. Any modifications to the installation plan, with final versions of the panel layout and any revisions to details of seaming, patching, penetrations, use of prefabricated specialty sections, or repair methods

3.2 Preconstruction Meeting

Prior to construction commencing at the landfill facility, a preconstruction meeting shall be held. This meeting will include the parties involved in the construction, including the CQA Officer, RPR, Construction and/or Installation Contractor, and Owner.

The objectives of this meeting include construction planning and coordination of tasks; identification of potential problems that might cause difficulties and delays in construction; and proper interpretation of design intent by contractor(s). It is important that the rules regarding testing, repair, *etc.*, be known and accepted by each party to this plan.

Specific topics considered for this meeting include the following:

- Review critical design details of the project, including the plans and specifications.
- Review measures for surface water runoff and runon diversion control including sump locations, siltation control, and pumping requirements.
- Make appropriate modifications to the Construction Quality Assurance Plan; develop project-specific addendums (if necessary).

- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting and for distributing documents and reports.
- Review requirements of the Soils Testing Laboratory and the Geosynthetics Testing Laboratory regarding sample sizes, methods of collection, and shipment. Also review turntimes for sample data and implications on construction schedule pending receipt of acceptance data.
- Review the number and locations of the testing requirements for soils and geosynthetic components.
- Review precautions to be taken to maximize bonding between lifts of compacted clay/bentonite-amended soil.
- Review the method for splicing segments of compacted clay/bentonite-amended soil liner.
- Review precautions to be taken to minimize desiccation of clay/bentonite-amended soil surfaces.
- Review methods of clay/bentonite-amended soil layer surface preparation and approval prior to geomembrane placement.
- Establish rules for writing on the geomembrane (*i.e.*, who is authorized to write, what can be written, and in which color); outline procedures for packaging and storing archive samples.
- Review the time schedule for all operations.
- Establish procedures for deployment of materials over completed geomembranes emphasizing protection of the membrane. Specific discussion shall address deployment of select granular fill on sidewalls.
- Observe where the site survey benchmarks are located, and review methods for maintaining vertical and horizontal control.
- Review permit documentation requirements.
- Review the survey documentation tables and plans that identify the locations where survey documentation information is required.
- Conduct a site walk-around to review material storage locations and general conditions relative to construction.

- Review geomembrane panel and seam layout drawings and numbering systems.
- Establish procedures for use of the geomembrane welding apparatus, if applicable.
- Establish appropriate intervals for seamers to record operating and ambient data.
- Finalize field cutout sample sizes.
- Review liner penetration procedures.
- Review repair procedures.

The meeting will be documented by the CQA Officer, and minutes will be distributed to all parties involved in the construction project.

END OF SECTION

Section 4

GENERAL CONSTRUCTION INSPECTION AND DOCUMENTATION

This section describes general documentation procedures to be implemented including use of forms, identification and resolution of problems or deficiencies, and photographic documentation.

4.1 Daily Reports

A daily summary report shall be prepared by the CQA Officer or the RPR under direct supervision of the CQA Officer, for each day of activity containing the following information:

1. Date, project name, location, and report preparer's name. Names of RPR on-site performing CQA under the supervision of the CQA Officer.

2. Time work starts and ends each construction work day. Also, the duration and reason for work stoppages (*i.e.*, weather delay, equipment shortage, labor shortage, unanticipated conditions encountered, *etc.*).

3. Data on weather conditions including temperature, humidity, wind speed and direction, cloud cover, and precipitation.

4. Construction Contractor's work force, equipment in use, and materials delivered to or removed from job site.

5. Chronological description of work in progress including locations and type of work performed.

6. Summary of meetings held and attendees.

7. A description of materials used, and references or results of testing and documentation.

8. Discussion of problems/deficiencies identified and corrective actions taken as described in Section 4.3 (Problem/Deficiency Identification and Corrective Action).

9. Identification/list of laboratory samples collected, marked, and delivered to laboratories, or clear reference to the document containing such information if samples were obtained.

10. An accurate record of calibrations, recalibrations, or standardizations performed on field testing equipment, including actions taken as a result of recalibrations. In addition, the results of other data recording such as geomembrane seam barrel temperature, or a clear reference to the document containing such information, if applicable.

11. Copies of each RPR's daily field data sheets.

Field data sheets shall be prepared for each work day by each RPR containing the following information:

12. Test or sample location and elevation.
13. Type of inspection.
14. The procedures used.
15. Test data (*i.e.*, proctor value, *etc.*).
16. Results.
17. Personnel involved in the inspection and sampling activities.
18. Signature of the RPR.

4.2 Forms, Checklists, and Data Sheets

Additional forms may be developed during the course of the project to provide specific needs such as geomembrane inspections or simply to improve efficiency of data collection. New forms shall be approved by the CQA Officer prior to their use.

4.3 Problem/Deficiency Identification and Corrective Action

Problem or deficiency identification and corrective action will be documented in the Daily Summary Report when a construction material or activity is observed or tested that does not meet the requirements set forth in this plan and in the construction specifications. The Summary Report should clearly reference other reports, photographs, or forms that contain data or observations leading to the determination of a problem or deficiency. Problem/deficiency identification and corrective action documentation may include the following information:

1. A description of the problem or deficiency, including reference to supplemental data or observations responsible for determining the problem or deficiency.
2. Location of the problem or deficiency, including how and when the problem or deficiency was discovered. In addition, an estimate of how long the problem or deficiency has existed.
3. An opinion as to the probable cause of the problem or deficiency.
4. A recommended corrective action for resolving the problem or deficiency. If the corrective action has already been implemented, then the observations and

documentation to show that the problem or deficiency has been resolved. If the problem or deficiency has not been resolved by the end of the day upon which it was discovered, then the report will clearly state that it is an unresolved problem or deficiency. Subsequent Daily Reports shall indicate the status of problems or deficiencies until resolved.

If the problem or deficiency has not been resolved, the CQA Officer and the preparer will discuss the necessary corrective actions. The CQA Officer will work with the Owner and Construction Contractor to implement actions as necessary to resolve the problem or deficiency. A description of such problems or deficiencies and corrective actions implemented shall be provided in the Construction Documentation Report.

The CQA Officer, working with the Owner and Construction Contractor, will determine if the problem or deficiency is an indication of a situation that might require changes to the plans and specifications and/or the CQA Plan. Revisions to the plans or specifications or the CQA Plan must be approved by the CQA Officer and the site Owner after consultation with the NC DEHNR. Documentation of the Department's concurrence and/or conditions regarding proposed changes shall be incorporated into the Construction Documentation Report.

4.4 Photographic Documentation

Photographs will be taken to document observations, problems, deficiencies, corrective actions, and work in progress. Photographs will be in 35-mm print format and will be filed in chronological order in a permanent protective file by the CQA Officer, or the RPR.

The following information should be documented in the daily report or a log book for each photograph:

1. Date and time.
2. Location where photograph was taken, including information regarding the orientation of the photograph itself for proper viewing (*i.e.*, looking south).
3. Description of the subject matter.
4. Unique identifying number for reference in other reports.
5. Name and signature of photographer.

4.5 Surveying

Surveying documentation requirements for each liner component are described in their respective plan sections. Required surveying will be performed by personnel experienced in construction surveying under the supervision of the CQA Officer. Surveys will be based on survey control monuments shown on Drawing Number 46751-C05 of the Phase I Construction Drawings - Landfill #3 or Drawing Number 46749-C05 of the Phase I Construction Plan Application. Elevations will be based on mean sea level (MSL) datum, and coordinates will be based on the North Carolina State Plane Coordinate System. The location of field tests and samples will be recorded. Generally, these locations can be determined by reference to nearby construction stakes or markings; however, if such convenient reference is not readily available, the CQA Officer or the designated RPR is responsible to provide or request survey control.

END OF SECTION

Section 5

COMPACTED SELECT CLAY FILL

Select clay fill refers to the compacted clay component of the composite liner. The select clay fill shall be either bentonite-amended soil or a natural clay that can be compacted to a permeability of 1.0×10^{-7} cm/s or less. The composite liner design consists of a one-foot-thick compacted clay layer overlain with a geosynthetic clay liner (GCL) with an 80-mil HDPE geomembrane. On-site silty sands are proposed for the bentonite-amended soil component of the landfill liner. If bentonite-amended soil is not used, a natural clay borrow source shall be located and used in the liner.

5.1 Procedures and Observation

The RPR will observe compacted clay liner and clay cover construction activities and document relevant observations to support certification of the following requirements:

1. The RPR will confirm the uniformity of the bentonite-amended soil/clay borrow soils. Soil excavation, proportioning, mixing, and placement will be monitored for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content.

2. The construction contractor will segregate and/or remove unsuitable materials such as soils not meeting acceptance criteria (boulders, cobbles, and organic material).

3. The RPR will measure field densities and moisture contents, using methods described in Subsection 5.2 (Sampling Requirements and Acceptance Criteria), to document that the compacted liner is in substantial conformance with the placement specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous clay mass.

4. Voids created by nuclear density gage testing or retrieval of Shelby tube samples will be backfilled with sodium bentonite.

5. The bentonite-amended soil/clay shall be placed in loose lift thicknesses not exceeding 8 inches and compacted with multiple passes of a sheepsfoot roller. If the soil is deposited in thickness exceeding 8 inches, dozers will be used to spread the soil to a 8-inch thickness prior to compaction. This will assure adequate reduction of clod size and provide a thin layer to achieve required compaction throughout the lift.

6. Areas of unacceptable hydraulic conductivity, compaction density, or moisture content, as defined by Subsection 5.2 (Sampling Requirements and Acceptance Criteria), will be documented by the RPR. Corrective action will consist of moisture-conditioning of the soil or additional compactive effort as necessary. Methods for moisture-conditioning

soils are described in Item 7 below. Following corrective actions, such areas will be retested.

7. If necessary, surfaces of liner to receive successive lifts of bentonite-amended soil/clay will be moisture-conditioned either by scarification and addition of water where desiccated, or by discing and air drying where saturated to promote effective bonding of lifts. Following scarification, water will be applied with a spray bar applicator or equivalent methods to achieve uniform distribution.

8. Bentonite-amended soil/clay compaction will be performed in a manner to achieve continuous and complete keying together of soil liner construction areas. Stepped joints will be utilized to connect lateral segments of the soil liner construction.

9. No frozen soils will be used for clay liner construction. Frozen soils in the compaction work area will be removed.

10. Stones two inches or larger shall be removed from the surface of the final lift of the clay liner to avoid potential for puncturing the geosynthetic clay liner. The method to detect and remove stones requires an initial overfill of compacted clay liner soils approximately one inch above designed liner grades. A grader will then blade the liner surface to obtain uniform liner grades and design elevations. Stones present will be exposed and loosened by the grading. The RPR shall inspect the liner during this process and document removal of stones by the Contractor. Voids made by removal of stones shall be filled with clay soil, and then the entire liner surface shall be rolled with a smooth drum compactor.

11. Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time any completed clay liner surfaces are exposed prior to receiving protective cover. Protective cover will be provided by installation of the geosynthetic clay liner and the geomembrane.

12. Preconstruction planning will be undertaken to minimize the need for traffic over the completed bentonite-amended soil/clay surface. Heavy trucking of materials (ingress or egress) and cleated equipment will not be allowed directly on completed liner surfaces. If this is unavoidable, an evaluation will be made upon termination of the haul route to determine if the liner should be reconstructed or repaired in such areas. Flotation-type all-terrain vehicles will be used to assist in deployment of the geosynthetic clay liner to avoid disruption of the completed earth liner surface.

5.2 Sampling Requirements and Acceptance Criteria

Field and laboratory sampling frequencies are based on proportionate sampling of construction areas or volume of material placed as specified below. This section describes required analysis, methods, sample frequency, and acceptance limits. Table 5-1 summarizes the minimum quality assurance testing recommended in Sections 5.2.1 and 5.2.2. The RPR will perform field tests and collect soil samples for laboratory analysis.

TABLE 5-1

SUMMARY OF QUALITY ASSURANCE TESTING FOR THE SELECT CLAY/BENTONITE-AMENDED SOIL LINER

TEST	FREQUENCY	COMMENT
Atterberg Limits Test [ASTM D4318]	One every 4,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil
Grain-size analyses (sieve and hydrometer) [ASTM D422]	One every 4,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil
Moisture Content [ASTM D2216]	One every 4,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil
Density/Moisture (Standard Proctor) [ASTM D698]	One every 4,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil
Permability Testing (Falling Head) [ASTM D5084 or SW846-EPA Method 9100]	Four tests on one sample obtained every 8,000 cubic yards and material changes	Source Material: Clay/ Bentonite-amended soil (on remolded source material)
Proofroll	All surfaces prior to liner placement	Subgrades for liner construction
Density/Moisture Content [ASTM S 2922 & ASTM D 3017] or [ASTM S 1556] or [ASTM D2937]	One per 10,000 square feet per lift (approximate 100-foot grid pattern)	Liner: Clay/bentonite-amended soil
Permability Testing (Falling Head) [ASTM D 5084 or SW 846-EPA Method 9110]	One per acre (43,560 square feet) per lift	Source Material: Clay/ Bentonite-amended soil (on tube samples obtained from the *in-situ* liner
Atterberg Limits Test [ASTM D 4318]	One per acre (43,560 square feet) per lift	Source Material: Clay/ Bentonite-amended soil (on tube samples obtained from the *in-situ* liner
Grain-size analyses (P200) [ASTM D 422]	One per acre (43,560 square feet) per lift	Source Material: Clay/ Bentonite-amended soil (on tube samples obtained from the *in-situ* liner
Density/Moisture [ASTM D 2216]	One per acre (43,560 square feet) per lift	Source Material: Clay/ Bentonite-amended soil (on tube samples obtained from the in-situ liner

5.2.1 Field Testing and Sampling

The following field testing and sampling methods and frequencies will be used by the RPR during construction of the bentonite-amended soil/clay liner and final cover.

- One field density and as-placed moisture content test (ASTM D3017 and ASTM D2922 Method B) will be performed for each compacted lift on an approximate 100-foot grid pattern.
- Representative (grab) soil samples of the liner and cover soils will be collected from the initial clay borrow source or from the on-site amended source and submitted to the Soils Testing Laboratory for testing described in Section 5.2.2. Additional samples will be collected every 4,000 cubic yards for each major soil type utilized. A sample will also be collected when changes in the physical appearance or soil characteristics are observed.
- A minimum of one undisturbed Shelby tube sample will be obtained for each acre (43,560 ft^2) or less for every lift of bentonite-amended soil/clay placed. Samples will be submitted to the Soils Testing Laboratory for testing described in Section 5.2.2.

At a minimum, at least one field density/moisture content test will be conducted per lift and at least one test per day of compacted bentonite-amended soil/clay construction. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each lift of soil liner placed.

A nuclear density-moisture gauge (NDG) will be used for field moisture and density determination. The calibration of NDGs used for documentation shall be initially checked and adjusted (if necessary) according to the manufacturer's guidelines. Initial calibration shall be made with a minimum of four drive-cylinder samples (ASTM D2937) analyzed for laboratory density and moisture content.

Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density. Specific moisture content requirements (a minimum of optimum or above) will be identified in the construction plans and specifications. The acceptable range will be based on Proctor moisture-density relationships and compaction versus permeability relationships.

5.2.2 Laboratory Testing

Routine laboratory testing of the compacted liner soils will be performed on samples from the clay borrow area or samples from the pugmill/disking operation and on the in-place soils collected by the RPR. Samples for determining in-place properties will be collected by pushing Shelby tubes. Soil characteristics will be determined from representative samples and from Shelby tube samples.

Undisturbed Sample Analysis

The following analysis will be performed on all undisturbed samples obtained:

Parameter	Test Method
Hydraulic Conductivity	ASTM D5084 or SW 846-EPA Method 9100
Moisture Content and Dry Density	ASTM D2216
Atterberg limits	ASTM D4318
Grain-Size Analysis (P200)	ASTM D422[a]

NOTES: [a] Percentage of soil finer than the No. 200 sieve (*i.e.*, soil finer than 0.075 mm).

Representative Sample Analysis

The following laboratory analyses will be performed on all representative samples obtained, except where noted:

Parameter	Test Method
Moisture-Density Relationship using Standard Proctor Compaction	ASTM D698[a,b]
Atterberg limits	ASTM D4318
Grain-Size Analysis (sieve and hydrometer)	ASTM D422[c]
Moisture Content	ASTM D 2216
Hydraulic Conductivity[d] on Remolded Samples	ASTM D 5084 or SW846-EPA Method 9100

NOTES:

[a] A five-point Proctor analysis is required for first and second sampling criteria.

[b] A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criteria (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, a five-point analysis will be performed in accordance with the first sampling criteria.

[c] Distribution shall be reported through the 0.002-mm particle size.

[d] For every 8,000 cubic yards of soil extracted from the borrow source, perform one set of hydraulic conductivity tests. A set typically consists of four hydraulic conductivity tests run on a sample of soil remolded to four different moistures and dry densities.

Laboratory Testing Acceptance Criteria

1. A saturated hydraulic conductivity of 1 x 10^{-7} cm/s or less

Typical Index Properties Recommended for Achieving Hydraulic Conductivities of 1x10^{-7} cm/s or Less

1. A liquid limit of 30% or greater
2. A plasticity index of 15% or greater
3. A percentage of fines (*i.e.*, material finer than the No. 200 sieve or 0.075 mm) 60 percent or greater.
4. A percentage of clay (*i.e.*, material finer than 0.002 mm) 20 percent or greater.

5.3 Thickness Documentation

Other locations include breaks in grade, toe of slope, mid-point, and top of sideslopes. The top of clay liner and cover grades will be surveyed on the same 50-foot grid pattern, as other locations surveyed for subbase grades. In the alignment for leachate collection lines or cover drainage pipes, bottom of trench elevations will be surveyed at 25-foot intervals in the same locations surveyed for trench undercuts. The clay liner thickness will be determined at surveyed locations and reported in table fashion. The minimum acceptable bentonite-amended soil/select clay liner thickness will be one-foot vertical to the bottom or to the slope. The location and elevation of samples requiring surveying will be recorded.

END OF SECTION

Section 6

GRANULAR MATERIAL

Granular materials include granular fill, aggregate fill, and other granular material shown or specified for pipe bedding and backfill material. The granular fill overlies the geomembrane liner between the leachate trench pipe bedding material and the protection layer of select waste (ash). The pipe bedding material refers to aggregate fill to be used for structural support of leachate collection pipes. Limestone and dolomite stone shall not be used in the leachate collection system unless no other suitable material is reasonably available. The aggregate fill should be rounded to subangular.

Refer to Detail R on Drawing Number 46751-C19 of the Phase I Construction Drawings or Detail H on Drawing Number 46749-C17 of the Construction Plan Application for specific details regarding the leachate drainage blanket and leachate collection pipe trench.

6.1 Procedures and Observation

The RPR will observe granular material placement activities and document relevant observations to support certification of the following requirements:

1. The RPR shall periodically observe aggregate fill material used for pipe bedding material, and granular fill for general conformance to material specifications and may randomly sample loads. The RPR will perform routine conformance sampling as defined in Subsection 6.2.

2. No trucks or heavy equipment shall travel directly on the geomembrane. Only low-contact-pressure equipment may operate over the geomembrane when there is a minimum 12-inch-thick layer of granular fill in-place. Procedures for deployment of pipe, aggregate fill, and/or geotextiles overlying geomembranes will be planned at the Pre-Construction Meeting. Special requirements for geomembrane protection and equipment necessary to deploy materials must be approved by the CQA Officer.

3. Care shall be exercised during placement of pipe bedding material to prevent undue damage to pipes, geomembrane, and geotextiles. Stone shall not be dropped from a height greater than 3 feet above the bottom of the pipe trench.

4. A geotextile cushion shall be placed between the geomembrane and the pipe bedding material placed in leachate collection trenches.

5. A minimum of 3 inches of bedding material shall be placed under leachate collection pipes prior to pipe placement, and a minimum of 6 inches of bedding material shall be placed over the top of leachate collection pipes.

6. A minimum 18-inch-thick granular fill shall be placed between the top of the leachate collection trenches or the composite liner and the layer of select waste (ash).

7. If granular fill is stockpiled on-site prior to use, measures should be taken to minimize contamination by fines such as wind-blown particles and surface soils during loading operations.

6.2 Sampling Requirements and Acceptance Criteria

Field sampling and laboratory testing frequencies are based on proportionate sampling of construction areas or volume of material placed as specified below. This section describes the required analysis, methods, sampling frequency, and acceptance limits. The RPR will collect granular material samples for laboratory analysis.

6.2.1 Field Testing

No field testing will be required for pipe bedding material or granular fill. However, as stated in Section 6.1 above, the RPR will perform visual inspection of these material for conformance to material specifications and may randomly sample deliveries.

6.2.2 Laboratory Testing

Representative (grab) samples will be obtained from the proposed bedding material, and graded granular fill sources prior to delivery of the material. The source sampling frequency will be dependent on the apparent uniformity of the source and must be approved by the CQA Officer.

Grab samples of pipe bedding material, and graded fill soils placed will be collected and analyzed as follows:

Soil Type	Frequency	Parameter	Test Method
Granular Fill	1/1,000 CY[a,b]	Grain-size	ASTM D422[c]
Granular Fill	1/2,500 CY[b,d]	Remolded hydraulic conductivity	ASTM D2434
Pipe Bedding Material	1/1,000 L.F. of Trench[e]	Grain-size	ASTM D422[c]
Pipe Bedding Material	1/2,000 L.F. of Trench	Remolded hydraulic conductivity	ASTM D2434

NOTES:
[a] For lesser volumes, a minimum of four samples shall be tested.
[b] This frequency may be reduced for uniform sources. Proposed reductions will be submitted for NC DEHNR approval prior to implementation.
[c] Testing shall be required only to the #200 sieve.
[d] For lesser volumes, a minimum of two samples shall be tested.
[e] For documentation areas with less than 3,000 feet of pipe trench, a minimum of three samples shall be tested.

Laboratory Testing Acceptance Criteria

Pipe bedding material shall have a uniformity coefficient less than 4, contain no more than 5 percent by weight passing the #4 sieve, have a maximum particle diameter of 3/4 inch, have a remolded hydraulic conductivity of 1 cm/s or greater, and have a rounded to subangular particle shape. Granular fill materials shall meet the grain-size distribution criteria specified in the construction plans and specifications.

6.3 Thickness Documentation

Aggregate fill placed along collection pipe alignments will be surveyed for elevation prior to pipe placement and following pipe backfilling at 50-foot intervals to document the thickness of aggregate fill placed below pipe inverts and above the top of pipe. The minimum acceptable stone thickness will be 3 inches below and 6 inches above the leachate collection piping.

END OF SECTION

Section 7
GEOTEXTILES

This section of the CQA Plan applies to non-woven geotextiles used as a component of geocomposites and in the leachate collection system. The geotextiles used in the geocomposites will meet the applicable requirements of this section. Geocomposites are discussed in Section 11. A cushion will be placed over the geomembrane in the leachate collection system.

This section is divided into three major subheadings, which cover the quality assurance requirements for Pre-Installation (includes geotextile manufacturers), Installation, and Post-Installation (includes the final examination of the geotextiles prior to placing the appropriate material above the geotextile). The terms Pre-Installation, Installation, and Post-Installation are applicable only to the geotextile installation and do not apply to the overall construction of the landfill facility.

7.1 Pre-Installation

7.1.1 Manufacturing

Material Specifications

The geotextile will be supplied to the site in factory rolls.

Quality Control Requirements

Prior to the delivery of any geotextile rolls to the site, the Geotextile Manufacturer will provide to the CQA Officer the manufacturer's Quality Control Plan used for production of the geotextile rolls.

Every roll of geotextile for delivery to the site must be manufactured and inspected by the Geotextile Manufacturer, according to the following requirements:

1. The geotextile must contain no needles used for punching.
2. The geotextile must be free of holes and any other sign of contamination by foreign matter.

Manufacturer's Certification

The Geotextile Manufacturer will provide certification, based on tests performed in accordance with the methods listed in Table 7-1 that the geotextile supplied under this plan will meet the material specifications listed in Tables 7-2. These tests may be performed by the Geotextile Manufacturer's Laboratory or a laboratory contracted by the manufacturer. Additionally, the

TABLE 7-1

GEOTEXTILE TESTS AND TEST METHODS

PROPERTY	TEST METHODS
Apparent Opening Size	ASTM D4751
Grab Tensile Properties Tensile Strength Break Elongation	ASTM D4632
Mass Per Unit Area	ASTM D3776
Permitivity	ASTM D4491
Puncture Resistance	ASTM D4833
Trapezoidal Tear	ASTM D4533
Mullen Burst	ASTM D3786

TABLE 7-2

GEOTEXTILE ACCEPTANCE SPECIFICATIONS

TEST	TYPE A BOTTOM LINER AND LEACHATE PIPING TRENCH	TYPE B FINAL COVER SYSTEM AND UNDER RIPRAP	TYPE C USED UNDER ROADWAYS	CRITERION
Apparent Opening Size (US Sieve Number)	100	70	100	Max
Grab Tensile Properties[a] Tensile Strength (lbs)	200	150	200	Min
Grab Tensile Properties[a] Break Elongation (%)	50	50	50	Min
Permitivity (gal/min/ft^2)	80	90	80	Min
Puncture Resistance (lbs)	130	120	130	Min
Mullen Burst (psi)	450	410	400	Min
Trapezoidal Tear (lb)	80	65	80	Min

Note:

[a] These tests will be performed and results will be reported in both the machine and cross directions.

manufacturer shall provide certification that the manufacturer's Quality Control Plan was fully implemented for the geotextile materials supplied under this Plan. The manufacturer shall provide documentation to verify the results of the manufacturer's QC Plan implementation if required by the CQA Officer.

7.1.2 Delivery, Handling, and Storage of Geotextile Rolls

(Note: ASTM Standard D4873 titled Standard Guide for Identification, Storage and Handling of Geotextiles was used in preparing these guidelines.)

Each geotextile roll, for use at the landfill facility, will be marked by the Geotextile Manufacturer with the following information and in the following manner:

1. When fabric is rolled on a core, identify each roll with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.

2. Each roll label will contain the following information at a minimum:

    a. Name of manufacturer (or supplier)
    b. Style and type number
    c. Unit weight (ounces per square yard)
    d. Roll length and width
    e. Batch (or lot) number
    f. Nominal product thickness
    g. Date of manufacture
    h. Direction for unrolling
    i. Roll number

3. On the outside of the wrapping, all lettering should be a minimum 1/2 inch high, and on the inside of the core, the lettering should be at least 1/4 inch high.

The Geotextile Manufacturer will use the following guidelines in packaging, wrapping, and preparing all geotextile rolls for shipment:

1. When cores are required, use those that have a crushing strength sufficient to avoid collapse or other damage while in use.

2. Cover each roll with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

The following practices should be used as a minimum in receiving and storing geotextile rolls in the designated storage area at the job-site:

1. While unloading or transferring the geotextile rolls from one location to another, prevent damage to the wrapping or to the geotextile itself. If practicable, the installer may use fork lift trucks fitted with poles that can be inserted into the cores of rolls. Be sure that the poles are at least two-thirds the length of the rolls to avoid breaking the cores and possibly damaging the geotextile. Do not drag rolls.

2. Store the geotextile rolls to ensure that they are adequately protected from the following:

    a. Precipitation
    b. Ultraviolet radiation, including sunlight
    c. Strong oxidizing chemicals, acids, or bases
    d. Flames, including welding sparks
    e. Temperatures in excess of 160°F
    f. Soiling

The RPR will observe and document, throughout the pre-installation, installation, and post-installation periods, that the Installer provides adequate handling equipment used for moving geotextile rolls and the equipment and that the handling methods used do not pose unnecessary risk of damage. The Installer is responsible for means and methods to implement the work.

The Installer will be responsible for assuring that all materials installed meet specifications (*i.e.*, the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geotextile roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job-site:

1. Date of shipment from Geotextile Manufacturer

2. Date of receipt of delivery at job-site

3. For each geotextile roll the following information will be noted:

    a. Roll number
    b. Batch (lot) number

7.2 Installation

This section describes the quality assurance requirements applicable to the installation of geotextiles.

This section describes installation, observation, and documentation of geotextiles.

7.2.1 Placement

The Installer will install all geotextiles in such a manner to ensure that they are not damaged and in a manner that complies with the following:

1. On sideslopes, the geotextiles will be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile in tension.

2. In the presence of winds, all geotextiles will be secured by other suitable methods. The temporary weighted material will be left in place until replaced with cover material as shown on the design plans and specifications.

3. In-place geotextiles will be cut with special care to protect other materials from damage that could be caused by the cutting of the geotextiles.

4. The Installer will take necessary precautions to prevent damage to any underlying layers during placement of the geotextile.

5. During placement of geotextiles, care will be taken not to entrap in the geotextile any stones, excessive dust, or moisture that could damage the geotextile, or generate clogging of drains or filters.

6. A visual examination of the geotextile will be carried out over the entire surface after installation by the Installer to ensure that no potentially harmful foreign objects, such as needles, are present.

7.2.2 Seams and Overlaps

The following requirements will be met with regard to seaming and overlapping of geotextile rolls:

1. A minimum 12-inch fabric overlap will be required to form geotextile seams.

2. No horizontal seams will be allowed on slopes steeper than 5- horizontal to 1-vertical (*i.e.*, seams will be along, not across, the slope), except as part of a geotextile repair. Horizontal repair seams on such slopes will be sewn or thermally bonded.

3. The Installer will pay particular attention to seams to ensure that no earthen materials could be inadvertently trapped beneath the geotextile.

4. Sewing (if required per item 2 above) will be performed with thread made from the same base material as the geotextile, or suitable equivalent.

The RPR will be responsible for observing and documenting that the above provisions are performed by the Installer in an acceptable manner.

7.3 Post-Installation

7.3.1 Final Examination

The RPR will perform a final geotextile examination after installation of each geotextile layer has been completed. The objectives of the final examination are as follows:

1. Examine for presence of holes, tears, or other deterioration.

2. Examine geotextile for excessive tension due to stretching of the fabric during installation.

If there will be an extended time delay between completion of the geotextile and the start of the installation of any overlying cover, then the Installer will make provisions, by temporarily covering or using other suitable methods, to protect the geotextile against exposure to sunlight and ultraviolet radiation.

7.3.2 Placement of Soil Materials

The construction contractor will place all soil materials located on top of a geotextile in such a manner as to minimize the following:

1. Damage of the geotextile.

2. Slippage of the geotextile on underlying layers.

3. Excessive tensile stresses imposed on the geotextile.

END OF SECTION

Section 8
GEOMEMBRANES

This section of the Construction Quality Assurance Plan applies to the high density polyethylene (HDPE) geomembrane used in the landfill base composite liner, the white high density polyethylene geomembrane used as the liner at the leachate storage tank, and the very low density polyethylene (VLDPE) geomembrane used in the cap composite liner.

The geomembrane will be supplied to the site in factory rolls. No factory seams will be used to prepare larger panels of geomembrane for delivery to the site. This plan, therefore, does not contain any QA/QC requirements for factory seaming.

This section is divided into four major subheadings, which cover the QA requirements for the Pre-Installation (includes resin manufacturers and geomembrane manufacturers), Installation, Field Seaming, and Post-Installation (includes the final examination of the geomembranes prior to placing the appropriate material above the geomembrane). These terms Pre-Installation, Installation, Field Seaming, and Post-Installation are applicable only to the geomembrane installation and do not apply to the overall construction of the landfill facility.

8.1 Pre-Installation

This section describes the quality control measures that are applicable to the polyethylene (PE) resin manufacturers, geomembrane manufacturers, and finished geomembrane roll delivery to the site prior to installation.

The geomembranes must be fabricated from polyethylene resin, and the fabricated HDPE geomembrane must be classified as Type III, Class C, Category 4 or 5 as defined by ASTM D1248. The fabricated VLDPE membrane must be classified as Type III, Class C, Category 3 or 4 per ASTM D1248. (Note: the classifications are based on tests performed on the finished product, not the polyethylene resin used to fabricate the geomembrane.)

In the event that during the course of construction, geomembrane materials are obtained from a different manufacturer or are made from different resins, seam samples formed by joining the original and the proposed geomembrane shall be tested to confirm the construction compatibility of the two

geomembrane materials. Prior to the use of the new geomembrane material, a minimum of two seamed samples (as described above) shall be submitted to the geosynthetics laboratory for nondestructive and destructive seam testing as described in Subsections 8.3.4 and 8.3.5. The CQA officer shall review the testing results prior to authorizing the use of the new geomembrane material.

8.1.1 Manufacturing

Material Specifications

The following list specifies the required membrane materials for liner construction:

Base liner	80-mil HDPE
Leachate storage tank liner	80-mil white HDPE-Textured with conductive backing
Final cover sideslopes and cap	60-mil VLDPE-Textured

Quality Control Requirements

Prior to the delivery of any geomembrane rolls to the site, the Geomembrane Manufacturer will provide the CQA Officer with the following information:

1. The resin supplier, location of supplier's production plant(s), and resin brand name and product number.

2. Any test results conducted by the Geomembrane Manufacturer and/or the Resin Manufacturer testing laboratories to document the quality of the resin used in fabricating the geomembrane.

3. The Quality Control Plan that the Geomembrane Manufacturer will be using for the geomembrane being supplied.

Every roll of geomembrane for delivery to the site must be manufactured and inspected by the Geomembrane Manufacturer according to the following requirements:

1. First quality polyethylene resin must be used.

2. The geomembrane must contain no more than a maximum of 1 percent by weight of additives, fillers, or extenders, excluding carbon black.

3. The geomembrane must have no striations, roughness (except for where the textured geomembrane is specified), or bubbles on the surface.

4. The geomembrane must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geomembrane Manufacturer will routinely perform the following test program on the raw resin and will report the results on a periodic basis to the CQA Officer:

1. Collect and test a minimum of one sample for the parameters in Item #2 below for every 50,000 pounds of resin received.

2. Perform carbon black content, carbon black dispersion, specific gravity, melt flow, and moisture content. Moisture content can be performed by any approved method. All other test methods are listed in Table 8-2.

Manufacturer's Certification

The Geomembrane Manufacturer will provide certification, based on tests performed by either the Geomembrane Manufacturer's laboratory or other outside laboratory contracted by the Geomembrane Manufacturer, that the geomembrane supplied under this plan will meet the specifications of the National Sanitation Foundation (NSF) Standard 54 titled Flexible Membrane Liners, Table 4 (revised May 1991), except as noted in Subsection 8.2.1 under Procedures for Determining Geomembrane Roll Test Failures. Additionally, the manufacturer shall provide certification that the manufacturer's Quality Control Plan was fully implemented for the geomembrane material supplied under this plan. The manufacturer shall provide documentation to verify results of the manufacturer's Quality Control Plan implementation if requested by the CQA officer.

8.1.2 Delivery, Handling, and Storage of Geomembrane Rolls

The geomembrane will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane rolls will be stored on-site in a designated area and will be protected from long-term ultraviolet exposure prior to actual installation.

Each geomembrane roll will be marked by the Geomembrane Manufacturer with the following information (on a durable gummed label, or equivalent, on the inside of the core):

1. Name of manufacturer
2. Product type and identification number (if any)
3. Roll length and width
4. Batch (or lot) number
5. Nominal product thickness
6. Date of manufacture
7. Roll (or field panel) number

When cores are required for preparing geomembranes for shipment, the manufacturer shall use cores with sufficient crushing strength to avoid collapse or other damage while in use.

The following practices should be used as a minimum in receiving and storing geomembrane rolls in the designated storage area at the job site:

1. While unloading or transferring the geomembrane rolls from one location to another, prevent damage to the geomembrane itself. The preferred method involves use of a spreader-bar, straps, and a loader. Do not drag rolls.

2. Store the geomembrane rolls to ensure that they are adequately protected from the following:

    a. Equipment damage
    b. Strong oxidizing chemicals, acids, or bases
    c. Flames including welding sparks
    d. Temperatures in excess of 160°F
    e. Soiling

The RPR will observe and document, throughout the pre-installation, installation, and post-installation periods that the Installer provides adequate handling equipment for moving geomembrane rolls and that the equipment and the handling methods used do not pose unnecessary risk of damage. The installer is responsible for means and methods to implement the work.

The Installer will be responsible for assuring that all materials installed meet specifications (*i.e.*, that the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geomembrane roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job-site:

1. Date of shipment from Geomembrane Manufacturer
2. Date of receipt of delivery at job-site
3. For each geomembrane roll, the following information will be noted:
    a. Roll number
    b. Batch (lot) number

8.2 Installation

This section includes discussions of geomembrane roll testing requirements, earthwork required for geomembrane placement, placement of the geomembrane, defects and repairs of geomembranes, and requirements applicable to other materials in contact with the geomembranes. Subsection 8.3 describes the installation and testing requirements for geomembrane seams.

All parties involved in the installation of the geomembrane should be familiar with geomembranes and should emphasize protection of the geomembrane from damage during construction activities.

8.2.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the Geosynthetic Testing Laboratory in testing the geomembrane roll samples. Subsection 8.1.1, under Quality Control Requirements, describes the test methods that are performed on an infrequent basis to demonstrate the uniformity of resin used to fabricate geomembranes shipped to the job-site. Seam testing is described in Subsections 8.3.4 and 8.3.5.

Test Methods

Geomembrane roll samples will be collected by the RPR. Sample frequency will be based on ASTM D4354 Procedure A where the number of units per lot is defined as the number of rolls for a specified lot (using batch or lot numbers) delivered to the job site in one shipment. Required sampling frequencies are shown in Table 8-1.

Samples will be 3 feet long by the full width of the roll and will not include the first 3 feet of any roll. Since machine direction for geomembrane rolls is the direction that the material comes off the roll, machine direction for any sample will always be along the 3-foot-length dimension of the sample.

Table 8-2 titles list the tests and the test methods to be performed on the HDPE and geomembrane roll samples, respectively. The specifications and methods used in evaluating the results are discussed below under Procedures for Determining Geomembrane Roll Test Failures. Unless specified otherwise, preparation of sample specimens will be performed in

TABLE 8-1

NUMBER OF UNITS TO BE SELECTED AS LOT SAMPLE—SPECIFICATION CONFORMANCE

NUMBER OF UNITS IN LOT	NUMBER OF UNITS SELECTED
1 to 2	1
3 to 8	2
9 to 27	3
28 to 64	4
65 to 125	5
126 to 216	6
217 to 343	7
344 to 512	8
513 to 729	9
730 to 1,000	10
1,001 or more	11

TABLE 8-2

HDPE GEOMEMBRANE TESTS AND TEST METHODS

PROPERTY	TEST METHOD
Carbon Black Content	ASTM D1603
Carbon Black Dispersion	ASTM D3015[a]
Dimensional Stability[b]	ASTM D1204, 1 Hour at 100°C
Density	ASTM D792
Tear Resistance[b]	ASTM D1004
Puncture Resistance	FTMS 101, Method 2065
Tensile Properties[b] Yield Stress Yield Elongation Break Stress Break Elongation	ASTM D638[a]
Thickness	ASTM D751[c,d]

Notes:

(a) Test method as modified in Annex A of NSF Standard 54.

(b) These tests will be performed and results, reported for both machine and cross direction.

(c) Use ASTM test method as modified by NSF Standard 54, Flexible Membrane Liners (revised May 1991).

(d) In the absence of a standard test method for the thickness of textured geomembranes, this test method will be used; however, it may not be applicable for some geomembranes, depending on the manufacturing process.

TABLE 8-3

VLDPE GEOMEMBRANE TESTS AND TEST METHODS

PROPERTY	TEST METHOD
Carbon Black Content	ASTM D1603
Carbon Black Dispersion	ASTM D3015
Melt Flow Index	ASTM D1238 with load of 2.16 kg at 190°C
Density	ASTM D792, Method A; or ASTM D1505
Tear Resistance[1]	ASTM D1004
Puncture Resistance	FTMS 101, Method 2065
Tensile Properties[1] Break Stress Break Elongation	ASTM D638, Type IV specimen at 2 inches/minute
Thickness	ASTM D751[2,3], Part 8.1.3

Notes:

1 These tests will be performed and results, reported for both machine and cross direction.

2 Use ASTM test method as modified by NSF Standard 54, Flexible Membrane Liners (revised May 1991).

3 In the absence of a standard test method for the thickness of textured geomembranes, this test method will be used; however, it may not be applicable for some geomembranes depending on the manufacturing process.

accordance with the referenced test method. Results for tear resistance and each of the tensile property tests will be reported for both the machine and cross direction.

Role of Testing Laboratory

The Geosynthetic Testing Laboratory will be responsible for performing the tests on samples submitted to them as described above under Test Methods. Results of tests performed will be reported to the CQA Officer and the RPR.

Retesting of geomembrane rolls for quality assurance purposes, because of failure to meet any or all of the acceptance specifications listed in Tables 8-3 and 8-4, can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Tables 8-2 and 8-3; however, the results will only be applicable to their own quality control needs. These results will not be substituted for the quality assurance testing described herein.

Procedures For Determining Geomembrane Roll Test Failures

Tables 8-4, 8-5, and 8-6 list the acceptance specifications for the HDPE, the white textured HDPE, and VLDPE geomembranes, respectively. These tables apply to both textured and nontextured geomembranes. For those tests where results are reported for both machine and cross direction, each result will be compared to the listed specification to determine acceptance.

The HDPE membrane values listed in the acceptance specifications of Table 8-3 are from Table 4 of NSF 54, Flexible Membrane Liners (revised May 1991), except for the property of melt flow index, which is based on current acceptable industry practice. Currently, no industry-accepted standard specifications exist for textured geomembranes. Therefore, textured HDPE geomembranes will be required to meet the same specifications listed for nontextured geomembranes in Table 8-4.

NSF is currently developing material property standards for VLDPE membranes; however, these standards are not final. Therefore, the acceptance values listed in Table 8-5 are based on current acceptable industry practice and manufacturer's minimum specifications for textured VLDPE geomembranes.

TABLE 8-4

HDPE GEOMEMBRANE 80-MIL ACCEPTANCE SPECIFICATIONS

PROPERTY	UNITS	TYPE OF CRITERION	ACCEPTABLE VALUE[a]
Carbon Black Content	% by weight	Range	2 - 3
Carbon Black Dispersion	N/A	Range	A1, A2, or B1
Melt Flow Index	g/10 min	Maximum	0.3
Density	N/A	Minimum	0.940
Tear Resistance[c]	lb	Minimum	52
Puncture Resistance	lb	Minimum	96
Tensile Properties			
Yield Stress[c,d]	ppi	Minimum	168
Yield Elongation[c]	%	Minimum	12
Break Stress[c,e,f]	ppi	Minimum	304
Break Elongation[c,f]	%	Minimum	560
Thickness (lowest individual)	mils	Minimum	72
Thickness (minimum average)	mils	Average	80

Notes:

[a] Values are from Table 4 of NSF Standard 54, Flexible Membrane Liners (revised May 1991), unless otherwise indicated

[b] Values are based on current acceptable industry practice

[c] Test is performed in both machine and cross direction

[d] Values given correspond to a minimum yield stress of 2,100 psi for either machine or cross direction.

[e] Values given correspond to a minimum break stress of 3,800 psi for either machine or cross direction.

[f] Values given apply to nontextured geomembranes only. Refer to manufacturer's specifications for minimum acceptable values of textured geomembranes.

TABLE 8-5

TEXTURED WHITE GEOMEMBRANE 80-MIL ACCEPTANCE SPECIFICATIONS

PROPERTY	TEST METHOD	UNIT	ACCEPTABLE VALUE [1]	TYPE OF CRITERION
Thickness	ASTM D1593	mils	72-94	RANGE
Density	ASTM D1238[a]	g/cc	.94	MINIMUM
Melt Flow Index	ASTM D1238[b]	.3 max	.3	MINIMUM
Tensile Properties	ASTM D638 MODIFIED TYPE IV DUMB-BELL @ 2 IPM			
Strength Yield		PPI	190	MINIMUM
Strength at Break		PPI	100	MINIMUM
Elongation at Yield		%	13	MINIMUM
Elongation at Break		%	150	MINIMUM
Tear Resistance	ASTM D1004	lbs.	45	MINIMUM
Puncture Resistance	FTMS 101B	lbs.	80	MINIMUM
Environmental Stress Crack	ASTM D1693	hours	1500 min	MINIMUM
Thermal Stability	ASTM D3083	minutes	2000 minutes	MINIMUM
Coefficent of Linear Thermal Expansion	ASTM D696	$x10^{-4}$/cm/cm °C	2.0	MINIMUM

NOTES:

[a] Condition A

[b] Condition E

[1] All values are Minimum Average Roll Values (MARV) unless otherwise noted.

TABLE 8-6

TEXTURED VLDPE GEOMEMBRANE 60-MIL ACCEPTANCE SPECIFICATIONS

PROPERTY	UNITS	TYPE OF CRITERION	ACCEPTABLE VALUE[1]
Carbon Black Content	% by weight	Range	2 - 3
Carbon Black Dispersion	N/A	Range	A1, A2, or B1
Melt Flow Index	g/10 min	Maximum	0.10
Density	(g/cc)	Minimum	0.89
Tear Resistance[2]	lb	Minimum	24
Puncture Resistance	lb	Minimum	57
Tensile Properties[2] Break Stress Break Elongation	 ppi %	 Minimum Minimum	 70 300
Thickness (lowest individual)	mils	Minimum	36
Thickness (minimum average)	mils	Average	40

Notes:

[1] Values are based on current acceptable industry practice.

[2] Test is performed in both machine and cross direction.

The following procedure will be used for interpreting results:

1. If the test values meet the stated specifications in Tables 8-4, 8-5, and 8-6, then the roll and the lot will be accepted for use at the job-site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.

2. If the results do not meet the specifications, then the roll, the lot, and the entire shipment, if applicable, will be considered unsuitable for use in the liners at the site. The Geomembrane Manufacturer can request, however, retesting of samples from either the original roll sample or another sample collected by the RPR and forwarded to the Geosynthetic Testing Laboratory. For retesting, two additional tests must be performed for the failed test procedure. If both of the retests are acceptable, then the roll and lot will be considered acceptable; if either of the two additional tests fail, then the roll and lot are unsuitable without further recourse and will be immediately marked for removal from the site.

8.2.2 Earthwork

The Construction Contractor will be responsible for preparing the supporting soil according to the plans and specifications and Section 5 of this plan. For installation of any of the geomembranes, the Installer will certify in writing that the surface on which the geomembrane will be installed is acceptable. This certification of acceptance will be reported by the Installer prior to the start of geomembrane installation in the area under consideration. Unacceptable areas noted by the Installer will be immediately reported to the RPR.

The soil surface will also be examined by the RPR to evaluate any areas softened by precipitation or cracked due to desiccation. The daily observation will be documented in the daily report. Areas determined to be unacceptable will be reworked by the Construction Contractor until acceptable.

8.2.3 Placement

Location and Layout Drawing

A layout drawing for the geomembrane installation covered by this plan will be prepared by the Installer prior to installation and submitted to the CQA Officer, showing the location of geomembrane panels to be installed. Geomembrane panels will be identified by the RPR by the corresponding geomembrane roll number on the layout drawing as they are installed.

Installation Techniques

Geomembrane panels will be installed using one of the techniques described below. The Installer will determine the method that best suits the conditions at the time of installation considering factors such as schedule and weather conditions.

1. All geomembrane panels are placed prior to field seaming, in order to protect the underlying soil from rain, *etc.* Seams may be tack-welded or sand-bagged to prevent the geomembrane panels from shifting and to maintain proper overlap for eventual seaming.

2. Geomembrane rolls are placed one at a time, and each panel is seamed immediately after placement.

3. Any combination of the above two techniques.

If a decision is reached to place all panels prior to field seaming, care should be taken to facilitate drainage in the event of precipitation. Scheduling decisions must be made during placement in accordance with varying conditions. The RPR will evaluate changes in the schedule if proposed by the Installer and will advise the CQA Officer on the acceptability of the changes. The RPR will document that the condition of the supporting soil has not changed detrimentally during installation.

The RPR will record the roll number, location, and date of each geomembrane panel installed.

The Installer shall take the following precautions while installing the geomembrane:

1. Equipment used does not damage the geomembrane by handling, excessive heat, leakage of hydrocarbons, or by other means.

2. Personnel working on the geomembrane do not smoke, wear damaging clothing, or engage in other activities that could damage the geomembrane.

3. Method used to unroll the geomembrane does not cause scratches or crimps in the geomembrane and does not damage the supporting soil.

4. Method used to place the rolls minimizes wrinkles (especially differential wrinkles between adjacent panels).

5. Adequate temporary loading or anchoring (continuously placed, if necessary), which will not damage the geomembrane, will be placed to prevent uplift by the wind.

6. Direct contact with the geomembrane will be minimized. The geomembrane will be protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

Weather Conditions

Geomembrane placement will not be performed in an area of ponded water, during precipitation events, or in the presence of excessive winds. The RPR will document that this condition is fulfilled. The CQA Officer will cause to cease or postpone the geomembrane placement when conditions are unacceptable.

Damages

The RPR will examine each panel for damage after placement and determine which panels, or panel portions, should be rejected, repaired, or accepted. Damaged panels or panel portions that have been rejected will be marked, and their removal from the site will be recorded by the RPR. Panel repairs will be made according to the procedures described in Subsection 8.2.4.

8.2.4 Defects and Repairs

This section applies to all defects and repairs resulting from examinations, tests, or visual observations performed on the geomembrane material itself and on the seams used in joining rolls in the field.

Identification

All seam and non-seam areas of the geomembranes will be examined and documented by the RPR for identification of defects, holes, blisters, undispersed raw materials, and any signs of contamination by any foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The smooth nonconductive geomembrane surface will be swept with a broom and/or washed by the installer if the amount of dust or mud inhibits examination. The textured conductive backed HDPE will be spark tested in accordance with technical specifications and manufacturers' recommended procedure. Spark testing will be performed in addition to destructive and nondestructive seam testing.

Evaluation

Each suspect area identified will be nondestructively tested using the vacuum box test method described in Subsection 8.3.4. Each location that fails the non-destructive tests will be marked by the RPR and repaired by the Installer.

Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test will be repaired. Several procedures exist for the repair of these areas. The procedures available include the following:

1. Patching—used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

2. Grinding and rewelding—used to repair small sections of extruded seams.

3. Spot welding or seaming—used to repair small tears, pinholes, or other minor, localized flaws.

4. Capping—used to repair large lengths of failed seams.

5. Topping—used to repair areas of inadequate seams, which have an exposed edge.

6. Removing the bad seam and replacing with a strip of new material welded into place—used for repairing large lengths of fusion seams.

7. Others may be used at the recommendation of the Installer if agreed upon by the CQA Officer and the RPR.

The repair procedures, materials, and techniques will be approved in advance of the specific repair by the CQA Officer, RPR, and Installer. At a minimum, the following provisions will be satisfied:

1. Patches or caps will extend at least 6 inches beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 inches.

2. The geomembrane below large caps should be appropriately cut to avoid water or gas collection between the two sheets.

Examination of Repairs

Each repair will be numbered and logged by the RPR. Each repair will be nondestructively tested according to Subsection 8.3.4. Repairs that pass the above testing will be considered to

be adequately repaired, except that large caps may be of sufficient extent to require destructive seam sampling and testing, at the discretion of the RPR, according to the provisions of Subsection 8.3.5.

Failed tests indicate that the repair was inadequate and will be redone and retested until a passing result is obtained. The RPR will document that all repairs have been subjected to nondestructive testing and will record the number of each repair, the date, and the test outcome.

Large Wrinkles

When seaming of the geomembrane is completed, the RPR will examine the geomembrane for wrinkles and determine which wrinkles should be cut and seamed by the Installer. The wrinkle repair will be done in accordance with the equipment and procedures described in Subsections 8.3.2 and 8.3.3 (General Seaming Procedures), respectively, and it will be nondestructively tested using the vacuum box test method described in Section 8.3.4.

8.3 Field Seaming

This section covers the quality assurance procedures on seams used to join the rolls of geomembrane into a continuous layer. The installation of each of the geomembranes at the landfill facility will include 100 percent nondestructive testing of all field seams for joining adjacent rolls of geomembranes to determine openings or gaps between geomembrane sheets. In addition, destructive testing will be performed at a routine interval for determining the strength and mode of failure of field seams in both the shear and peel modes.

The allowable field seam methods, equipment, personnel qualifications, and destructive and nondestructive testing methods are described in this section.

8.3.1 Seam Layout

The Installer will provide the CQA Officer and the RPR with seam layout drawings for each of the geomembrane installations covered by this plan showing each expected seam. The CQA Officer will review the seam layout drawing and document that it is consistent with accepted practice and the design plans and specifications.

No horizontal seams will be allowed on slopes greater than 5- horizontal to 1- vertical. In corners and at other odd-shaped geometric intersections, the number of seams should be minimized. A seam numbering system comparable and compatible with the geomembrane roll numbering system will be agreed upon at the Preconstruction Meeting.

8.3.2 Seaming Equipment

The approved process for production field seaming (roll to roll) are the dual hot wedge (fusion-type) seam method and the extrusion fillet weld process. Specialty seams and repair seams (non-production) will be done by the extrusion fillet weld process. No other processes can be used without prior written authorization from the CQA Officer and the RPR. Only equipment that has been specifically approved by make and model will be used.

Dual Hot Wedge Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of the equipment to be used at the job-site:

1. An automated self-propelled type of apparatus will be used.
2. The welding apparatus will be equipped to continuously monitor applicable temperatures.
3. One spare operable seaming device will be maintained on site at all times.
4. Equipment used for seaming should not damage the geomembrane.
5. The geomembrane should be protected in areas of heavy traffic to prevent damage as discussed in Subsection 8.2.3.
6. For cross seams, the edge of the cross seams will be ground to a smooth incline (top and bottom) prior to welding.
7. For cross seams, the intersecting dual hot wedge seam must be patched using the extrusion fillet process described below.
8. The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after usage.

The Installer will keep records for each seamer performing dual hot wedge seaming, including welding machine I.D. number, ambient air temperature, geomembrane surface temperature,

and machine operating pressures and temperatures. This data will be recorded at intervals as agreed to at the Preconstruction Meeting.

Extrusion Fillet Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of extrusion welding equipment to be used at the job-site:

1. The welding apparatus will be equipped to continuously monitor temperature at the nozzle.

2. One spare operable seaming device will be maintained on-site at all times.

3. Equipment used for seaming should not damage the geomembrane.

4. The geomembrane should be protected in areas of heavy traffic to prevent damage.

5. The extruder will be cleaned and purged prior to beginning seaming, and at any time that seaming operations are stopped, until all heat-degraded extrudate has been removed from the barrel.

6. The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after usage.

7. Grinding geomembrane surfaces for welding preparation shall not be performed more than 1 hour prior to seaming.

The Installer and, if applicable, the Geomembrane Manufacturer will provide documentation to the CQA Officer regarding the quality of the extrudate used in the welding apparatus. At a minimum, the extrudate should be compatible with the base liner material and contain the same grade and quality of polyethylene resin as used in the base material.

The Installer will keep records for each seamer performing extrusion weld seaming, including welding machine I.D. number, extrudate, ambient air and geomembrane surface temperatures. This data will be recorded at intervals as agreed to at the Preconstruction Meeting.

8.3.3 Initial Requirements

Personnel Qualifications

All personnel performing seaming operations will be qualified by experience or by successfully passing seaming tests for the type of seaming equipment to be used. At least one seamer will have experience seaming a minimum of 1,000,000 ft^2 of polyethylene geomembrane using the same type of seaming apparatus to be used at the landfill facility. The most experienced seamer, the "master seamer," will have direct supervisory responsibility at the job site over less experienced seamers.

The Installer will provide a list of proposed seaming personnel and their experience records to the CQA Officer and the RPR for their review and approval.

Weather Conditions

The range of weather conditions under which geomembrane seaming can be performed are as follows:

1. Unless otherwise authorized in writing by the CQA Officer, no seaming will be attempted or performed at an ambient temperature below 32°F (0°C) or above 104°F (40°C).

2. Between ambient temperatures of 32°F (0°C) and 50°F (10°C), seaming will be performed only if the geomembrane is preheated by either sun or a hot air device, provided there is no excessive ambient cooling resulting from high winds.

3. Above 50°F (10°C), no preheating of the geomembrane is required.

4. Geomembrane will be dry and protected from the wind.

5. Seaming will not be performed during any precipitation event unless the Installer erects satisfactory shelter to protect the geomembrane areas for seaming from water and/or moisture.

6. Seaming will not be performed in areas where ponded water has collected below the surface of the geomembrane.

If the Installer wishes to use methods that may allow seaming at ambient temperatures below 32°F or above 104°F, the Installer will demonstrate and certify that the methods and techniques used to perform the seaming produce seams that are entirely equivalent to seams produced at

temperatures above 50°F and below 104°F, and that the overall quality of the geomembrane is not adversely affected.

The RPR will document the following items:

1. Ambient temperature at which seaming is performed.

2. Any precipitation events occurring at the site, including the time of such occurrences, the intensity, and the amount of the event.

The RPR will inform the CQA Officer if any of the weather conditions are not being fulfilled. The CQA Officer will cause to cease or postpone the geomembrane seaming when weather conditions are unacceptable.

Overlapping and Temporary Bond

The Installer will be responsible for the following:

1. Panels of geomembranes have a finished overlap of a minimum of 3 inches for extrusion welding and 4 inches for fusion welding; but, in any event, sufficient overlap will be provided to allow peel tests to be performed on the seam.

2. No solvents or adhesives will be used on the geomembranes unless the product has been approved in writing by the CQA Officer. Approval can only be obtained by submitting samples and data sheets to the CQA Officer for testing and evaluation.

3. Procedures used to temporarily bond adjacent geomembrane rolls must not damage the geomembrane; in particular, the temperature of the hot air at the nozzle of any spot welding apparatus must be controlled such that the geomembrane is protected at all times against potential damage.

Trial Seams

Trial seams will be made on fragment pieces of geomembrane to document that seaming conditions are adequate. Such trial seams will be made at the beginning of each seaming period, and at least once every four hours thereafter, for each seaming apparatus used that day. Also, each seamer will make at least one trial seam each day. Trial seams will be made under the same conditions as actual seams.

The trial seams will be examined by the Installer for squeeze-out, foot pressure applied by seaming equipment, and general appearance. If the seam fails any of these examinations, it will be repeated until satisfactory seams are obtained.

The trial seam samples will be at least 3 feet long by 1 foot wide after seaming, with the seam centered lengthwise. Seam overlap will be as indicated above, under Overlapping and Temporary Bond.

Two specimens, each 1 inch wide, will be cut from opposite ends of the trial seam sample by the Installer. The specimens will be tested respectively in shear and peel using a field tensiometer provided by the Installer, and they should not fail in the seam. If a specimen fails, the entire test will be repeated using two additional specimens cut from the trial seam sample or a new trial seam sample shall be made (with or without adjustments in the seaming process) and specimens cut for testing. If the second set of specimens also fails, the seaming apparatus and seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.

The remainder of the trial seam sample will be identified and marked by the RPR as follows:

1. An assigned sample number, welding apparatus used, and seamer name;

2. The date, time, applicable welding equipment operating temperatures, and ambient temperature at the time of seaming; and,

3. Whether the sample passes or fails.

The RPR may randomly select trial field samples for destructive testing by the Geosynthetic Testing Laboratory according to the test procedures described in Subsection 8.3.5 under Field Test Methods. The frequency for trial seam laboratory testing will be at the discretion of the RPR.

If a trial seam sample fails a destructive test performed by the Geosynthetic Testing Laboratory according to the acceptance criteria stated in Subsection 8.3.5, then a destructive test seam sample(s) will be taken from each of the seams completed by the seamer during the shift related to the failed trial seam test. These samples will be forwarded by the RPR to the

Geosynthetic Testing Laboratory and, if any of them fails the tests, the procedures described in Subsection 8.3.5 will apply. The conditions of this paragraph will be considered met if a destructive seam test sample, collected and tested according to the provisions under Location and Sampling Frequency and Sampling Procedure of Subsection 8.3.5, has already been taken and passed.

Seam Preparation

The Installer will meet the following conditions for each of the geomembrane installations covered by this plan:

1. Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

2. If seam overlap grinding is required, the grinding process will be completed according to the Geomembrane Manufacturer's instructions within 1 hour of the seaming operation, and in a way that will not damage the geomembrane or cause excessive striation of the geomembrane surface.

3. Seams will be aligned so as to minimize the number of wrinkles and "fishmouths."

General Seaming Procedures

Unless otherwise specified, the general seaming procedures to be used by the Installer for each of the geomembrane installations covered by this plan, and observed by the RPR, will be as follows:

1. A firm substrate will be provided to achieve proper support for seaming.

2. Fishmouths or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed, and any portion where the overlap is inadequate will then be patched with an oval or patch of the same geomembrane (including thickness) extending a minimum of 6 inches beyond the cut in all directions.

3. If seaming operations are to be conducted at night, adequate illumination will be provided.

8.3.4 Nondestructive Testing

Each field seam will be nondestructively tested over its full length using one of the methods described in this section. The purpose of nondestructive testing is to determine the continuity of the seams. Nondestructive testing, at this stage of development, does not provide any

information on the strength of seams. Seam strengths will be determined by destructive testing methods that are described in Subsection 8.3.5. Failure of any of the nondestructive or destructive tests will require the repair of the failed section according to the procedures contained in Subsection 8.3.5.

Nondestructive testing as described in this section will be performed on seams for every geomembrane installation covered by this plan. The recommended test methods for conducting the nondestructive seam testing are the air pressure test for dual hot wedge seams and the vacuum box test for extrusion fillet welds. These two nondestructive testing methods are described below.

The RPR will perform the following:

1. Observe all nondestructive seam testing, and examine all seams for squeeze-out, foot pressure, and general appearance. Failure of these criteria will be considered as failure of the seam, and repair or reconstruction will be required;

2. Document location, date, test unit number, name of tester, and outcome of all testing;

3. Inform the Installer and CQA Officer of any required repairs; and,

4. Document that appropriate repairs are made and that the repairs are retested nondestructively with passing results.

Air Pressure Testing

The following test procedures are applicable only to dual hot wedge seams. The equipment for performing the test should meet the following minimum requirements:

1. An air compressor or hand pump equipped with a pressure gauge and regulator capable of producing and sustaining a pressure between 25 to 30 psig and mounted on a cushion to protect the geomembrane surface; and,

2. Fittings, rubber hose, valves, *etc.*, to operate the equipment, and a sharp hollow needle or other approved pressure feed device.

Air pressure testing will be performed according to the following procedure:

1. Seal both ends of the seam to be tested.

2. Insert needle or other approved pressure feed device into the air space at one end of the dual hot wedge seam.

3. Energize the air compressor or hand pump to a pressure of 25-30 psig. Close the valve and observe the pressure response in the seam air space for approximately 7 minutes. The pressure should stabilize within the first 2 minutes and then remain essentially constant.

4. Record the pressure in the seam at the end of 2 minutes and again at the end of 7 minutes.

5. If the subsequent pressure loss exceeds 2 psig over the last 5-minute period or if the pressure does not stabilize, then the seam fails, and the defect must be located, repaired, and retested nondestructively.

6. If pressure loss does not exceed 2 psig over the last 5-minute period, then the seam is considered to have passed the nondestructive test provided the installer has verified that the air channel tested was not obstructed by noting a release of air pressure at the end of the tested seam interval opposite the pressure gauge.

Vacuum Box Test

Vacuum box testing is to be used on those seams made by the extrusion fillet process, to locate precisely the defects identified from air pressure testing, or to evaluate suspect seam and non-seam areas as discussed in Subsection 8.2.4.

Vacuum box testing equipment must meet the following minimum standards:

1. A five-sided vacuum box with an open bottom, a clear viewing panel on top, and a pliable gasket attached to the bottom;

2. A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections capable of achieving a vacuum of 10 psig; and,

3. A vacuum gauge on the tank with an operating range of 0 to 10 psig, and a vacuum gauge on the vacuum box with an operating range from 0 to 10 psig.

The following procedures will be used in performing the vacuum box test:

1. Ensure seams to be tested are clean and relatively free from soil or foreign objects that might prohibit a good seal from being formed between the vacuum chamber and the geomembrane.

2. Energize the vacuum pump and create a vacuum in the tank of 5 to 10 psig.

3. Wet a strip of geomembrane approximately twice the size of the vacuum box with the soapy solution.

4. Place and center the vacuum box with the gasket in contact with the geomembrane surface over the wetted area of the seam.

5. Applying a normal force to the top of the vacuum box, close the bleed valve, and open the vacuum valve. Check to make certain that a tight seal is created between the geomembrane and the vacuum box. A minimum vacuum of 5 psig should be used for testing with the maximum allowable testing pressure never exceeding 10 psig of vacuum.

6. With the vacuum drawn, use the viewing panel to examine the geomembrane seam for bubbles resulting from the flow of air through the seam. Continue this examination for not less than 10 seconds.

7. Remove the vacuum box by first closing the vacuum valve and opening the bleed valve. Proceed to step 8 if bubbles appear in Step 6. If no bubbles appear in step 6, then proceed directly to step 9.

8. If bubbles appear through the geomembrane, mark the defective area for repair according to the provisions of Subsection 8.2.4. All repairs must be tested with passing nondestructive results.

9. Move the vacuum box along the seam to be tested, overlapping the previously tested area by no less than three inches.

8.3.5 Destructive Seam Testing

Destructive seam testing will be performed on the geomembrane seams covered by this plan. Destructive seam testing is performed to determine the strength of the seam in both shear and peel failure modes. Destructive seam testing will be performed within 48 hours of sampling either in an on-site laboratory by personnel under the direction of the CQA Officer or at the Geosynthetic Testing Laboratory.

Location and Sampling Frequency

The RPR will select locations where seam samples will be cut out for the destructive testing. Test locations will be determined during seaming at the RPR's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential causes of an imperfect seam. The Installer will not be informed in advance of any location where seam samples will be taken.

The minimum frequency of sample collection will be one test location per every 500 linear feet of seam length. This minimum frequency is to be taken as an average for the entire installation area.

Sampling Procedure

Samples will be cut under the direction of the RPR as the seaming progresses. For each sample location, information will be documented as follows:

1. Assign a sample number and mark accordingly.

2. Record sample location on the layout drawing.

3. By sample number, record the reason for collecting the sample (*e.g.*, as part of statistical testing program, suspicious seam, *etc.*).

4. Note on the sample, for the peel test, which geomembrane is the top and which is the bottom with respect to seams performed using dual hot wedge (fusion) weld techniques.

5. Record pertinent information including date, time, seaming unit number, and name of seamer.

Specimens for qualitative field testing will be taken prior to removal of the laboratory sample. Samples for field tensiometer testing will be 1 inch wide by 16 inches long with the seam centered parallel to the width. The distance between the two samples should be 42 inches measured from inside edge to inside edge. If both samples pass the field tensiometer test described below under Field Test Methods, then the sample for laboratory testing will be taken according to the procedure described below.

The sample for laboratory testing will be located between the two samples used for field testing. Therefore, the laboratory sample will be 12 inches wide by 42 inches long with the seam centered lengthwise. The sample will be cut by the RPR into three parts and distributed as follows:

1. A 12-inch-by-16-inch sample will be given to the Installer for testing if so desired.

2. A 12-inch-by-16-inch sample will be given to the Owner for record storage.

3. An 8-inch-by-16-inch sample will be transmitted to the Geosynthetic Testing Laboratory or on-site testing laboratory by the RPR.

The RPR will make periodic reports to the Installer detailing the locations of samples taken that must be repaired.

All holes cut into the geomembrane resulting from destructive seam sampling will be immediately repaired by the Installer in accordance with the repair procedures described in Subsection 8.2.4. The repaired area will be nondestructively tested in accordance with the requirements of Subsection 8.3.4.

Field Test Methods

The two 1-inch-wide samples described above under Sampling Procedure will be field tested for both peel and shear. Testing will be performed using a field tensiometer or equivalent device to qualitatively determine the mode of failure. The seam will be considered as passing if the failure in both peel and shear does not occur with the seam. If the samples fail the field tensiometer test, then the repair procedures of Subsection 8.2.4 for the holes left by the cut-out samples, and seam reconstruction procedures for the repair of the defective seam, discussed later in this subsection, must be implemented.

Laboratory Test Methods

Laboratory testing of the destructive seam samples will be performed by the Geosynthetic Testing Laboratory or on-site testing laboratory under the direction of the CQA Officer. All destructive seam tests, whether performed on trial seam samples (as described above) or on samples cut out from production seams, will be performed in general accordance with the methodology of ASTM D4437, which stipulates that at least five specimens should be tested in shear and five in peel. Samples will be cut in alternating order (e.g., shear & peel, peel & shear) and should be tested in the order of cutting, to determine if any trend in seam quality along the length of the sample exists. All specimens will be cut as 1-inch-wide strips to ensure that the seam does not exceed the test gauge length of the specimen.

The following tests will be performed on each seam sample submitted for laboratory testing:

1. Shear and peel maximum tension is the maximum load per unit width of a 1-inch-wide specimen expressed in pounds per inch of width in both the shear and peel mode, according to ASTM D4437 as modified by NSF Standard 54.

2. Shear elongation at break is the extension at break expressed as a percentage of the initial distance between the edge of the fused track and the nearer grip. This distance should be the same on both sides of the seam and is usually 1 inch. No referenced ASTM test exists for this procedure as defined. The value that failure occurred will be noted on the results.

3. Peel seam separation estimates the area of seam interface separation expressed as a percentage of the original area.

Also, for both the seam shear and peel tension tests, an indication will be given for each specimen tested that defines the locus of the failure. The loci will be defined by using Figure A-4 and Figure A-6 from Part 5, Annex A of NSF 54.

For the seam shear tests, specimens should be inserted in the test machine with minimum gauge lengths of 1/2 inch between each edge of the seam and the adjacent grip. The crosshead speed will be 2 inches per minute for HDPE and 20 inches per minute for VLDPE. Parameters monitored during the test will be load and crosshead displacement.

For the peel tests, specimens will be inserted in the tensile machine so the grips are no closer than 1 inch to the edge of the seam. The grips may be closer than 1 inch only if there is insufficient material to allow insertion at this setting. Seam peel specimens will be tested at 2 inches per minute crosshead speed for HDPE and 20 inches per minute for VLDPE.

For shear tests, the following values will be reported for each specimen tested:

1. Maximum tension in pounds per inch;
2. Elongation at break indicating at what percentage the specimen failed; and,
3. The locus of failure using the above designations.

For peel tests, the following values will be reported for each specimen tested:

1. Maximum tension in pounds per inch;
2. Seam separation expressed as percent of original seam area; and,
3. Locus of failure.

For each set of five specimens, the mean and standard deviation will be calculated and reported for shear maximum tension and peel maximum tension.

Role of Testing Laboratory

The Geosynthetic Testing Laboratory or on-site testing laboratory will be responsible for performing the tests on samples submitted to them as described above. Results of tests performed will be reported to the CQA Officer and the RPR. Retesting of seams, because of failure to meet any or all of the specifications listed below, can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or Installer may perform their own quality control testing in accordance with the methods and procedures defined above under Laboratory Test Methods; however, the results, if substantially different from those obtained by the Geosynthetic Testing Laboratory or on-site laboratory, may only be used to request a retesting by the Geosynthetic Testing Laboratory or on-site testing laboratory. All quality assurance test results from the Geosynthetic Testing Laboratory or on-site laboratory govern, over any test results from the Geomembrane Manufacturer of Installer. Only the CQA Officer is authorized to approve a retesting request.

Procedures For Determining Destructive Seam Test Failures

The procedures described in this section apply to the destructive testing procedures defined above under Field Test Methods and Laboratory Test Methods. Specifications for destructive seam testing are shown in Table 8-7, Table 8-8, and Table 8-9. Procedures for repairing failed seams are given in Subsection 8.2.4 of this plan.

TABLE 8-7

80-MIL HDPE GEOMEMBRANE SEAM ACCEPTABLE SPECIFICATIONS

PROPERTY	TEST METHOD	UNITS	MINIMUM AVERAGE VALUE[1]
Shear Strength[2]	ASTM D4437 (NSF 54 modified)	ppi	171
Shear Elongation	--	percent	50
Peel Strength[2] - Fusion	ASTM D4437 (NSF 54 modified)	ppi	124
Peel Strength[2] - Extrusion	ASTM 4437 (NSF 54 modified)	ppi	95
Peel Separation	--	percent	10[3]

NOTES:
1 The average of all five specimen test results must meet these requirements. In addition, four out of the five test results must meet these requirements.
2 Failure type in peel must be film-tear bond (FTB) for 4 out of 5 test specimens.
3 Maximum Acceptance Value.

TABLE 8-8

80-MIL TEXTURED HDPE GEOMEMBRANE SEAM ACCEPTABLE SPECIFICATIONS

PROPERTY	TEST METHOD	UNITS	MINIMUM AVERAGE VALUE[1]
Shear Strength[2]	ASTM D4437 (NSF 54 modified)	ppi	151
Shear Elongation	--	percent	50
Peel Strength[2] - Fusion	ASTM D4437 (NSF 54 modified)	ppi	118
Peel Strength[2] - Extrusion	ASTM 4437 (NSF 54 modified)	ppi	84
Peel Separation	--	percent	10[3]

NOTES:
1 The average of all five specimen test results must meet these requirements. In addition, four out of the five test results must meet these requirements.
2 Failure type in peel must be film-tear bond (FTB) for 4 out of 5 test specimens.

Results from the shear and peel tests for the HDPE geomembrane will be evaluated by criteria, which are based on the values for material properties for yield stress (Note: yield stress of the base geomembrane is considered a more representative criterion than bonded seam strength) from Table 4 (HDPE Geomembranes) of NSF Standard 54 titled Flexible Membrane Liners (revised May 1991).

TABLE 8-9

60-MIL TEXTURED VLDPE GEOMEMBRANE SEAM ACCEPTABLE SPECIFICATIONS

PROPERTY	TEST METHOD	UNITS	MINIMUM AVERAGE VALUE[1]
Shear Extrusion	ASTM D4437	ppi	60
Shear Fusion	ASTM D4437	ppi	60
Peel Strength[2] - Fusion	ASTM D4437	ppi	50
Peel Strength[2] - Extrusion	ASTM 4437	ppi	52

NOTES:
[1] The average of all five specimen test results must meet these requirements. In addition, four out of the five test results must meet these requirements.
[2] Failure type in peel must be film-tear bond (FTB) for 4 out of 5 test specimens.

Results from the shear and peel tests for the VLDPE will be evaluated by the following criteria:

1. Minimum acceptable individual specimen shear elongation values will be no less than 50 percent.

2. Maximum allowable individual specimen peel separation value will be 10 percent.

3. Failure type in peel must be film-tear bond (FTB) for 4 out of 5 test specimens.

The Installer has the following two options in determining the repair boundary whenever a seam has failed: either the field tensiometer testing or laboratory destructive testing:

1. The seam can be reconstructed between any two previously tested and passed destructive seam test locations.

2. The Installer can trace the welding path to an intermediate location (at a 10-foot minimum from the point of the failed test in each direction) and request that field tensiometer tests be performed at these intermediate locations. If the field tensiometer sample results are acceptable, then full laboratory samples are taken and tested. If the laboratory tests are acceptable, then the seam is reconstructed between these intermediate locations. If either sample fails, then the process is repeated until acceptable destructive seam tests have been performed in both directions away from the original failed sample location. All retesting of seams, according to this procedure, will use the sampling methodology described above under Sampling Procedure.

For all seams reconstructed due to a failing destructive seam sample, an additional sample taken from the reconstructed zone must pass destructive seam testing.

The RPR will be responsible for documenting all actions, including test results submitted by the Geosynthetic Testing Laboratory, taken in conjunction with seam testing. The RPR will also be responsible for keeping the CQA Officer informed on seam testing results and seaming progress.

8.4 Post-Construction

Each geomembrane covered by this plan will be examined by the RPR. Any defects, whether due to failed seams, pinholes, or other penetrations, will be repaired. In addition, a stress crack examination will be performed along the seams of all the geomembrane installations covered by the plan.

This examination, by experienced personnel, will utilize the procedures described in the EPA Field Inspectors Manual titled "Stress Cracking of Flexible Membrane Liner Seams." This document identifies three levels of stress crack development with Level #1 being those that can be observed only under a microscope, Level #2 being those that are barely visible to the eye, and Level #3 being those that are complete fractures.

The geomembranes covered by this plan will be examined for Level #2 and Level #3 stress cracks according to the procedure described in the Field Inspector's Manual under the heading "Field Inspection Recommendations." This examination will be performed by experienced personnel only. Any Level #2 or #3 stress cracks found will be immediately marked by the RPR and will be repaired according to the provisions of Subsection 8.2.4.

Placement of the drainage layer material shall proceed as soon as practical following the RPR's testing and acceptance of completed geomembrane areas. The granular layer will provide ultraviolet protection, thermal insulation, and protection from physical damage.

END OF SECTION

Section 9
GEONETS

Geonets will be part of a geocomposite consisting of a non-woven geotextile heat bonded to the top of the geonet. The geonets used in the geocomposites will meet the applicable requirements of this section. Geocomposites are discussed in Section 11.

As geonets will not be used independently (*i.e.*, only used as a component of the geocomposite), portions of this section are not applicable. Section 9 (Geonets) is included to provide a reference source for geonet material specifications and testing requirements as called for in Section 11.

This section is divided into three major subheadings which cover the quality assurance requirements for Pre-Installation (includes geonet manufacturers), Installation, and Post-Installation (includes the final examination of the geonets prior to placing the appropriate material above the geonet). The terms Pre-Installation, Installation, and Post-Installation are applicable only to the geonet installation and do not apply to the overall construction of the landfill facility.

9.1 Pre-Installation

9.1.1 Manufacturing

Material Specifications

The geonets used must be fabricated from polyethylene resin, and the fabricated geonet must be classified as Type III, Class C, Category 4 or 5 as defined by ASTM D1248 (Note: this classification is based on tests performed on the finished product, not the polyethylene resin used to fabricate the geonet).

Quality Control Requirements

Prior to the delivery of any geonet rolls to the site, the Geonet Manufacturer will provide the CQA Officer with the following information:

1. The resin supplier, location of supplier's production plant(s), and resin brand name and product number.

2. Test results obtained by the Geonet Manufacturer and/or the Resin Manufacturer's testing laboratories to document the quality of the resin used in fabricating the geonet.

3. The Quality Control Plan that the Geonet Manufacturer will be using for the geonet being supplied.

Every roll of geonet for delivery to the site must be manufactured and inspected by the Geonet Manufacturer, according to the following requirements:

1. First-quality polyethylene resin must be used.

2. The geonet must contain no more than a maximum of 1 percent by weight of additives, fillers, or extenders, excluding carbon black.

3. The geonet must have no striations, roughness, or cuts on the surface.

4. The geonet must be free of blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geonet Manufacturer will routinely perform the following tests on the raw resin, at the stated frequencies, and will report the results on a periodic basis to the CQA Officer:

1. Collect and test a minimum of one sample for the parameters in Item #2 below for every 50,000 pounds of resin received.

2. Perform carbon black content by ASTM D1603, carbon black dispersion by ASTM D2663 Method B, specific gravity by ASTM D792 Method A, melt flow index by ASTM D1238 with a load of 2.16 kg and at 190°C, and moisture content by any approved method.

Manufacturer's Certification

The Geonet Manufacturer will provide certification, based on tests performed in accordance with the methods listed in Table 9-1 that the geonet supplied under this plan will meet the material specifications listed in Table 9-1. These tests may be performed by the Geonet Manufacturer's laboratory or by a laboratory contracted by the manufacturer. Additionally, the manufacturer shall provide certification that the manufacturer's Quality Control Plan was fully implemented for the geonet materials supplied under this plan. The manufacturer shall provide documentation to verify the results of the manufacturer's CQA Plan implementation if requested by the CQA Officer.

TABLE 9-1

GEONET PROPERTIES

PROPERTY	UNITS	VALUE	TEST	CRITERION
Thickness	mils	225	ASTM D1777	Minimum
Density	g/cu cm	0.93	ASTM D1505	Minimum
Melt Flow Index	g/10 min	1.0	ASTM D1238	Maximum
Carbon Black Content	Percent	2 - 3	ASTM D1603	Range

9.1.2 Delivery, Handling, and Storage of Geonet Rolls

Each geonet roll for use at the landfill facility will be marked by the Geonet Manufacturer with the following information and in the following manner:

1. When the net is rolled on a core, identify each roll with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.

2. Each roll label will contain the following information at a minimum:

   a. Name of manufacturer (or supplier)
   b. Style and type number
   c. Roll length and width
   d. Batch (or lot) number
   e. Nominal product thickness
   f. Date of manufacture
   g. Direction for unrolling
   h. Roll number

3. On the outside of the roll, all lettering should be a minimum 1/2 inch high; and on the inside of the core, the lettering should be at least 1/4 inch high.

The Geonet Manufacturer will use the following guidelines in packaging and preparing all geonet rolls for shipment:

1. When cores are required, use those that have a crushing strength sufficient to avoid collapse or other damage while in use.

2. Geonets must be rolled on the cores so that they will unroll in the machine direction. The machine direction is defined as the direction parallel with the longest diagonal in the diamond pattern of the geonet.

The following practices should be used as a minimum in receiving and storing geonet rolls in the designated storage area at the job-site:

1. While unloading or transferring the geonet rolls from one location to another, prevent damage to the geonet. If practicable, the Installer may use fork lift trucks fitted with poles that can be inserted into the cores of rolls. Be sure that the poles are at least two-thirds the length of the rolls to avoid breaking the cores and possibly damaging the geonet. Do not drag the rolls.

2. Store the geonet rolls to ensure that they are adequately covered to protect the geonet from the following:

    a. Precipitation
    b. Ultraviolet radiation, including sunlight
    c. Strong oxidizing chemicals, acids or bases
    d. Flames, including welding sparks
    e. Temperatures in excess of 160°F
    f. Soiling

The RPR will observe and document throughout the pre-installation, installation, and post-installation periods that the Installer provides adequate handling equipment used for moving geonet rolls and that the equipment and handling methods used do not pose unnecessary risk of damage. The Installer is responsible for means and methods to implement the work.

The Installer will be responsible for assuring that materials installed meet specifications (*i.e.*, the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geonet roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job-site:

1. Date of shipment from Geonet Manufacturer

2. Date of receipt of delivery at job-site

3. For each geonet roll the following information will be noted:

    a. Roll number
    b. Batch (lot) number

9.2 Installation

This section describes the quality assurance requirements applicable to the installation of geonets. This section includes installation, observations, and documentation of geonets.

9.2.1 Placement

The Installer will install all geonets in such a manner as to ensure that they are not damaged in any way and in a manner that complies with the following:

1. On sideslopes, the geonets will be securely anchored, then rolled down the slope in such a manner as to continually keep the geonet in tension. If necessary, the geonet will be positioned by hand after being unrolled to minimize wrinkles.

2. In the presence of winds, all geonets will be secured by suitable methods. The temporary weighted material will be left in place until replaced with cover material as shown on the design plans and specifications.

3. Cutting should be done according to manufacturer's recommendations.

4. The Installer will take necessary precautions to prevent damage to underlying layers during placement of the geonet.

5. During placement of geonets, care will be taken not to entrap in the geonet any stones, excessive dust, or moisture that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geonet, the geonet will be cleaned prior to placement of the next material on top of the geonet.

6. Unless otherwise approved by the CQA Officer, geonets will not be welded or tack welded to the underlying geomembranes.

9.2.2 Stacking and Joining

When several layers of geonets are stacked, care should be taken to prevent strands from one layer from penetrating the channels of the adjacent layer, thereby significantly reducing the transmissivity. This cannot happen if stacked geonets are placed in the same direction. A stacked geonet should not be laid in a perpendicular direction to the underlying layer.

The following guidelines should be used in stacking and joining geonets:

1. Adjacent rolls will be overlapped by a minimum of four (4) inches.

2. These overlaps will be secured by spot-welding to each other or tying.

3. Tying can be achieved by strings, plastic fasteners, or polymer braid. Tying devices will be white or brightly colored for easy identification. Metallic devices will not be used in any circumstances.

9.2.3 Repairs

Any tears or other defects in the geonet will be repaired by placing a patch extending a minimum of 2 feet beyond the edges of the hole or tear. The patch will be secured to the original geonet by spot-welding or tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geonet. Tying devices as indicated in Subsection 9.2.2 will be used. The RPR will examine and document that the repair of any geonets is performed according to the above procedure.

9.3 Post-Installation

9.3.1 Final Examination

The RPR will perform a final geonet examination after installation of each geonet layer has been completed. The objectives of this step are as follows:

1. Examine for presence of tears or defects.
2. Examine overlaps and tying or spot-welding.

If any portion of the geonet requires repairs due to the above examination, they will be performed according to the procedures in Subsection 9.2.3. The RPR will document the result of the final examination, including any subsequent repairs.

END OF SECTION

Section 10

GEOSYNTHETIC CLAY LINER

This section of the CQA Plan applies to the geosynthetic clay liner material used in the landfill base composite liner and composite final cover. This specification covers the quality assurance and technical requirements for the furnishing, installation, and post-installation of the geosynthetic clay liner.

10.1 Definitions

For the purposes of this section of the plan guideline, the following terms are defined as indicated below:

Geosynthethic Clay Liner (GCL). A factory-manufactured hydraulic barrier consisting of sodium bentonite clay supported by geotextiles which are held together by needling, stitching, or adhesives.

Geotextile. Any permeable textile used with foundation, soil rock, earth, or any other geotechnical engineering related material as an integral part of a human-made project, structure, or system.

Minimum Average Roll Value. the minimum average value of a particular physical property of a material, for 95 percent of all of the material in the lot.

Overlap. Where two adjacent GCL panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

10.2 References

USP-NF-XVII	Swell Index Test
ASTM E 946	Water Absorption of Bentonite by Porous Plat Method
ASTM D 3776	Weight (Mass) Per Unit Area of Woven Fabrics
ASTM D 5084	Hydraulic Conductivity of Saturated Porous Material Using a Flexible Wall Permeameter
ASTM D 4873	Guide for Identification, Storage and Handling of Geotextiles
ASTM D 4632	Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D 3486	Test Method for Mullen Burst Strength of Textiles

10.3 Submittals

With the bid, the Contractor shall furnish the following information:

- Conceptual description of the proposed plan for placement of the GCL panels over the area of installation.
- GCL manufacturer's affidavit providing assurance that the qualifications of Section 10.4 of this specification have been achieved.
- At the Engineer's request:
  - A representative sample of the GCL, suitable for testing.
  - A project reference list consisting of the principal details of at least ten projects totaling at least 10 million square feet in size.

Upon shipment, the Contractor shall furnish the following:

- GCL manufacturer's quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification.
- Manufacturer's warranty covering materials and workmanship of the GCL.

10.4 Qualifications

- GCL Manufacturer must have produced at least 10 million square feet of GCL, with at least 8 million square feet installed.
- GCL Installer must either have installed at least 1 million square feet of GCL, or must provide to the Engineer satisfactory evidence, through similar experience in the installation of other types of geosynthetics, that the GCL will be installed in a competent, professional manner.

10.5 Products

The GCL shall be ***Bentomat*** as manufactured by Colloid Environmental Technologies Company (CETCO), ***Claymax*** as manufactured by the Clem Environmental Corporation, or an approved equivalent as defined by compliance with these specifications. The GCL shall consist of a layer of pure sodium bentonite clay encapsulated between two polypropylene geotextiles, one woven and one non-woven, and shall comply with all of the manufacturing processes and physical/chemical criteria listed in this section. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets the requirements of this specification.

10.5.1 Materials

The GLC shall have the properties necessary to achieve substantial compliance with the following tables. All values are minimum average roll values (MARVs) unless indicated otherwise.

- The bentonite utilized in the manufacturer of the GCL, as well as any accessory bentonite provided for seaming and detail work, shall be Volclay® Wyoming-grade sodium bentonite with the properties listed in Table 10-1 below.

TABLE 10-1

SODIUM BENTONITE

PROPERTY	TEST METHOD	VALUE
Montmorillonite Content	Various Methods	90% (Approximate)
Particle Size	ASTM D 421	20% maximum + #20 mesh 20% maximum - #40 mesh
Free Swell	USP-NF-27 XVII	24 cc minimum
Moisture Content	ASTM 4643	10% maximum as shipped
Water Absorption	ASTM E 946	800% typical

- The GCL itself shall have the physical properties listed in Table 10-2 below.

TABLE 10-2

GCL PHYSICAL PROPERTIES

PROPERTY	ASTM METHOD	VALUE
Thickness, typical (mm)	D 1777	5
Clay Mass/Area (psf)	D 3776 (mod.)	1 (at 20% moisture)
Grab Strength (lb)	D 4632	90
Grab Elongation	D 4632	20
Puncture Resistance (lb)	D 4833	102
Permeability (cm/sec)	D 5084	5×10^{-9} cm/sec*

* At 5 psi maximum effective confining stress.

All materials shall be approved by the CQA Officer.

10.5.2 GCL Panel Dimensions

The dimensions of the full-size panels shall be minimal nominal dimensions of 13.5 feet in width and 100 feet in length. "Short" rolls (those manufactured to a length less than 100 feet) are a necessary by-product of the GCL manufacturing process, but will only be allowed at a rate no greater than 5 per truckload or every 36,000 square feet, whichever is less.

10.5.3 Seam Overlap Lines

A 6-inch "lap" line and a 9-inch "match" line shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap. Lines shall be printed in easily visible, non-toxic ink.

10.5.4 Product Documentation

Upon request, the manufacturer shall provide the CQA Officer or other designated party with the QA/QC certifications for each shipment of GCL. The certification shall be signed by a responsible party employed by the manufacturer such as the QA/QC Manager, Production Manager, or Technical Services Manager. The QA/QC certifications shall include:

- GCL lot and roll numbers (with corresponding shipping information).
- Manufacturer's test data for raw materials used in GCL production, including, at a minimum, mass/area data and tensile test data.
- Manufacturer's test data for finished GCL product, including at a minimum, clay mass/area data and tensile testing data.
- Certificates of analysis for the bentonite clay used in GCL production.

10.5.5 Product Labeling

Prior to shipment, the GCL manufacturer shall affix a label to each roll identifying the following characteristics:

- Product identification information (manufacturer name and address, brand name, product code)
- Lot number and roll number.
- Roll length and width.
- Total roll weight.

10.5.6 Packaging

- The GCL shall be wound around a cardboard core 4 inches in diameter to facilitate handling. The core is not intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

- All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

10.6 Execution

10.6.1 Shipping and Handling

- The manufacturer assumes responsibility for initial loading and shipping of the GCL. Unloading, on-site handling, and storage are the responsibility of the installer or other designated party.

- A visual inspection of each roll should be made as it is unloaded to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

- The party responsible for unloading the GCL should contact the manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment to be utilized.

10.6.2 Storage

- Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry, and well-drained.

- Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks or by use of the dunnage shipped between rolls. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four).

- All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

10.6.3 Earthwork

- The surface upon which the GCL is installed shall be prepared an compacted in accordance with the project plans and drawings. All surfaces to be lined shall be smooth and free of debris, roots and sticks, and sharp rocks larger than two inches. At a minimum, the level of compaction should be such that no rutting is caused by installation equipment or other construction vehicles.

- Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no sharp irregularities or abrupt elevation changes shall exist in the subgrade.

- The project RPR shall certify his acceptance of the subgrade before GCL placement.

- It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed above.

- At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated in accordance with the project plans. The trench shall be excavated and approved by the RPR prior to GCL placement. No loose soil shall be allowed at the bottom of the trench, and no sharp corners or protrusions shall exist anywhere within the trench.

10.6.4 GCL Placement

Placement of the GCL shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the CQA Officer.

- During start-up of the GCL installation, an agent or representative of the Manufacturer shall provide on-site assistance and instruction to the Contractor, CQA Officer, and RPR regarding the appropriate installation techniques.

- The use of equipment capable of freely suspending the GCL roll is required. A spreader bar and core pipe are also required for supporting the roll and allowing it to unroll freely. The core bar and spreader bar shall not bend or flex excessively when a full roll is lifted.

- GCL panels shall be placed with the white side (non-woven geotextile) facing down. On sloped areas exceeding a steepness of 4H:1V, the long dimension of all panels shall be oriented parallel to the slope, and the ends of these panels shall be secured in an anchor trench. Panels placed on flat areas require no particular orientation. Panels should be placed from the highest elevation to the lowest within the area to be lined, to facilitate drainage in the event of precipitation. Panels shall be placed free of tension or stress yet without wrinkles or folds. It is not permissible to stretch the GCL in order to fit a designated area. Panels shall not be dragged across the subgrade into position except where necessary to obtain the correct overlap for adjacent panels.

- Panels may be placed in any weather conditions except for heavy rain and extremely high wind.

- The Contractor shall unwrap and install only as much GCL in one working day as can be covered with earthen backfill or a geomembrane. In no case shall the GCL be exposed to the elements at the end of the day.

10.6.5 GCL Panel Seaming

- All GCL seams shall be formed by executing a bentonite-enhanced overlap to ensure that a continuous seal is achieved between panels.

- A 6-inch to 9-inch overlap should exist at seam locations. The lap line and match lines printed on the panels shall be used to assist in obtaining this overlap. The edges of the GCL panels should be adjusted to smooth out any wrinkles, creases, or "fishmouths" in order to maximize contact with the underlying panel.

- After the overlying panel is placed, its edge shall be pulled back to expose the overlap zone. Any soil or debris present in the overlap zone or entrapped in the geotextiles shall be removed. A fillet of granular bentonite shall then be poured in a continuous manner along the overlap zone (between the edge of the panel and the 6-inch line), at a rate of at least one-quarter pound per lineal foot. The use of a watering can or line chalker is recommended to improve the uniformity and consistency of the bentonite enhancement. CQA for this process shall be conducted in accordance with the Manufacturer's CQA plan.

- On gently sloping areas (gentler than 4H:1V) where seams may be placed across the slope, overlaps should be "shingled" so as to prevent flow into the seam.

10.6.6 Damage Repair

- Any damage in the form of cuts or tears in the GCL, shall be identified and repaired by the installer by cutting a patch from unused GCL and placing it over the affected area.

- The damaged area should be removed of all dirt and debris. A patch of GCL shall be cut to fit over the damaged area and to extend one foot in all directions around it. If directed by the manufacturer, accessory bentonite shall then be placed around the perimeter of the affected area at the rate of one-half pound per lineal foot, and the patch shall be placed over the damage. An epoxy-based adhesive shall be used to keep the patch in position during backfill operations.

- RPR will observe uniform 6-inch overlap.

- RPR will observe that placement of geomembrane is performed in a manner that prevents seams in the geosynthetic clay liner from opening.

10.6.7 Detail Work

- Detail work, defined as the work necessary to seal the liner to pipe penetrations, foundation walls, drainage structures, spillways, and other appurtenances, shall be performed as recommended by the GCL Manufacturer.

10.6.8 Placement of Overlying Materials

- If the cover material is soil or aggregate fill, a minimum thickness of 9 inches shall be placed over the GCL. The soil cover shall be free of sharp-edged stones greater than 2 inches in size. The use of especially calcareous cover material shall be prohibited.

- Soil cover shall be placed with low ground pressure equipment. A minimum thickness of 24 inches of cover shall be kept between heavy equipment and the GCL at all times, except when final-grading. No vehicles should be driven directly on the GCL until the proper thickness of cover has been placed. Care should be taken to avoid damaging the GCL by making sharp turns or pivots with equipment.

- To prevent damage to the GCL, the initial lift(s) of soil cover shall not be compacted in excess of 85 percent Modified Proctor density.

- When covering GCL installed on sloped areas steeper than 4H:1V, the cover should be pushed upslope to minimize tension on the GCL.

- If the cover material is a geomembrane or other geosynthetic, precautions shall be taken to prevent damage to the GCL by restricting heavy equipment traffic. Unrolling the geosynthetic can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

- If a textured geomembrane is placed over the GCL, a slip sheet (such as 20-mil smooth HDPE) shall first be placed over the GCL in order to allow the geomembrane to slide into its proper position.

- Any leading edge of panels left uncovered shall be protected at the end of the working day with a waterproof sheet which is adequately secured with sandbags or other ballast.

10.6.9 Activation

For any application in which non-aqueous liquids are to be contained (such as in secondary containment for above-ground storage tanks), the GCL **must** be hydrated after installation is completed. The GCL is **not** a barrier to non-aqueous liquids until it is hydrated with fresh water. This is typically accomplished by natural rainfall; however, if immediate service is required of the lined area, then the area must be artificially hydrated by applying fresh water at the rate of one-quarter gallon per square foot for at least 72 hours prior to use.

END OF SECTION

Section 11
GEOCOMPOSITES

A geocomposite will be installed over the barrier layer in the final cover and the barrier layer in the liner on the 3 (horizontal): 1 (vertical) sideslopes to provide drainage.

This section is divided into three major subheadings, which cover the quality assurance requirements for Pre-Installation, Installation, and Post-Installation. The terms Pre-Installation, Installation, and Post-Installation are applicable only to the geocomposite installation and do not apply to the overall construction.

11.1 Pre-Installation

11.1.1 Manufacturing

Material Specifications

Geotextile and geonet suitable for producing the geocomposite to be used in the landfill final cover are based on the material specifications of the geotextile and geonet listed in Subsections 7.1.1 and 9.1.1, respectively.

Quality Control Requirements/Manufacturer's Certification

The Geocomposite Manufacturer (fabricator) will provide the CQA Officer with certification of geotextile and geonet materials used in the fabrication of the geocomposite rolls delivered to the job site. Requirements for the manufacturer's certification for geonets are described in Subsection 9.1.1. Requirements for the manufacturer's certification of geotextiles are shown in Table 11-1.

11.1.2 Delivery, Handling, and Storage of Geocomposite Rolls

Each geocomposite roll, for use at the landfill facility, will be marked by the Geocomposite Manufacturer with the following information and in the following manner:

1. When fabric is rolled on a core, identify each roll with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.

2. Each roll label will contain the following information at a minimum:

   a. Name of manufacturer (or fabricator)
   b. Style and type number

c. Roll length and width
d. Batch (or lot) number, if applicable
e. Date of manufacture
f. Direction for unrolling
g. Roll number

3. On the outside of the roll, all lettering should be a minimum 1/2 inch high, and on the inside of the core, the lettering should be at least 1/4 inch high.

The Geocomposite Manufacturer will use the following guidelines in packaging, wrapping, and preparing all geocomposite rolls for shipment:

1. When cores are required, use those that have a crushing strength sufficient to avoid collapse or other damage while in use.

2. Cover each roll with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

The following practices should be used as a minimum in receiving and storing geocomposite rolls in the designated storage area at the job-site:

1. While unloading or transferring the geocomposite rolls from one location to another, prevent damage to the geocomposite. If practicable, the Installer may use fork lift trucks fitted with poles that can be inserted into the cores of rolls. Be sure that the poles are at least two-thirds the length of the rolls to avoid breaking the cores and possibly damaging the geocomposite. Do not drag the rolls.

2. Store the geocomposite rolls to ensure that they are adequately covered to protect the geocomposite from the following:

a. Precipitation
b. Ultraviolet radiation, including sunlight
c. Strong oxidizing chemicals, acids or bases
d. Flames, including welding sparks
e. Temperatures in excess of 160°F
f. Soiling

The RPR will observe and document throughout the pre-installation, installation, and post-installation periods for observing and documenting that the Installer provides adequate handling equipment used for moving geocomposite rolls and that the equipment and handling methods used do not pose unnecessary risk of damage. The Installer is responsible for means and methods to implement the work.

The Installer will be responsible for assuring that materials installed meet specifications (*i.e.*, the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geocomposite roll deliveries. The following information, at a minimum, will be recorded on the log for each shipment received at the job-site:

1. Date of shipment from Geocomposite Manufacturer
2. Date of receipt of delivery at job-site
3. For each geocomposite roll, the following information will be noted:
   a. Roll number
   b. Batch (lot) number, if applicable

11.2 Installation

This section describes the quality assurance requirements applicable to the installation and testing of geocomposites. This section includes roll sample testing, installation, observations, and documentation of geocomposites.

11.2.1 Testing Requirements

This subsection describes the test method, including sampling procedures and frequencies, and the role of the Geosynthetic Testing Laboratory in testing the geocomposite roll samples.

Test Method

Unless specified otherwise, all sampling procedures will be performed in accordance with the referenced test method defined in this section.

Geocomposite roll samples will be collected by the RPR. Sample frequency will be based on ASTM D4354, Procedure A, where the number of units per lot is defined as the number of rolls for a specified lot (using batch or lot numbers) delivered to the job site in one shipment. Required sampling frequencies are shown in Table 8-1.

Samples will be 3 feet long by the full width of the roll and will not include the first 3 feet of any roll. Since machine direction for the geocomposite rolls is the direction that the material comes

off the roll, machine direction for any sample will always be along the 3-foot-length dimension of the sample.

Table 11-1 lists the test and the test method to be performed on geocomposite roll samples. The specifications and methods in evaluating the results are discussed below under Procedures for Determining Geocomposite Roll Test Failures.

Results for ply adhesion will be reported for both the machine and cross direction (machine direction will be taken as the direction the geonet is taken off of the rolls).

Role of Testing Laboratory

The Geosynthetic Testing Laboratory will be responsible for performing the test on samples submitted to them as described above. Results of tests performed will be reported to the CQA Officer and the RPR.

Retesting of geocomposite rolls for quality assurance purposes, because of failure to meet any or all of the specifications listed below, can only be authorized by the CQA Officer.

The Geocomposite Manufacturer (fabricator) and/or installer may perform their own tests according to the methods and procedures defined in Table 11-1; however, the results will only be applicable to their own quality control needs. These results will not be substituted for the quality assurance testing described herein.

Procedures For Determining Geocomposite Roll Test Failures

Table 10-1 lists the accepted values that are applicable to the geocomposite. The values in Table 10-1 are based on minimum values.

The following procedure will be used for interpreting results relative to acceptance or rejection of rolls and shipments of geocomposites to the site:

1. Test results for the stated specifications in Table 11-1 will be evaluated in accordance with ASTM D4759 for determining acceptance of roll shipments.

2. The RPR will coordinate and document the conformance testing and the determination of material acceptance or rejection.

TABLE 11-1

GEOTEXTILE COMPONENT OF GEOCOMPOSITE ACCEPTANCE SPECIFICATIONS

PROPERTY	UNITS	ACCEPTABLE VALUE	TEST METHOD	TYPE OF CRITERION
Ply Adhesion - Machine Direction	ppi	1.0	ASTM F904	Minimum
Ply Adhesion - Cross Direction	ppi	1.0	ASTM F904	Minimum
Apparent Opening Size	NA	No. 70	ASTM D4751	Minimum
Grab Strength	lb	50	ASTM D4632	Minimum
Grab Strength Elongation	Percent	30	ASTM D4532	Minimum
Trapezoidal Tear	lb	75	ASTM D4533	Minimum
Puncture Strength	lb	95	ASTM D4833	Minimum
Mullen Burst Strength	lb/sq in.	360	ASTM D3786	Minimum
Permittivity	ga/min/ft^2	110	ASTM D4491	Minimum

11.2.2 Placement

The Installer will install all geocomposites in such a manner as to ensure that they are not damaged in any way and in a manner that complies with the following:

1. On sideslopes, the geocomposites will be securely anchored, then rolled down the slope in such a manner as to continually keep the geocomposite in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles.

2. In the presence of winds, all geocomposites will be secured by suitable methods. The temporary weighted material will be left in place until replaced with cover material as shown on the design plans and specifications.

3. Cutting should be done according to manufacturer's recommendations.

4. The Installer will take necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

5. During placement of geocomposites, care will be taken not to entrap any stones, excessive dust, or moisture that could cause clogging of the drainage system.

11.2.3 Overlaps and Joining

The following requirements will be used with regard to overlapping and joining of geocomposite rolls:

1. Adjacent rolls will be overlapped by a minimum of 4 inches.

2. These overlaps may be secured by tying to each other.

3. Tying can be achieved by strings, plastic fasteners, or polymer braid. Tying devices will be black or brightly colored for easy identification. Metallic devices will not be used in any circumstances.

4. No horizontal joints or overlaps will be allowed on slopes greater than 5-horizontal to 1-vertical (*i.e.*, seams will be along, not across, the slope), except as part of a patch.

11.2.4 Repairs

Any tears or other defects in the geocomposite will be repaired by placing a patch extending a minimum of 2 feet beyond the edges of the hole or tear. The patch will be secured to the original geocomposite by tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geocomposite

material. Tying devices will be as indicated in Subsection 11.2.3. The RPR will examine and document that the repair of any geonets is performed according to the above procedure.

11.3 Post-Installation

11.3.1 Final Examination

The RPR will perform a final geocomposite examination after installation of each geocomposite layer has been completed. The objectives of this step are as follows:

1. Examine for presence of tears or defects
2. Examine overlaps to make certain that they are in conformance with the requirements of Subsection 11.2.3.

If any portion of the geocomposite requires repairs due to the above examination, they will be performed according to the procedures in Subsection 11.2.4.

If there will be an extended time delay between completion of the geocomposite and the start of the installation of any overlying cover, the Installer will make provisions, by using a temporary covering or other suitable methods, to protect the upper geotextile component against exposure to sunlight and ultraviolet radiation.

11.3.2 Placement of Soil Materials

The construction contractor will place all soil materials located on top of the geocomposite in such a manner as to minimize the following:

1. Damage of the geocomposite.
2. Slippage of the geocomposite on underlying layers.
3. Excessive tensile stresses imposed on the geocomposite.

If portions of the geocomposite are exposed, the RPR will periodically place two (or more, at his discretion) marks on the geocomposite 10 feet apart along the slope and measure the elongation of the geocomposite during the placement of soil.

END OF SECTION

Section 12

SELECT ASH FILL

Select ash fill refers to select ash material that will be placed as a leveling course over the liner granular material, and on the waste as it approaches final grade to provide a levelling course prior to placement of the final cover.

12.1 Procedures and Observations

The RPR will observe select ash fill placement activities and document relevant observations to support certification of the following requirements:

1. Select ash fill material shall be free of cinders and solid impurities capable of puncturing the geosynthetic clay liner (GCL) or the geomembrane.

2. Select ash fill shall be placed in 8-inch loose depth maximum lifts and compacted with a minimum of two passes of the compaction equipment.

3. The completed select ash fill layer shall have a uniform surface.

12.2 Field and Laboratory Testing

Field and laboratory testing of select ash fill material is not required, however, as discussed in Subsection 12.1 above, the RPR will observe and document the consistency of the fill material and placement procedures.

12.3 Thickness Documentation

The top and bottom of the select ash fill layer will be surveyed on a 50-foot grid pattern. The minimum acceptable compacted thickness will be 12 inches vertical in the liner and 6 inches vertical in the cap.

END OF SECTION

Section 13
PIPING

This section of the CQA Plan applies to piping used in the leachate collection and removal system in the landfill liner and in the gas removal system. This section is divided into three major subheadings which cover the QA requirements for the Pre-installation (which includes resin manufacturers, piping manufacturers, and fabricators), installation, and Post-installation (which includes the final observation and documentation of piping installations prior to installation of other materials over and around the pipe). These terms Pre-installation, Installation, and Post-installation are applicable only to the piping installation and do not apply to the overall construction.

Individual pipe sizes and standard dimension ratios (SDRs) to be used for each individual pipe installation are not detailed in this section, rather the plans and specifications should be used for the determination of correct size and wall thickness.

13.1 Pre-Installation

This section describes the QA measures that are applicable to the polyethylene (PE) resin manufacturers, piping manufacturers, piping fabricator used to perforate the pipe, and finished piping delivery to the site, prior to installation.

13.1.1 Manufacturing

Material Specifications

Any pipe used must be made from extra high molecular weight (EHMW) polyethylene (PE) resin, and the manufactured piping must be classified as Type III, Class C, Category 5, Grade P34 material according to ASTM D1248 and also have a cell classification of 345434C as defined by ASTM D3350. Pipe shall be free of paint or other surface treatments.

Quality Control Requirements

Prior to the delivery of any piping to the site, the piping manufacturer will provide the CQA Officer with the following information:

1. The resin supplier, location of suppliers production plant(s) and resin brand name and product number.

2. Any test results obtained by the piping manufacturer and/or the pipe manufacturer's testing laboratories to document the quality of the resin used in manufacturing the piping.

3. The Quality Control Plan that the piping manufacturer will be using for the pipe being supplied.

Fabricator

The Piping Fabricator will be responsible for perforating the pipe, delivered by the Piping Manufacturer, according to the plans and specifications. The Piping Fabricator will be responsible for preparing and shipping the perforated pipe to the job-site. Marking of the pipe must be performed in accordance with Subsection 13.1.2.

Manufacturer's Certification

The Piping Manufacturer will provide certification, based on tests performed by either the Piping Manufacturers laboratory or other outside laboratory contracted by the Piping Manufacturer, that the pipe supplied under this plan will meet the following specifications:

1. The finished pipe is classified as Type III, Class C, Category 5, Grade P34 according to the provisions of ASTM D1248.

2. The finished pipe meets the cell classification of 345434C according to the provisions of ASTM D3350.

3. The finished pipe has the SDR value specified.

13.1.2 Delivery, Handling, and Storage of Piping

Each bundle of pipe prepared for shipment by the Piping Fabricator will be marked with the following information:

1. Nominal Size
2. Dimension Ratio
3. Pressure Rating
4. Type (Manufacturer)
5. Material Classification
6. Certification Bases
7. Blank Position for NSF/FM Use
8. Pipe Test Category
9. Plant

10. Extruder Number
11. Date
12. Operator Number
13. Shift Letter
14. Resin Supplier Code

EXAMPLE: 10" IPS SDR 15.5 110 psi (Trade Name) PE 3408 ASTM F-714 NSF-pw C3 P5 06FEB89 55A P

The pipe will be protected, during shipment, from excessive heat or cold, puncture, or other damaging or deleterious conditions. The pipe will be stored on-site in a manner suitable to protect it from long-term ultraviolet exposure, prior to actual installation.

The RPR will observe and document throughout the pre-construction, construction, and post-construction periods that the installer provides adequate handling equipment for moving pipe and that the equipment and handling methods used do not pose unnecessary risk of damage. The installer is responsible for means and methods to implement the work.

The installer will be responsible for making certain that the manufacturer, type and size of each pipe is correct. The RPR will maintain a log of pipe deliveries throughout the installation. The following information at a minimum will be recorded on the log for each shipment received at the job site:

1. Date of shipment from piping manufacturer
2. Date of receipt of delivery at job site
3. For each pipe, the following information will be noted:
   a. Pipe size and type
   b. Batch (lot) number

13.2 Installation

This section describes the requirements applicable to pipe installation. This section includes installation, observations, and documentation of piping installations.

13.2.1 Pipe Seams

Unless approved otherwise by the CQA Officer, all pipe seams will be made by the butt fusion procedure as defined by Phillips Driscopipe, Inc. and Plexco Piping Company. Sections of polyethylene pipe should be joined into continuous lengths on the job site above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400°F, alignment, and 75 psi interfacial fusion pressure. Butt fusion joining shall be 100 percent efficient offering a joint weld strength equal to or greater than the tensile strength of the pipe. Socket fusion shall not be used. Extrusion welding or hot gas welding of HDPE shall not be used for pressure pipe applications nor in fabrications where shear or structural strength is important. Flanges, unions, grooved-couplers, transition fittings and some mechanical couplers may be used to mechanically connect HDPE pipe without butt fusion. Refer to the manufacturer's recommendations. The following procedures will be used regarding butt fusion seams:

1. Seams should be made at the pipe manufacturer's recommended heater plate temperature of approximately 400°F for fusing pipe and fittings.

2. For pipe diameter sizes 4" (nominal) and larger seams will be made using the hydraulic fusion machines. For pipe diameters of less than 4" manual fusion equipment can be used.

3. Care will be taken to make certain that adequate pressures are used for fusing pipes and that sufficient cooling periods are allowed prior to testing, bending, or backfilling of pipe sections.

13.2.2 Placement Requirements

Pipe placement will be done in accordance with the following procedures and requirements:

1. Piping placement will not be performed in the presence of excessive moisture. the RPR will document that this condition is fulfilled. Additionally, the RPR will document that the supporting backfill has not been damaged by weather conditions. The RPR will inform the CQA Officer is any of the above conditions are not fulfilled for evaluation of the necessity of corrective action.

2. The prepared surface underlying the piping has not deteriorated since previous acceptance, and it is still acceptable immediately prior to piping placement.

3. Method used to place the piping does not cause damage to the piping and does not disturb the supporting backfill.

4. The RPR will observe and document all pipe installation. Deviations from the plans and specifications will be brought to the attention of the CQA Officer for evaluation of the necessity of corrective action.

5. The RPR will observe and document the placement of geotextile filter to line the trenches and placement of pipe bedding stone around collector pipes according to the plans and specifications and the procedures described in Subsection 7.2.1.

6. Observations and measurements should be made to ensure that the pipes are the specified size, manufactured of the specified material, and that pipe perforations are sized and spaced as specified.

7. All piping should be located as noted in the plans and specifications. Locations, grades, and size requirements are specified on the details of the plan set. Observations and surveying measurements should be made to ensure the pipes are placed at the specified locations and grades, and in the specified configuration. Observations should be made throughout the construction to ensure that backfilling is completed as specified in the plans and specifications and that, in the process, the pipe network is not damaged.

13.2.3 Pipe Boots

Pipe boots shall be installed as shown on approved shop drawings with a continuous extrusion weld joining the pipe to the geomembrane liner. The RPR shall observe all pipe boot installations.

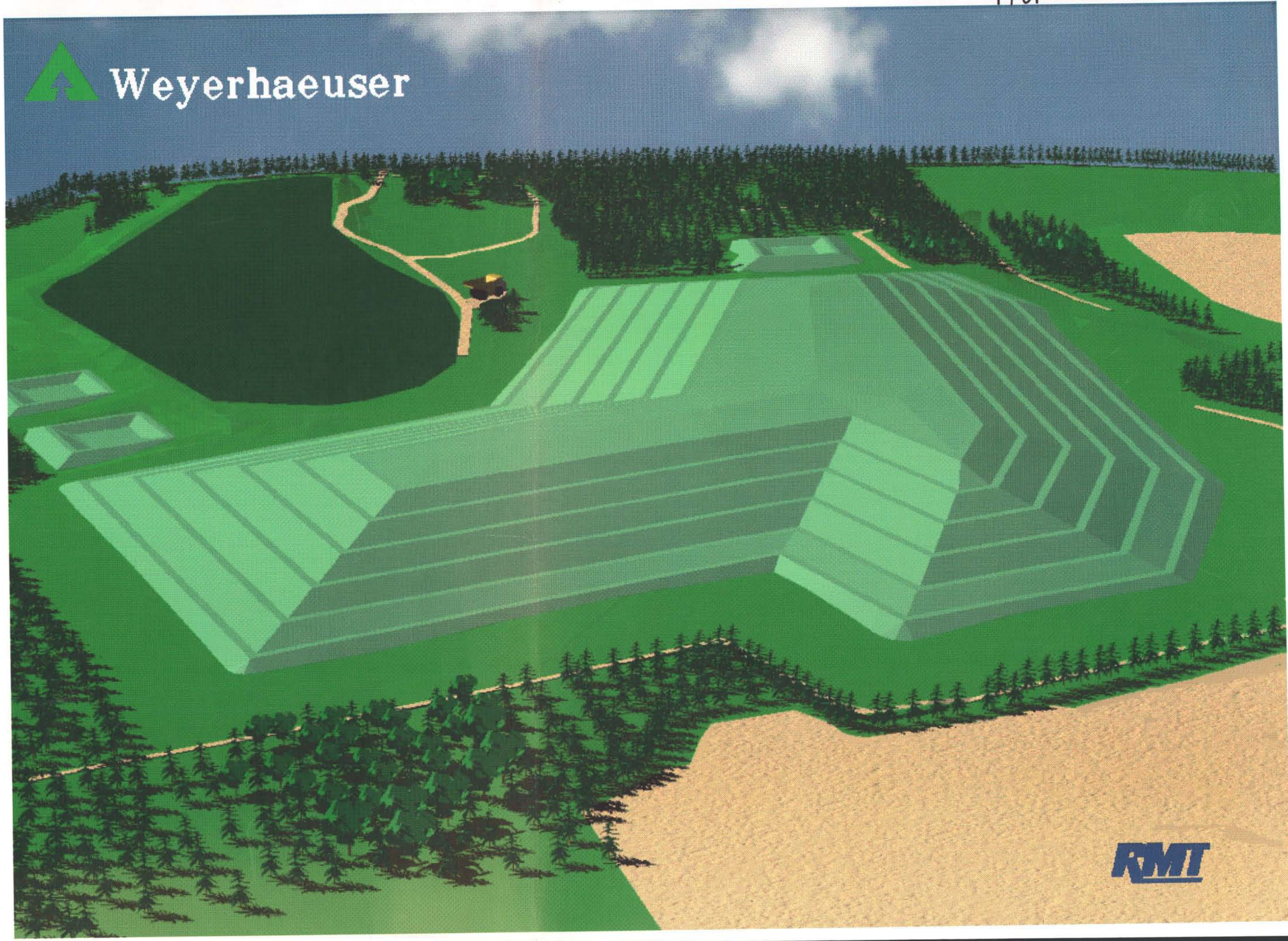
13.2.4 Damages

The RPR will examine each pipe after placement for damage. Damaged pipes or portions of pipes which have been rejected will be marked and removed from the installation area and documented by the RPR.

13.3 Post-Installation

Pipe inverts (or top of pipe elevations) and coordinate locations shall be surveyed at 50-foot intervals and at all tee connection locations. Additional surveying requirements regarding granular soil backfill placement are discussed in Subsection 6.3.

END OF SECTION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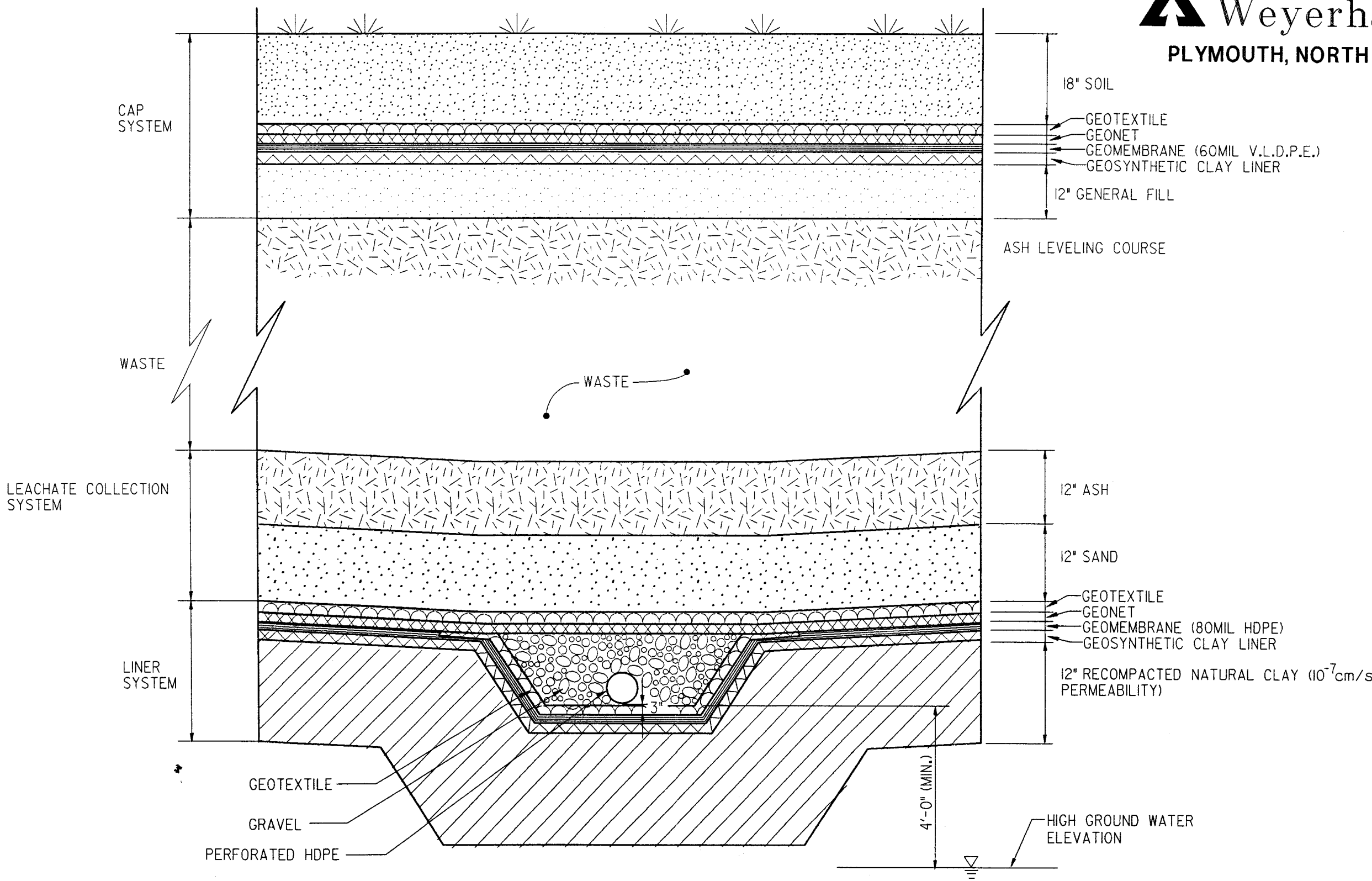
PLYMOUTH, NORTH CAROLINA



TYPICAL FACILITY SECTION - OPTION I

N.T.S.

RMT INC.	Drawn By: E. TERRY
	Approved By: P.W.
	Date: 6-28-93
	Proj. No.: 467.49

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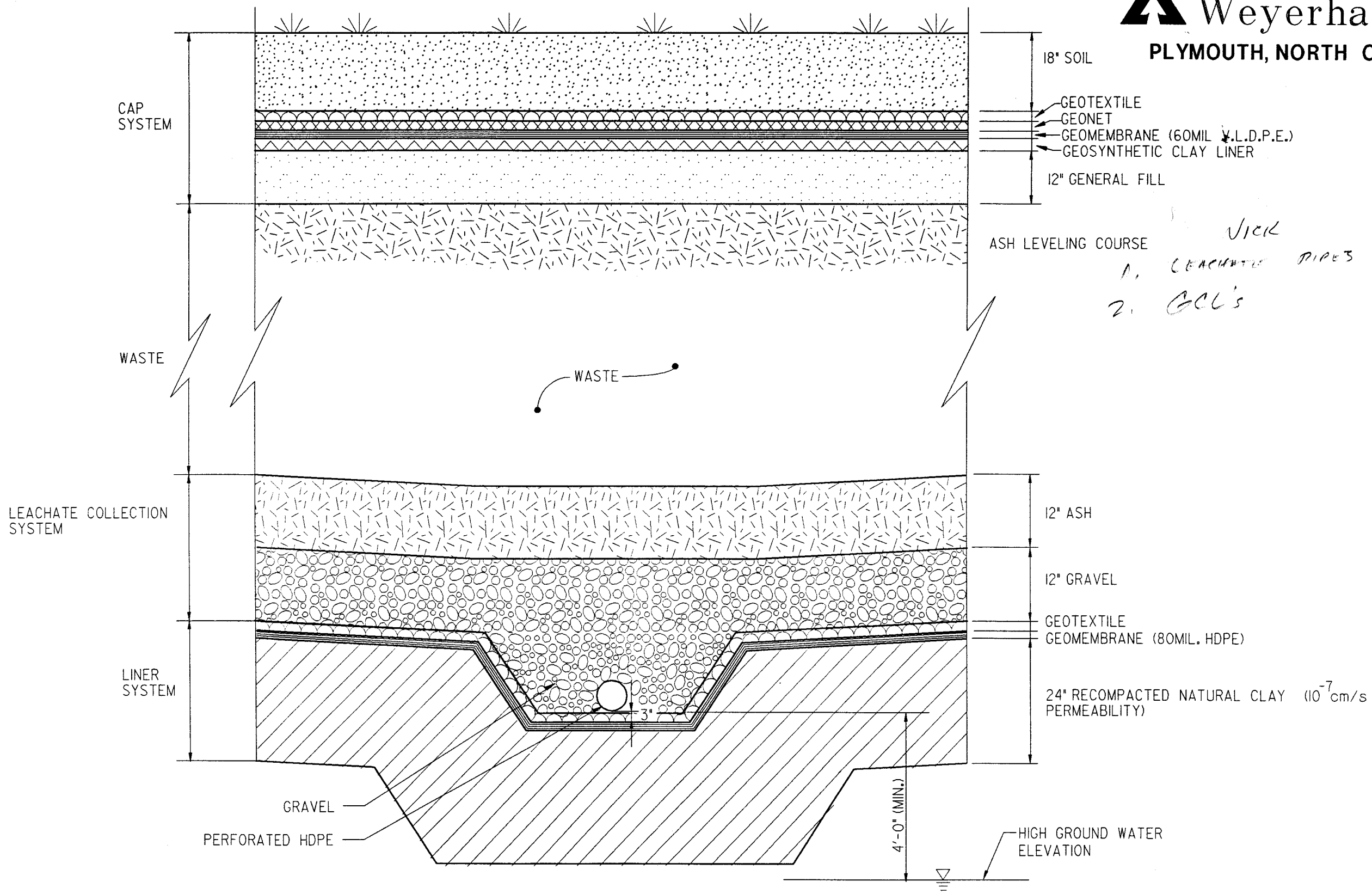
MPM 6-28-93

Weyerhaeuser
PLYMOUTH, NORTH CAROLINA



VICK
1. LEACHATE PIPES
2. GCL's

TYPICAL FACILITY SECTION - OPTION II

N.T.S.

RMT INC.

Drawn By: M. MYERS
Approved By: P.W.
Date: 6-28-93
Proj. No.: 467.49

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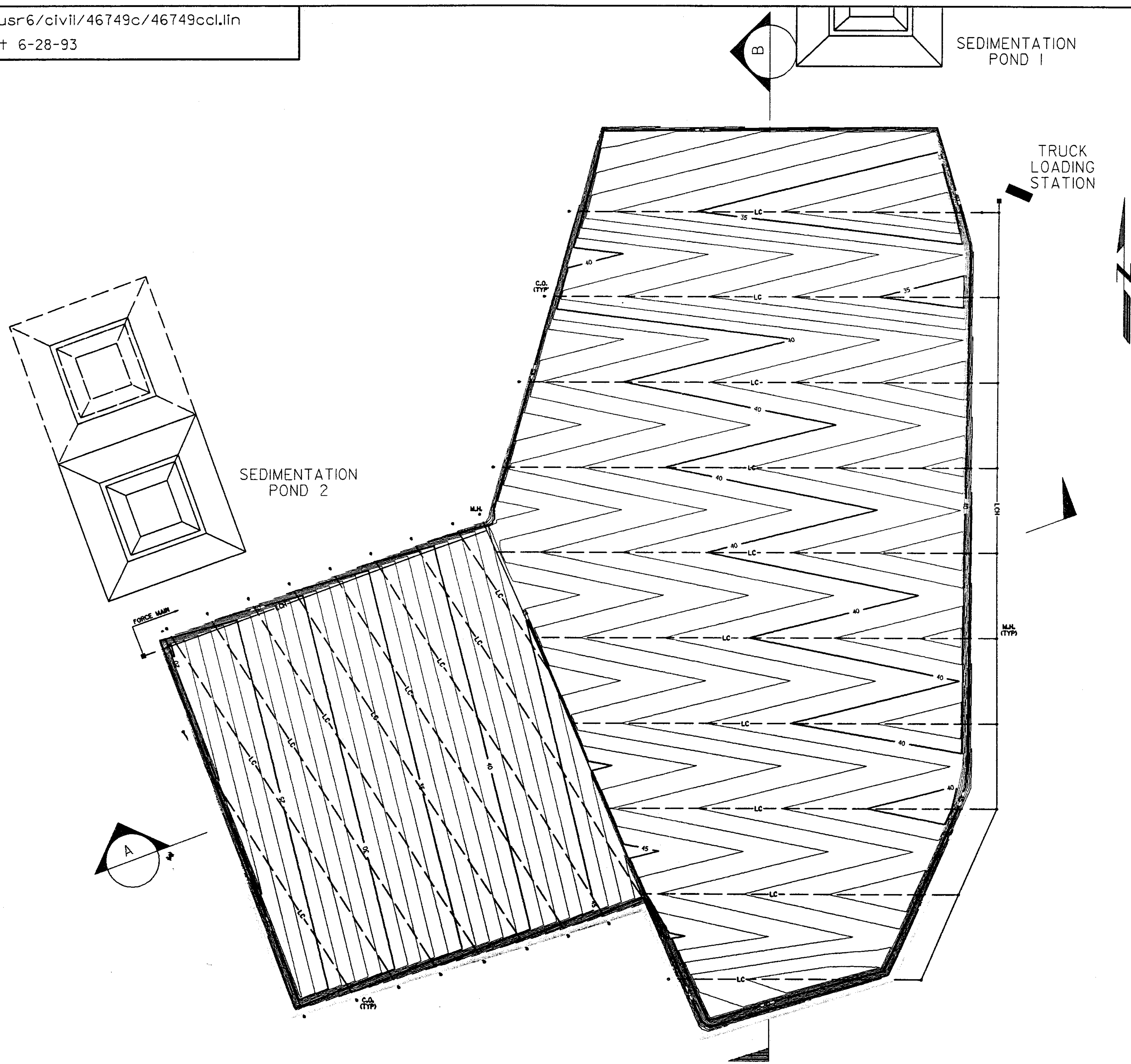

Weyerhaeuser
PLYMOUTH, NORTH CAROLINA

0 3000' 6000'
SCALE: 1" = 3000'

RMT INC.

Drawn By: E. TERRY	
Approved By: P.W.	
Date: 6-28-93	
Proj. No.: 467.49	

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MPM 6-28-93

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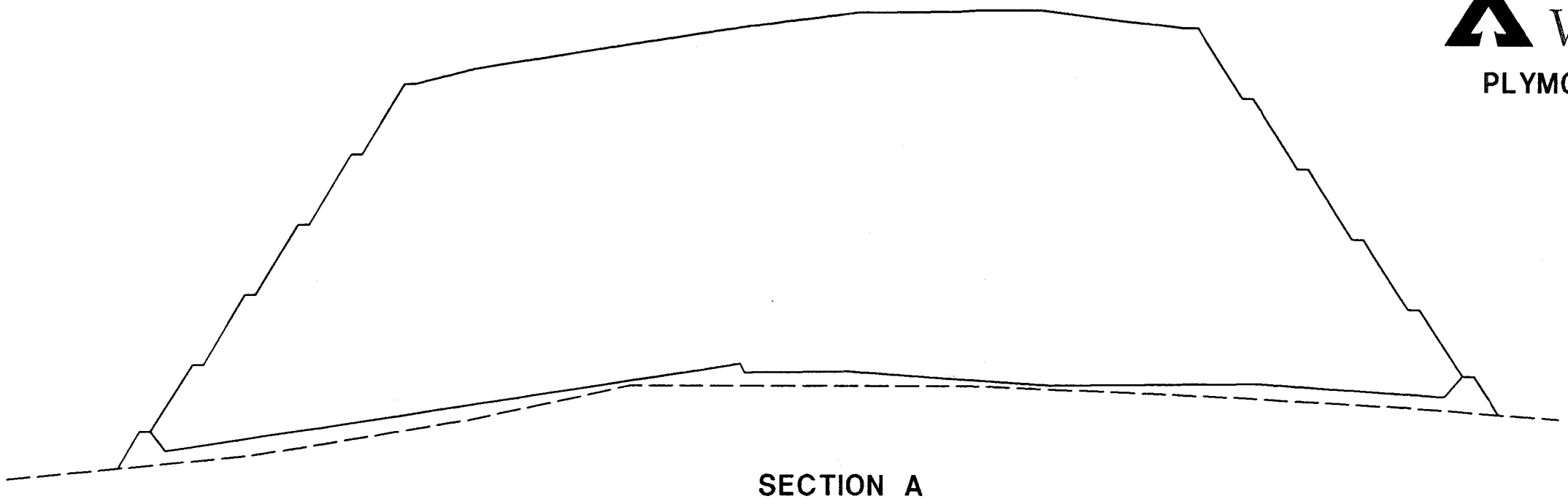
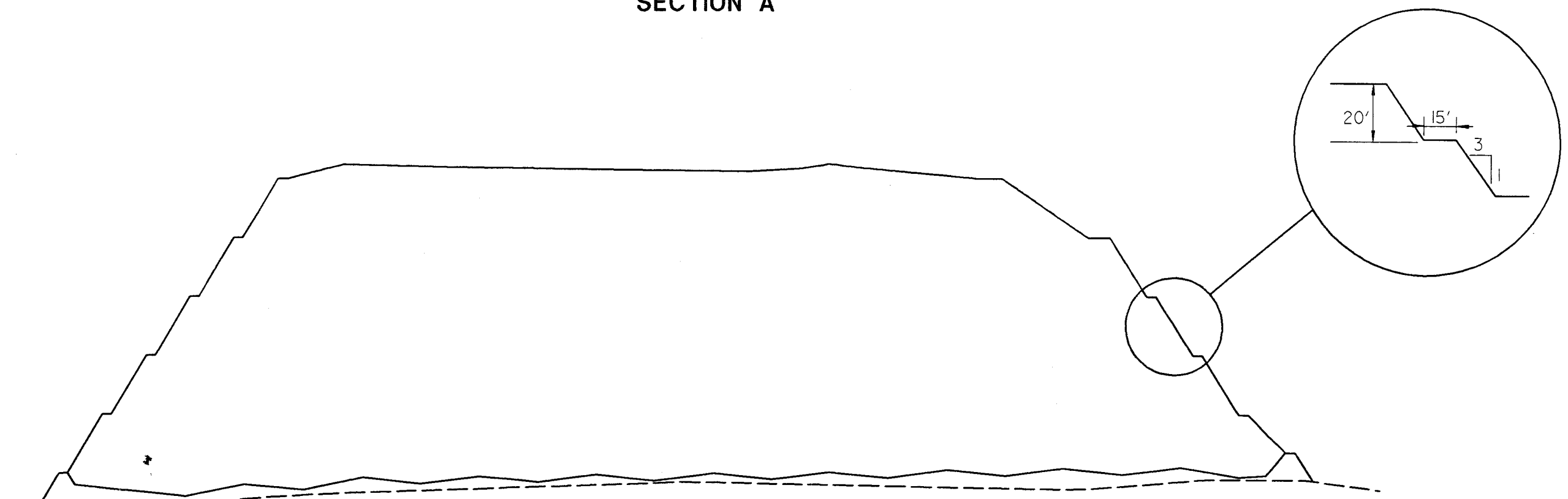


SECTION A



SECTION B

RMT INC.	Drawn By: E. TERRY
	Approved By: P.W.
	Date: 6-28-93
	Proj. No.: 467.49