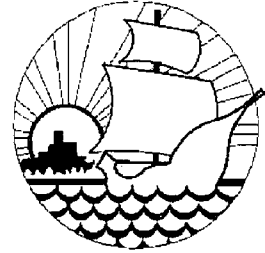


**Manatee County
Florida**



Lena Road Landfil

**Construction Quality
Assurance Plan**

**HDR Project Number:
07982-029-096**

March 16, 2000

HDR
HDR Engineering, Inc.

CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN

**PARTIAL CLOSURE NUMBER 2
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA**

March 16, 2000

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FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION

MAR 17 2000

SOUTHWEST DISTRICT
TAMPA

Prepared for:

**Manatee County, Florida
Project Management Department**

Prepared by:

HDR Engineering, Inc.

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SECTION 1.0

INTRODUCTION

The purpose of this document is to provide the quality assurance requirements for the construction of the final cover system for the Lena Road Landfill in Manatee County. The Construction Quality Assurance (CQA) Plan contains the minimum inspection, testing, manufacturing, material and installation requirements needed to ensure that the design requirements of the final cover system are met during construction. This document addresses the test methods, test frequencies and documentation necessary to ensure adherence to the permitted landfill design. At the completion of construction of each phase, a Construction Quality Assurance Report will be submitted to Florida Department of Environmental Protection (FDEP) based on the implementation of the CQA Plan

In addition to the methods, procedures and requirements outlined in this CQA Plan, refer to the following documents:

- FDEP Regulations Chapter 62-701.400
- Project Specifications
- Manufacturer's Quality Assurance Manuals (where applicable)
- FML Installer's Construction Quality Control Plan
- ASTM Standards - Latest Edition

The final cover system for the Lena Road Landfill is composed of the following components:

- Eighteen-inch thick subbase overlying the waste, which is composed of soils with the necessary strength to provide an interface friction angle of 24 degrees between the subbase and the overlying geomembrane.
- 40-mil thick linear low density polyethylene (LLDPE) geomembrane liner overlying the subbase. The liner is to be smooth on the top deck and textured (both sides) on the side slopes
- Geocomposite drainage layer is placed over the LLDPE liner.
- Eighteen-inch thick protective soil cover is placed over the liner system, composed of soils with the necessary strength to provide an interface angle of 24 degrees between the protective cover and underlying geosynthetics.
- Six-inch thick vegetative soils layer capable of sustaining vegetation.

This section provides the definitions for terms used in this CQA Plan.

Earthwork Contractor - The firm responsible for excavation and subbase preparation under the liner installation. The firm may also be responsible for placing protective cover and drainage materials over the installed lining system. In many cases, the General Contractor serves as the Earthwork Contractor.

Flexible Membrane Lining (FML): - Essentially an impermeable synthetic material used as an integral part of a lining system. It is sometimes referred to as a geomembrane, sheet or panel. On this project, the FML will consist of a Linear Low Density Polyethylene (LLDPE) material. Smooth liner will be used on the top deck and textured material on the side slopes.

FML Installation Subcontractor - The firm responsible for handling, storing, placing, seaming, and other aspects of the installation of the FML, geosynthetic cushion, geonets and geotextiles as a part of the composite lining system.

Geosynthetics - A generic classification given to synthetic (man-made plastic) materials used in geotechnical engineering applications. Included are flexible membrane lining, geotextiles, geonets, geogrids, geocomposites and geocells.

Geotechnical Professional (GP) - Person(s) of firm(s) authorized by the Owner to manage and oversee the execution of the work. This includes a professional engineer registered in the State of Florida who possesses professional experience in geotechnical engineering and testing, or a graduate geologist who has a minimum of four years experience in engineering geology and is experienced in geotechnical testing and its interpretations. The Geotechnical Professional is also responsible for observing, testing and documenting activities related to liner quality assurance during the installation of the lining system.

Geonet - A 3-dimensional netlike polymeric material used for drainage

Geocomposite or Geonet Composite - A combination of geonet and geotextile bonded together and used as a drainage layer.

Geotextile - A permeable synthetic textile used with soil, rock, sand, gravel or any other similar materials as an integral part of the composite lining system. It provides protection to the FML as a geosynthetic cushion and also serves as a filter interface between two types of soil materials.

Manufacturer - Firm(s) responsible for the production of FML, geonet, geotextile and geocomposite from resin.

Owner or County - Manatee County, Florida

Project Documents - All FML Installation Subcontractor submittals, construction plans, record plans, construction specifications, QA plan, safety plan and project schedule.

Project Plans and Specifications - All project related plans and specifications including design modifications and as-built plans.

Protective Layer - The soil layer(s) over the Flexible Membrane Liner, composed of clean (select) borrow free of sharp objects or other contaminants as specified in the Construction Plans and Specifications or Record Drawings and top soil as specified in the Construction Plans and Specifications or Record Drawings.

Qualified Engineering Technician - The qualified representative of the Geotechnical Professional who is NICET - Certified in Geotechnical Engineering Technology at Level 1 or higher, who is an engineering technician with a minimum of four years of directly related experience or a graduate engineer/geologist with one year of directly related experience.

Quality Assurance - Actions taken by the Geotechnical Professional (GP) to assure conformity of the liner system production and installation with the Quality Assurance Plan, drawings and specifications. QA is provided by a party independent of installation.

Quality Assurance Laboratory - The firm responsible for conducting tests on samples of liner system components taken from the site. The laboratory shall be independent of the Owner, Manufacturer, FML Installation Subcontractor and any party involved with the manufacture and/or installation of any of the geosynthetics.

Quality Control - Actions taken by the FML manufacturers and FML Installation FML Installation Subcontractor to ensure that the geosynthetic materials and workmanship meet the requirements of project plans and specifications.

Subgrade - Soil base on which the liner system will be placed. Subgrade is synonymous for subbase.

Work - All tools, equipment, supervision, labor and material or supplies necessary to complete the project as specified herein and as shown on the plans.

SECTION 2.0

RESPONSIBILITY AND AUTHORITY

The principal organizations involved in permitting, designing and construction of the solid waste disposal facility include the permitting agency, facility owner/operator, design engineer, CQA Engineer, General Contractor ("Contractor") who usually constructs the earthwork and drainage portions of the project and the FML Installation Subcontractor. The principal organizations, their areas of responsibility and lines of authority as delineated for the CQA Plan are listed below. This establishes the necessary lines of communication that will facilitate an effective decision making process during implementation of the CQA Plan.

2.1 Permitting Agency

The Florida Department of Environmental Protection (FDEP) as permitting agency is authorized by law to issue a permit for the construction of a solid waste disposal facility. It is the responsibility of the FDEP to review the facility owner/operator's permit application, including the site-specific CQA Plan, for compliance with FDEP's regulations and to make a decision to issue or deny a permit based on this review. The FDEP has the responsibility and authority to review and accept or reject any design revisions or requests for variance that are submitted by the facility owner/operator after the permit is issued. The FDEP also has the responsibility and authority to review all CQA documentation during or after facility construction to confirm that the approved CQA Plan was followed and that the facility was constructed as specified in the design.

2.2 Facility Owner/Operator

Manatee County, Florida ("County") is the facility owner/operator and is responsible for the design, construction, and operation of the solid waste disposal facility. This responsibility includes complying with the requirements of the FDEP in order to obtain a permit and assuring the FDEP, by the submission of CQA documentation, that the facility was constructed as specified in the design. The County has the authority to select and dismiss organizations charged with design, CQA, and construction activities. The County also has the authority to accept or reject design plans and specifications, CQA Plans, reports and recommendations of the CQA Engineer, and the materials and workmanship of the FML Installation Subcontractor.

2.3 Design Engineer

HDR Engineering, Inc. ("Engineer") is the design engineer and is primarily responsible for designing a solid waste disposal facility that fulfills the operational requirements of the County and the performance requirements of the FDEP. Design activities shall not end until the facility construction is completed; the Engineer may be requested to change some component designs if unexpected site conditions are encountered or changes in construction methodology occur that could adversely affect facility performance. CQA provides assurance that these unexpected changes or conditions will be detected, documented, and addressed during construction.

The County has the authority to delegate additional responsibility and authority to the Engineer by expressed consent (i.e., a contractual agreement). Additional responsibilities and authority include formulating and implementing a site-specific CQA Plan, periodic review of CQA documentation, modifying construction site activity, and identifying corrective measures in cases where deviation from the specified design or failure to meet design criteria, plans, and specifications is detected by the CQA Engineer.

2.4 Construction Observation Engineer

The Construction Observation Engineer (COE) is a Professional Engineer registered in Florida, employed by or under contract to the Owner, who is charged with construction observation. The COE or his representative is charged with coordinating project meetings and observing and documenting construction activities as assigned in Sections 3.0, 4.0 and 5.0. The Construction Observation Engineer will coordinate all construction observation reports including record drawings and prepare construction certification documents.

2.5 Construction Quality Assurance Engineer

The overall responsibility of the Construction Quality Assurance Engineer (the "CQAE") is to perform the activities specified in the CQA Plan (e.g., inspection, sampling, documentation). At a minimum, CQAE personnel includes an engineer registered with experience in liner construction in Florida and any necessary supporting inspection personnel. The responsibilities and authority of each of these individuals are clearly defined in this CQA Plan and in the associated contractual agreements with the County. Specific responsibilities of the CQAE include:

- a. Reviewing design criteria, plans, and specifications for clarity and completeness to insure that the CQA Plan can be implemented.
- b. Educating CQA inspection personnel on CQA requirements and procedures.
- c. Scheduling and coordinating CQA inspection activities.
- d. Directing and supporting the CQA inspection personnel in performing observations and tests by:
 - Confirming that regular calibration of testing equipment is properly conducted and recorded.
 - Confirming that the testing equipment, personnel, and procedures do not change over time and assuring that any changes do not adversely impact the inspection process.

- confirming that the test data are accurately recorded and maintained (this may involve backtracking selected reported results to the original observation and test data sheets)
 - verifying that the raw data are properly interpreted, recorded, validated, reduced, and summarized
- e. Providing reports to the Engineer on the inspection results including:
- review and interpretation of all data sheets and reports
 - identification of work that the CQAE believes should be accepted, rejected, or uncovered for observation, or that may require special testing, inspection, or approval
 - rejection of defective work and verification that corrective measures are implemented
- f. Verifying that the FML Installation Subcontractor's construction quality control plan is in accordance with the site-specific CQA Plan.
- g. With the Engineer's approval, reporting to the Contractor/FML Installation Subcontractor the results of all observations and tests as the work progresses, and interacting with the FML Installation Subcontractor to provide assistance in modifying the materials and work to comply with the specified design.
- h. Providing signed, sealed final report and record drawings to the Engineer stating that the final cover system has been installed in substantial conformance with the plans and specifications.

For the supporting CQAE inspection personnel, specific responsibilities include:

- a. Performing independent onsite inspection of the work in progress to assess compliance with the facility design criteria, plans, and specifications
- b. Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by the CQA Plan.
- c. Reporting to the CQAE results of all inspections including work that is not of acceptable quality or that fails to meet the specified design.

2.6 Construction Quality Assurance Laboratory

The Construction Quality Assurance Laboratory (CQAL) shall be a qualified laboratory (not hired by the Contractor, FML Installation Subcontractor or FML manufacturer) retained to perform the closure construction. The CQAL shall be responsible for performing and reporting the results of all conformance and construction quality assurance tests (See Tables 4-1, 5-1 and 5-2.) and reporting them to the CQAE.

2.7 General Contractor or "Contractor"

The responsibility of the Contractor includes organizing and scheduling the work including coordination of subcontractors, laboratory testing and communication with the Engineer and Owner. It is generally anticipated that the Contractor will do the earthwork portion of the project and perhaps drainage device installation.

2.8 FML Installation Subcontractor

It is the responsibility of the FML Installation Subcontractor to construct the solid waste disposal facility in strict accordance with design criteria, plans, and specifications, using the required construction procedures and techniques.

The responsibilities include but are not limited to:

- a. Approve shop drawings prior to submission to the Engineer.
- b. Determine and verify:
 - Field measurement
 - Field construction criteria
 - Catalog numbers and similar data
 - Conformance to Specifications
- c. Coordinate each submittal with other submittals and with the requirements of work and of the Plans and Specifications.
- d. Notify the Engineer in writing, at time of submission, of any variance in the submittals from the requirements of the Plans and Specifications. Any such deviations permitted by the Engineer will require modifications to the Plans and Specifications.

SECTION 3.0

SUBGRADE AND PROTECTIVE LAYERS

This section contains procedures and tests which must be implemented in order to ensure the soil components of the final cover system meet the design standards. This is a critical component of the Construction Quality Assurance Plan. All required tests and sampling procedures within this section shall be performed in accordance with generally accepted engineering procedures.

3.1 Subbase

3.1.1 Preconstruction

Soil material to be used as subbase shall consist of select borrow meeting all requirements specified in applicable permits and contract documents. The borrow for liner subbase must be of approved regular borrow unless otherwise specified or noted on drawings. If fill comes from an off-site location, submit to CQAE for approval a minimum of 48 hours prior to intended use.

Refer to the following standard references or project specifications with respect to materials test and physical parameters.

1. Florida Department of Transportation Standard Specifications for Road and Bridge Construction, Latest Edition
2. ASTM D2488, D422, D4318 and D2487

Soil for the subbase should be free of deleterious material (sticks, roots, waste, etc.) or rock fragments, boulders or cobbles greater than 1 inch in size. Fines content of installed soil shall be a maximum of 10% (passing #200 sieve) and monitored as specified in Table 3-1.

Prior to installation, the Contractor shall have the soil to be used for the subbase layer tested by a qualified laboratory to demonstrate that the materials demonstrate a minimum 24 degree interface friction angle between all layers of the final cover system. See Section 4.2.4 for specific test procedures.

The CQA personnel on-site shall test materials and monitor compliance with requirements of the project specifications. All observation and tests shall be conducted at locations selected by the party (COE or CQAE) who has been assigned responsibility for verification and documentation of the element in question.

3.1.2 Construction

The following is an outline of the minimum construction requirements for the subgrade. For more detailed information see the project Plans and Specifications.

- a. Obtain approval from CQAE with regard to suitability of soils and acceptable subgrade.
- b. Regrade waste and/or soil cover or install soil cover over in-place waste to provide layer thicknesses, slopes and elevations as specified in drawings upon completion. If design elevations are not all achievable with in-place waste and soil, the cover system can be constructed with the approval of the COE achieving only the specified slopes and layer thicknesses.
- c. Proof roll subbase soils with a ten (10) ton drum roller, two (2) passes in each of two (2) perpendicular directions or as directed by COE or CQAE. The subbase shall be compacted and proof rolled under observation of the COE to assure the maximum practical compaction under the existing field conditions has been achieved. No numerical compaction specification is provided because it is not necessary for stability of the subgrade and protection of the FML and because field conditions over the in-place fill will vary from day to day and location to location. Soils must be within a range of suitable moisture content that allows for compaction.
- d. All soft soils identified during proof rolling shall be reworked or removed and backfilled with suitable fill material and recompacted. Remove loose, wet, soft or frozen material and replace with approved material as directed by CQAE.
- e. The CQAE will inspect the final surface for smoothness and uniformity. Any objects protruding from the final surface or coarse fragments within the surface material that may result in damage to the FML will be removed.

Weather conditions shall be observed and recorded by the COE and/or CQAE and appropriate actions will be taken when unsuitable weather conditions exist.

3.2 **Protective and Vegetative Soil Layers**

3.2.1 Preconstruction

Soil material used for the protective and vegetative soil layers are to meet the same requirements for the subbase soils as detailed in Section 3.1.1.

3.2.2 Construction

Protective cover does not require compaction control; however, it should be stable for construction and maintenance traffic. Care will be exercised in placement so as not to

shift, wrinkle or damage the underlying geosynthetic layers, and the placement methods will be documented.

The protective cover shall be placed under the direct supervision of the CQAE. The Contractor shall utilize care to avoid damage to the Flexible Membrane liner. No vehicular traffic will be permitted on the unprotected liner. The loose thickness of the initial layer of protective cover shall not be less than 12 inches and spread with low ground pressure equipment (maximum pressure 8 psi). Fill shall be placed by equipment pushing from the bottom to top of slope. Protective cover shall not be compacted. Refer to project specifications for material to be placed above the FML.

Observation activities that shall be conducted by CQAE during protective cover installation are specified in Table 3-1.

Surveying stakes are prohibited over the closed lined portion of the landfill.

All observation and test locations shall be conducted at locations selected by the CQAE.

Weather conditions shall be observed and recorded by the COE and/or CQAE and appropriate actions will be taken when unsuitable weather conditions exist.

The required thickness of protective cover will be verified by survey methods on an established grid system with not less than one verification point per 5,000 square feet of surface.

TABLE 3-1
Soil Installation Inspection

Liner Element	Factors To Be Inspected	CQAE Inspection Methods	Test Method Reference
Subgrade, Protective Layers	Removal of unsuitable materials	Observation	N/A
Subgrade	Proof rolling	Observation	N/A
Subgrade, Protective Layers, Topsoil	Filling of fissures or voids	Observation	N/A
Subgrade and Protective Layers Around Structures	Compaction of soil backfill	Observation	N/A
Subgrade, Protective Layers, Topsoil	Surface finishing	Observation	N/A
Subgrade, Protective Layers,	Slope	Verify Surveying by FML Installation Subcontractor	N/A
Subgrade, Protective Layers,	Soil type (index properties)	Visual-manual procedure Particle size analysis Atterberg limits Soil classification	ASTM D2488 ASTM D422 ASTM D4318 ASTM D2487

SOURCE: EPA

NOTE: N/A = Not Applicable

SECTION 4.0

FLEXIBLE MEMBRANE LINER (FML)

4.1 General

This Section covers the work necessary to construct and test the flexible membrane lining (FML) system, which will consist of a 40 mil Linear Low Density Polyethylene (LLDPE) material. The overall objective is to provide an effective lining system at the completion of the work. The LLDPE will be smooth on the top deck and flat areas and textured (both sides) on the side slopes.

4.2 Submittals

4.2.1 Manufacturer's Certification of CQA Plan Conformance

The Contractor/FML Installation Subcontractor shall submit written certification by the Manufacturer that the lining materials conform to the requirements of the CQA Plan; are similar and of same formulation as that for which certification is submitted; and has been demonstrated by actual usage to be satisfactory for the intended application. This submittal is required prior to delivery of the LLDPE.

4.2.2 FML Installation Subcontractor's and Manufacturer's QC Program

The Manufacturer and the FML Installation Subcontractor, each, shall submit a complete description of its quality control program, as applicable, for manufacturing, handling, installing, testing, repairing and providing a completed lining in accordance with requirements of the CQA Plan. The description shall include, but not be limited to, polymer resin supplier, product identification, acceptance testing, fabrication and production testing, installation testing, documentation of changes, alterations and repairs, retests and acceptance. Each shall also present documented evidence of its ability and capacity to perform this Work as described in Section 4.3 below.

4.2.3 FML Installation Subcontractor's Installation Plan

The FML Installation Subcontractor shall submit installation drawings, description of installation procedures, and a schedule for performing/completing the Work. Installation drawings shall show a lining sheet layout with proposed size, number, position, and sequence of placing of all sheets and indicating the location of all field seams. Installation drawings shall also show complete details and/or methods for anchoring the lining at its perimeter, making field seams, and making anchors/seals to pipes and structures.

The FML Installation Subcontractor shall submit a complete description of welding procedures for making field seams and repairs. The welding procedures shall conform to the latest procedures recommended by the lining Manufacturer and to the CQA Plan.

The FML Installation Subcontractor shall submit for approval by the Geotechnical Professional certification that the surface(s) on which the lining will be placed is acceptable. Installation of the lining shall not commence until this certification is furnished to the Geotechnical Professional. This certification will be consistent with the requirements specified by the geomembrane supplier for the surface in order to preserve the warranty for the geomembrane.

4.2.4 FML Installation Subcontractor's Material Submittals

The FML Installation Subcontractor shall submit for approval by the Geotechnical Professional samples of lining material(s) and field seams prior to start of construction. The FML Installation Subcontractor shall submit six (6) 8-inch x 10-inch samples of lining material(s) and six (6) samples of field seams. The field seam samples shall be fabricated by the FML Installation Subcontractor using the same materials, equipment and procedures for the lining. Samples shall measure 12 inches plus seam width in width and 18 inches in length. The samples shall be numbered and dated.

Laboratory interface friction tests shall be conducted in general accordance with ASTM D 5321, on the following interfaces:

- 1) Textured HDPE liner and HDPE geocomposite
- 2) Textured HDPE liner and subgrade.
- 3) Geocomposite and protective soil layer.

At the FML Installation Subcontractor's expense, a qualified laboratory must perform direct shear tests at effective normal stresses of 1,500, 3,000 and 6,000 lbs/ft².

A minimum saturated interface friction angle of 24 degrees is required from the direct shear tests.

4.3 Quality Assurance

Prior to start of work, the lining Manufacturer and the FML Installation Subcontractor, each, shall submit for approval by the Geotechnical Professional documented evidence of its ability and capacity to perform this Work. Each shall have successfully manufactured and/or installed a minimum of two (2) million square feet of similar lining material in solid waste containment structures. The FML Installation Subcontractor can meet these criteria by teaming with an FML Installation Subcontractor who is identified in the bid along with the firm's experience.

The FML Installation Subcontractor shall submit the name and qualifications of its project superintendent that will be on the project whenever lining materials are being handled/installed plus the names and qualifications of senior installation personnel on the project.

The Quality Control Plan(s) to be implemented for the Work by the lining Manufacturer and the FML Installation Subcontractor shall be in accordance with applicable paragraphs of the CQA Plan.

The Manufacturer shall provide on-site technical supervision and assistance at all times during installation of the lining system. The Manufacturer and FML Installation Subcontractor, as applicable to each, shall submit for approval by the Geotechnical Professional written certification that the lining system was installed in accordance with the Manufacturer's recommendation, the CQA Plan, project specifications and drawings, and approved submittals.

The Geotechnical Professional will initiate a pre-installation meeting with the Manufacturer and FML Installation Subcontractor prior to installation of the lining system. Topics for review/discussion shall include, as a minimum, project plans and specifications, approved submittals, training and qualification procedures for FML Installation Subcontractor personnel, and demonstration of making a field welded seam(s) including peel and shear tests.

Prior to installation of the lining system, the FML Installation Subcontractor shall instruct the workmen of the hazards of installation, such as handling sheets of lining material in high winds; use of equipment; application of solvents, adhesives and caulks; and walking on lining surfaces. Work gloves, safety glasses, hard hats, and smooth-soled shoes are minimum safety wear requirements when working on the FML. Safety shoes must be worn when handling heavy objects.

The Geotechnical Professional shall have authority to order an immediate stoppage of work because of improper installation procedures, safety infractions, or for any reason which may result in a defective liner.

4.4 Delivery, Storage and Handling

Materials will be delivered to the site after the required submittals have been furnished and approved. The delivered roll goods will be marked by the manufacturer to show at a minimum the following information:

- Name of manufacturer
- Product type
- Product thickness
- Manufacturing batch code
- Date of manufacture
- Physical dimensions
- Roll number

The FML Installation Subcontractor shall submit for approval by the Geotechnical Professional a method(s) for handling and storage of lining material(s) which have been delivered to the project site. These materials shall be stored in accordance with the Manufacturer's recommendation.

Lining materials delivered to the site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The storage area shall

be such that all materials are protected from mud, soil, dirt and debris. The stacking of lining shall not be higher than two rolls.

Under no circumstances shall the lining be subjected to materials, sandbags, equipment or other items being dragged across its surface. Nor shall workmen and others slide down slopes atop the lining. All scuffed surfaces resulting from abuse of any kind caused by the FML Installation Subcontractor in performance of the Work shall be repaired at the Geotechnical Professional's direction.

The FML Installation Subcontractor shall be completely responsible for shipping, storage, handling, and installation of all lining materials in compliance with the CQA Plan.

4.5 Products

The Linear Low Density Polyethylene (LLDPE) lining materials shall be new, first quality products designed and manufactured specifically for the purposes of the Work and shall have satisfactorily demonstrated by prior use to be suitable and durable for such purposes. The flexible membrane shall be made from polyethylene resins containing no plasticizers, fillers, chemical additives, reclaimed polymers, or extenders. For ultraviolet resistance, the FML material shall contain not less than 2.0 percent carbon black as determined by ASTM D 1603. The only other compound ingredients to be added to the FML resin shall be anti-oxidants and heat stabilizers required for manufacturing. The FML shall be supplied as a single ply continuous sheet with no factory seams and in rolls with a minimum width of 22 FT. The roll length shall be maximized to provide the largest manageable sheet for the fewest field seams.

The FML lining materials shall be as manufactured by GSE Lining Systems, Inc., Houston, Texas; Poly-America, Inc., Grand Prairie, Texas; Serrot International, Henderson, Nevada; Agru America, Inc., Kingwood, Texas or approved equal.

The standard tests described in Table 4-1 will be performed on the FML material.

TABLE 4-1**Standard Tests on Linear Low Density Liner Material**

Test	Type of Test	Standard Test Method	Value Smooth FML	Value Textured FML	Frequency of Testing
Resin Quality Control	Density	ASTM D1505/D792	0.90	0.90	One per 100,000 ft ² and every resin lot
Manufacturer's Quality Control	Thickness (mils)	ASTM D 5199 (textured)	36	34	per manufacturer's quality control specifications
	Density (g/cc)	ASTM D1505 D792	0.90	0.90	One per 100,000 ft ² and every resin lot
	Carbon Black Content , min (%)	ASTM D1603 D4218	1.9	1.9	One per 100,000 ft ² and every resin lot
	Carbon Black Dispersion	ASTM D5596 (Category)	1 or 2	1 or 2	One per 100,000 ft ² and every resin lot resin lot
	Minimum Tear Resistance (lb) (1)	ASTM D1004	22	22	One per 100,000 ft ² and every resin lot
	Minimum Puncture Resistance (lb)	ASTM D4833	36	34	One per 100,000 ft ² and every resin lot
Conformance Testing by 3 rd Party Independent Laboratory	Thickness (mils)	ASTM D 5199 (textured)	36	34	Every resin lot not to exceed one every 100,000 ft ²
	Density (g/cc)	ASTM D1505 D792	0.90	0.90	Every resin lot not to exceed one every 100,000 ft ²
	Minimum Tear Resistance (lb) (1)	ASTM D1004	22	22	Every resin lot not to exceed one every 100,000 ft ²
	Minimum Puncture Resistance (lb)	ASTM D4833	36	34	Every resin lot not to exceed one every 100,000 ft ²

1. MD/CD = MD - Machine Direction/CD - Cross Direction, Test value shall be average ten values, five values in each direction.

The Contractor/FML Installation Subcontractor is responsible for providing a certification and supporting certified laboratory data that the product delivered to the site meets the physical and chemical properties listed in Table 4-1. The CQAE will send, at his discretion, random samples to an independent laboratory for confirmation testing.

Extrusion resin used for fusion welding with extrudate to make field seams between FML sheets and for repairs shall be LLDPE produced from and the same as the LLDPE sheet resin. Physical properties shall be same as LLDPE lining sheets.

4.6 Installation Procedures

Prior to installation of the FML, a site inspection will be conducted by the Geotechnical Professional and the FML Installation Subcontractor to verify measurements, structures and surface conditions to support the FML.

The FML Installation Subcontractor will provide written documentation to the Geotechnical Professional that surfaces to receive the FML have been inspected and are acceptable for installation of the lining.

Before the work begins, the FML Installation Subcontractor will inspect all lining materials for damage from transit. Materials that cannot be repaired will be rejected and removed from the work area and site.

During unwrapping of lining materials for use and placement, the FML Installation Subcontractor will visually inspect all materials, particularly surfaces of lining sheets, for imperfections and faulty areas. All such defective places will be marked and repaired in accordance with approved methods.

The FML will be installed as shown on the project plans and approved installation drawings. Placement of the FML will be done such that good fit, without bridging, is provided on all covers and grade changes. Excessive slack will be avoided to minimize rippling during the soil cover operation.

Sheets of FML materials will be of such lengths and widths and will be placed in such a manner as to reduce field seaming to a minimum. The lining will be anchored in accordance with details shown on approved plans and drawings. The lining will be anchored and sealed to structures, pipes and other types of penetrations, (if any), in accordance with details shown on approved plans and drawings. All changes in approved installation drawings and procedures must be approved by the Geotechnical Professional.

Extreme care will be taken during installation of the lining to be certain no damage is done to any part of the lining. Dragging of the FML material on the subgrade will be avoided. Smoking by installation personnel will be prohibited. All handling and installation procedures will be performed by workers wearing shoes with smooth soles. Shoes with soles that have patterns in relief shall be prohibited. No foot traffic will be allowed on the FML except with approved

shoes. No vehicular traffic will be allowed on the lining. All motor driven equipment using fuel will have spark arrestors. No gasoline driven generators or cans of gas or solvent will be placed directly on the lining material. Under no circumstances will the lining be used as a work area to prepare patches or to store tools and supplies. If needed, a tarpaulin of approved material will be spread out as a work area.

During installation, the FML Installation Subcontractor will be responsible for protecting the lining against adverse effects of high winds such as uplift. Sand bags will be used as required to hold the lining material in position during installation. Sand bags will be sufficiently close-knit to preclude fines from working through the bottom, sides or seams. Paper bags, whether or not lined with plastic, will not be permitted. Burlap bags, if used, must be lined with plastic. Bags will contain not less than 40, nor more than 60 pounds of sand having 100 percent passing a number 8 screen and will be tied closed after filling, using only plastic ties. Bags that are split, torn, or otherwise losing their contents will be immediately removed from the work area and any spills immediately cleaned up. Metal or wire ties will not be used.

The FML material will not be installed under adverse climatic conditions, unless the FML Installation Subcontractor can demonstrate that his installation techniques adequately compensate for such adverse conditions and quality of workmanship is not compromised. Adverse climatic conditions occur when the air temperature measured 6 inches above the FML surface is less than 32°F and decreasing, or more than 104°F; when it is raining; or when there is frost on the ground; or during conditions of excessive winds.

FML field seams will be lap seams as shown on approved plans and drawings. The lap seams will be formed by lapping the edges of FML sheets a minimum of 4 inches. The contact surfaces of the sheets will be wiped clean to remove dirt, dust, moisture, and other foreign materials. For fillet weld seams, bevel edge of FML and clean oxidation from surfaces to receive extrudate by disk grinding or equivalent not more than one hour before seaming.

Lap seam intersections involving more than 3 thicknesses of lining material will be avoided, and all seam intersections will be offset at least 2 FT. No horizontal field seams will be allowed on the slope and sheets of lining material on the slopes will extend down slope out onto bottom a minimum of 5 FT from toe of slope.

Field seams between sheets of FML material will be made using approved fusion welding systems, equipment and techniques. Approved fusion welding systems include fillet weld using extrudate, lap weld using extrudate, and lap weld using single or double wedge welder. If the wedge welder is used, excess free edge of the seam (wider than three-inches) of the top sheet will be removed without affecting the integrity of the seam.

Any necessary repairs to the FML will be made with the lining material itself, using approved fusion welding systems, equipment and techniques. The patch size will be 4 inches larger in all directions than the area to be patched. All corners of the patch will be rounded with a 1 inch minimum radius.

All seams and seals of the FML will be tightly bonded on completion of the work. Any lining surface showing injury due to scuffing or penetration by foreign objects or showing distress will be replaced or repaired as directed by the Geotechnical Professional.

Cleanup within the work area will be an ongoing responsibility of the FML Installation Subcontractor. Particular care will be taken to insure that no trash, tools, and other unwanted materials are trapped beneath the lining. Care will be taken to insure that all scraps of lining material are removed from the work area prior to completion of the installation.

4.7 Field Quality Control

Inspection and testing will involve the full time observation of the installation of the FML, including the making and testing of lining seams and patches and periodic measurement of the liner material thickness to insure compliance.

Test seams will be made to verify that adequate conditions exist for field seaming to proceed. Each seamer will produce a test seam at the beginning of each shift to determine the peel and tensile strength of the seam. The Geotechnical Professional may require a sample field seam be made at any time during seaming production to verify equipment/operator performance and seam integrity. In addition, if a seaming operation has been suspended for more than 1/2 hour or if a breakdown of the seaming equipment occurs, a test seam will be produced prior to resumption of seaming operations.

The trial weld sample must be a minimum of three feet long and one foot wide, with the seam centered lengthwise. The Geotechnical Professional must observe all trial welding operations, quantitatively test each trial weld for peel and shear, and record the results. A minimum of two peel and two shear tests will be performed per trial seam. Double wedge weld trial seams shall have a minimum of four peel tests performed. The trial weld shall be completed under the same conditions for which the panels will be welded. The trial weld must meet the requirements for peel and shear as stated in the following paragraph and the break must be ductile or a film tearing bond (FTB) for a wedge weld.

During the field seaming operation, destructive samples will be removed from field seams by the FML Installation Subcontractor at locations selected by the Geotechnical Professional. Repairs to the field seams will be made in accordance with repair procedures specified in this CQA Plan. The samples will have a width of 12 inches plus the seam width and length of 42 to 48 inches. A minimum of one stratified sample per 500 feet of field seam will be made. All field seams will have a film tear bond in peel and shear. At the very least, the peel adhesion and bonded shear strength must be 62% and 95%, respectively, of the strength of the parent material, but no less than 22 ppi and 34 ppi, respectively for smooth 40 mil LLDPE and 22 ppi and 34 ppi, respectively for textured 40 mil LLDPE. A sufficient amount of the seam must be removed in order to conduct field testing, independent laboratory testing, and archiving of enough material in order to retest the seam when necessary. The archived material will be kept at the independent laboratory. Field testing shall include at least two peel tests per sample (four when possible for testing both tracks on dual-track fusion welded seams). Independent laboratory testing shall

consist of five shear tests and five peel tests per sample (ten when possible for both tracks of dual-track fusion welded seams). Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the FML. Capped sections shall be non-destructively tested. Additional destructive test samples may be taken if deemed necessary by the Geotechnical Professional or his representative.

All field-tested samples from a destructive-test location must be passing in both shear and peel for the seam to be considered as passing. The independent laboratory testing must confirm these field results. The passing criterion for independent laboratory testing is that four of five samples must pass in shear and four of five must pass in peel (four of five samples from each dual track fusion welded seam, when possible to test each seam, must be passing) before the seam is considered as passing. Sample testing will be conducted by an independent testing agency paid for by the Owner. The independent testing agency will save all test samples including specimens tested until notified by the Geotechnical Professional relative to their disposal. All specimens which have failed under test will be shipped immediately by express delivery to the Geotechnical Professional for determination of corrective measures to be taken, which includes retest or repair of failed section.

For destructive samples which have failed the passing criterion, the FML Installation Subcontractor will reconstruct all the field seams between any two previous passed seam locations which include the failed seam or will go on both sides of the failed seam location (10 feet minimum), take another sample each side and test both. If both pass, the FML Installation Subcontractor will reconstruct the field seam between the two locations. If either fails, the FML Installation Subcontractor will repeat the process of taking samples for test. In all cases, acceptable field seams must be bounded by two passed test locations. The decision of the Geotechnical Professional will be final.

In the event capping of a field seam is required, the FML Installation Subcontractor will use a cover strip of the same thickness as the lining (and from the same roll, if available) and of 8 inches minimum width. It will be positioned over the center of the field seam and welded to the lining using a fillet weld each side.

All FML sheets, seams, anchors, seals, and repairs will be visually inspected by the FML Installation Subcontractor for defects. In addition, all seams and repairs will be further checked by a metal probe. Depending on seam welding equipment used, all seams and repairs will be tested by a vacuum testing device, a spark testing device and/or air pressure.

A visual inspection of the lining sheets, seams, anchors and seals will be made by the FML Installation Subcontractor as the installation progresses and again on completion of the installation. Defective and questionable areas will be clearly marked and repaired. Final approval of repairs will be given by the Geotechnical Professional.

If the fillet weld, extrusion lap weld or single hot-wedge fusion lap weld is used to weld seams, the FML Installation Subcontractor will further test all seams and repairs in the FML by vacuum box. All vacuum box testing will be done in the presence of the Geotechnical Professional. The

area to be tested will be cleaned of all dust, debris, dirt and other foreign matter. A soap solution will be applied to the test area with a paint roller and the vacuum of 3 psi air pressure will be induced and held at least ten seconds to mark for repair any suspicious areas as evidenced by bubbles in the soap solution.

If the fillet weld is used to weld seams, the FML Installation Subcontractor will further test all seams and repairs in the FML by using a high voltage spark detector if vacuum box or air pressure methods cannot be performed. The setting of the detector will be 20,000 volts. In order to conduct this test, all seams to be tested will be provided with not less than gauge 24-30 copper wires properly embedded in the seams and grounded. All spark testing will be done in the presence of the Geotechnical Professional. All defective areas will be marked for repair.

If the double hot-wedge is used, the FML Installation Subcontractor will further test all seams in the FML by using the air pressure test which consists of inserting a needle with gauge in the air space between welds. Air will be pumped into space to 30 psi and held for 5 minutes. If pressure does not drop more than 4 psi, then the seam is acceptable.

All costs of retesting of the FML including reruns of field weld tests and all repairs will be at the Contractor's or FML Installation Subcontractor's expense.

The FML Installation Subcontractor will retain responsibility for the integrity of the FML system until acceptance by the Geotechnical Professional. The FML will be accepted by the Geotechnical Professional when:

- a) Written certification letters including record drawings, have been received by the Geotechnical Professional.
- b) Installation is completed.
- c) Documentation of completed installation, including all reports, is complete.
- d) Verification of adequacy of field seams and repairs, including associated testing, is complete.
- e) Acceptance of the completed work will include receipt of all submittals and all work completed to the satisfaction of the Geotechnical Professional.

SECTION 5.0

GEONET COMPOSITE (GEOCOMPOSITE)

The subsurface drainage system above the FML will be composed of a geocomposite placed directly above the FML.

5.1 Geocomposite Drainage Material

The geocomposite is a sandwiched composite, formed of one nonwoven geotextile heat bonded to each side of a geonet core. The geotextile on the both surfaces of the geonet shall be a minimum of 8 oz/sy meeting the standard requirements in Table 5-1 and Specifications 02777. The geonet core shall be manufactured from nonfoamed, nonthermally degraded polyethylene, which is clean and free of any foreign contaminants. The manufactured geonet shall conform to the standard requirements in Table 5-2 and Specification 02777, and shall be placed in accordance with manufacturer's recommendations and Specification 02777.

5.2 Geocomposite Inspection

The following subsection describes the CQAE inspection activities that are necessary during the geocomposite installation. Refer to the project specifications for proper construction and test requirements.

The CQAE shall observe the geocomposite placement to confirm that the specifications are followed, including coverage of all specified areas and adequate material overlap or seaming.

The CQAE shall take appropriate actions during adverse weather conditions and document thoroughly.

TABLE 5-1**Standard Tests on Geotextile Material**

Test	Type of Test	Standard Test Method	Value	Frequency of Testing
Manufacturer's Quality Control	Fabric Weight (oz/sy)	ASTM D3776	7.1 - 8.5	One per 100,000 ft ²
	Thickness (mils)	ASTM D5199	95 - 110	One per 100,000 ft ²
	Grab Tensile Strength (lbs) (1)	ASTM 4632	210 - 225	One per 100,000 ft ²
	Grab Elongation (%) (1)	ASTM 4632	60 - 95	One per 100,000 ft ²
	Puncture Resistance (lbs)	ASTM D4833	95 - 120	One per 100,000 ft ²
	Mullen Burst Strength (psi)	ASTM D3786	360 - 430	One per 100,000 ft ²
	Permeability (cm/sec)	ASTM D4491	.35 - .38	One per 100,000 ft ²
	Water Flow Rate (gpm/sf)	ASTM D4491	110-175	One per 100,000 ft ²
Conformance Testing by 3rd Party Independent Laboratory	Fabric Weight (oz/sy)	ASTM D3776	7.1 - 8.5	Every resin lot not to exceed one every 100,000 ft ²
	Thickness (mils)	ASTM D5199	95 - 110	Every resin lot not to exceed one every 100,000 ft ²
	Grab Tensile Strength (lbs) (1)	ASTM 4632	210 - 225	Every resin lot not to exceed one every 100,000 ft ²
	Grab Elongation (%) (1)	ASTM 4632	60 - 95	Every resin lot not to exceed one every 100,000 ft ²
	Puncture Resistance (lbs)	ASTM D4833	95 - 120	Every resin lot not to exceed one every 100,000 ft ²
	Permeability (cm/sec)	ASTM D 4491	.35 - .38	Every resin lot not to exceed one every 100,000 ft ²

1. MD/CD = MD - Machine Direction/CD - Cross Direction, Test value shall be average ten values, five values in each direction.

TABLE 5-2**Standard Tests on Geonet Material**

Test	Type of Test	Standard Test Method	Value	Frequency of Testing
Resin	Specific Gravity/Density (g/cm ³) (min)	ASTM D 1505	.94	One per 100,000 ft ² and every resin lot
Manufacturer's Quality Control	Thickness (in)	ASTM D 5199	.25	Per manufacturer's quality control specifications
	Mass per Unit Area (lbs/ft ²)	ASTM D 5261	.20	One per 100,000 ft ² and every resin lot
	Carbon Black Content (% Minimum)	ASTM D 1603	2	One per 100,000 ft ² and every resin lot
	Tensile Strength	ASTM D 5035	50	One per 100,000 ft ² and every resin lot
	Transmissivity at 15,000 psf (m ² /sec)	ASTM D 4716	1 x 10 ⁻³	One per 100,000 ft ² and every resin lot

NOTE: Geotextiles shall be tested in accordance with Table 5.1.

SECTION 6.0

SLURRY WALL PENETRATION REPAIR

6.1 Observation

Either the COE or CQAE must observe the bentonite placement around the pipes and up to the top of the existing slurry wall. The person observing the placement shall document that the area around the pipes has been filled with the bentonite.

6.2 Testing

Prior to start of construction of the slurry trench penetrations, the source of water to be used to hydrate the bentonite chips shall be tested to ensure it complies with the following standards:

1. A pH equal to 7.0 plus or minus 1.0.
2. Total dissolved solids not greater than 500 parts per million.
3. Oil, organics, acids, alkali, or other deleterious substances not greater than 50 parts per million each.
4. Hardness less than or equal to 50 ppm.

Following hydration of the bentonite slurry wall repair, the CQAE or CQAL shall take at least one core from each repair location (outside the width of the slurry wall). The CQAL shall run a permeability test on each core to ensure that the repaired portion of the wall has a permeability of 1×10^{-7} cm/sec or less.

SECTION 7.0

THIRD PARTY CONSTRUCTION QUALITY ASSURANCE AND LABORATORY TESTING SERVICES

7.1 Qualifications

The following minimum qualifications must be met by the Construction Quality Assurance Engineer and Construction Quality Assurance Laboratory.

1. The CQAE and CQAL must have been in business for at least ten (10) continuous years of operation immediately prior to the date of this project.
2. The CQA team (CQAE and CQAL) must have inspected and tested a minimum of five (5) liner projects consisting of at least 10,000,000 square feet of HDPE liner and a minimum of five (5) liner projects consisting of at least 1,000,000 square feet of GCL. The CQA team shall be familiar with ASTM, NSF and other applicable test standards.
3. The CQAL shall possess testing equipment which is capable of testing 60 mil HDPE liner seams for peel according to ASTM D-413 (machine crosshead speed of 2 inches per minute) and liner seams for shear according to ASTM D-3083 (machine crosshead speed of 20 inches per minute). The CQAL shall be familiar with ASTM, NSF and other applicable test standards. The CQAL shall have performed a minimum of 100 sets of peel and shear tests on seams of material the same type as specified.
4. The CQAE shall provide one full-time NICET certified technician and other trained technicians to perform the required tests and inspections of the liner and shall provide test results within 48 hours of receipt of samples requiring laboratory testing.
5. The CQAE shall provide certified technicians to perform full time observation and documentation of activities related to the CQA of the FML.
6. The CQAE must have registered full-time Professional Engineers on staff to sign and seal a report documenting that the geomembrane liner system was constructed in accordance with the Contract Documents.

7.2 Responsibilities

The overall responsibility of the CQAE is to perform those activities specified in the CQA Plan (i.e., inspection, sampling, documentation). At a minimum, CQAE personnel should include a CQA Representative/Engineer and the necessary support CQA inspection personnel.

The CQAE is an individual assigned singular responsibility for all aspects of the CQA Plan implementation. The CQAE shall possess formal academic training in soils engineering, engineering geology or other closely associated discipline. The CQAE will be ultimately responsible for all other CQAE inspection personnel. The CQAE responsibilities include:

- Reviewing design criteria, plans, and specifications for clarity and completeness so that the CQA Plan can be implemented.
- Educating CQAE inspection personnel on CQA requirements and procedures.
- Scheduling and coordinating CQAE inspection activities.
- Directing and supporting the CQAE inspection personnel in performing observations and tests by:
 - Submitting blind samples (knowns, duplicates, and blanks) for analysis by the CQAE inspection personnel and one or more independent laboratories.
 - Confirming that regular calibration of testing equipment is properly conducted and recorded.
 - Confirming that the testing equipment, personnel, and procedures do not change over time or making sure that any changes do not adversely impact the inspection process.
 - Confirming that the test data are accurately recorded and maintained (this may involve selecting reported results and backtracking them to the original observation and test data sheets).
 - Verifying that the raw data are properly recorded, validated, reduced, summarized, and interpreted.
- Providing to the County reports on the inspection results including:
 - Review and interpretation of all data sheets and reports.
 - Identification of work that the CQAE believes should be accepted, rejected, or uncovered for observation, or that may require special testing, inspection, or approval.
 - Rejection of defective work and verification that corrective measures are implemented.
- Verifying that the FML Installation Subcontractor's construction quality control plan is in accordance with the site-specific CQA Plan.

- At the County's request, reporting to the Contractor/FML Installation Subcontractor results of all observations and tests as the work progresses and interacting with the FML Installation Subcontractor to provide assistance in modifying the materials and work to comply with the specified design.

For the supporting CQAE inspection personnel, specific responsibilities include:

- Performing independent onsite inspection of the work in progress to assess compliance with the facility design criteria, plans, and specifications.
- Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by the CQA Plan.
- Reporting to the Engineer and County results of all inspections including work that is not of acceptable quality or that fails to meet the specified design.

SECTION 8.0

REPORTING REQUIREMENTS AND DOCUMENTATION

8.1 Project Meetings

Conducting periodic project meetings is the responsibility of the Engineer who will make physical arrangements for meetings, record minutes and distribute copies to participants and those affected by decisions made at meetings. At a minimum the following meetings will be held.

- Preconstruction CQA meeting
- Problem or Work deficiency meetings

8.1.1 Preconstruction CQA meeting

This meeting shall be attended by the County, Engineer, CQAE personnel, and FML Installation Subcontractor. The topics should include but are not limited to:

- Providing each organization with all relevant CQA documents and supporting information.
- Familiarizing each organization with the site-specific CQA Plan and its role relative to the design criteria, plans, and specifications.
- Determining any changes to the CQA Plan that are needed to ensure that the facility will be constructed to meet or exceed the specified design.
- Reviewing the responsibilities of each organization.
- Reviewing lines of authority and communication for each organization.
- Discussing the established procedures or protocol for observations and tests including sampling strategies.
- Discussing the established procedures or protocol for handling construction deficiencies, repairs, and retesting.
- Reviewing methods for documenting and reporting inspection data.
- Reviewing methods for distributing and storing documents and reports.

- Reviewing work area security and safety protocol.
- Discussing procedures for the location and protection of construction materials and for the prevention of damage of the materials from inclement weather or other adverse events.
- Conducting a site walk-around to review construction material and inspection equipment storage locations.

The meeting shall be documented by a designated person, and minutes should be transmitted to all parties.

8.1.2 Weekly Progress Meetings

A progress meeting shall be held weekly at the work area at a time determined at the pre-construction meeting. At a minimum, the meeting should be attended by the Engineer, FML Installation Subcontractor and the County. The purpose of the meeting is to:

- Review the previous week's activities and accomplishments.
- Review status of progress schedule.
- Review the work location and activities for the week.
- Identify the FML Installation Subcontractor's personnel and equipment assignments for the week.
- Discuss any potential construction problems.

This meeting shall be documented by a member of the CQAE.

8.1.3 Problem or Work Deficiency Meetings

A special meeting shall be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting shall be attended by the Engineer, County, and the FML Installation Subcontractor and the CQAE. The purpose of the meeting is to define and resolve a problem or recurring work deficiency in the following manner:

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

The meeting shall be documented by the Engineer and transmitted to the County, FML Installation Subcontractor, and CQAE, if applicable.

8.2 Documentation

Documentation is an essential element of the CQA Plan. The following documentation and recordkeeping of inspection activities will be required.

8.2.1 Daily Summary Report

A summary report shall be prepared daily by the CQAE. This report will provide the chronological framework for identifying and recording all other reports. At a minimum, the summary reports shall include the following information:

- Unique identifying sheet number for cross-referencing and document control.
- Date, project name, location, and other identification.
- Data on weather conditions.
- Reports on any meetings held and their results.
- Unit processes, and locations, of construction under way during the timeframe of the daily summary report.
- Equipment and personnel being worked in each unit process, including FML Installation Subcontractors.
- Descriptions of areas or units of work being inspected and documented.
- Description of offsite materials received, including any quality verification (vendor certification) documentation.
- Calibrations, or recalibrations, of test equipment, including actions taken as a result of recalibration.
- Decisions made regarding approval of units of material or of work (blocks), and/or corrective actions to be taken in instances of substandard quality.
- Unique identifying sheet numbers of inspection data sheets and/or problem reporting and corrective measures reports used to substantiate the decisions described in the preceding item.
- Supporting inspection data sheets.

- Signature of the CQAE.

8.2.2 Inspection Data Sheets and Photographs

All observations, and field and/or laboratory tests, shall be recorded on an inspection data sheet. Required data to be addressed for most of the standardized test methods are included in the pertinent ASTM Standards.

Because of their highly specific nature, no standard format can be given for data sheets to record observations. Where possible, a checklist may be useful to ensure that no pertinent factors of a specific observation are overlooked.

At a minimum, the inspection data sheets shall include the following information:

- Unique identifying sheet number for cross-referencing and document control.
- Description or title of the inspection activity.
- Location of the inspection activity or location from which the same increment was obtained.
- Type of inspection activity; procedure used (reference to standard method when appropriate).
- Recorded observation or test data, with all necessary calculations.
- Results of the inspection activity; comparison with specification requirements.
- Personnel involved in the inspection activity.
- Signature of the appropriate CQAE inspection personnel and concurrence by the CQAE Engineer.

Items above may be formulated into site-specific checklists and data sheets so that details are not overlooked.

Photographic supporting data sheets also may prove useful. Such data sheets could be cross-referenced or appended to inspection data sheets and/or problem identification and corrective measures reports. At a minimum, photographic reporting data sheets should include the following information:

- A unique identifying number on data sheets and photographs for cross-referencing and document control.

- The date, time, and location where the photograph was taken and weather conditions.
- The size, scale, and orientation of the subject matter photographed.
- Location and description of the work.
- The purpose of the photograph.
- Signature of the photographer and concurrence of the CQAE.

These photographs will serve as a pictorial record of work progress, problems, and corrective measures. They should be kept in a permanent protective file in the order in which they were taken. The file should contain color prints; negatives should be stored in order in a separate file.

8.2.3 Problem Identification and Corrective Measures Reports

A problem is defined herein as material or workmanship that does not meet the specified design. Problem Identification and Corrective Measures Reports shall be cross-referenced to specific inspection data sheets where the problem was identified. At a minimum, they shall include the following information:

- Unique identifying sheet number for cross-referencing and document control.
- Detailed description of the problem.
- Location of the problem.
- Probable cause.
- How and when the problem was located (reference to inspection data sheets).
- Estimation of how long problem has existed.
- Suggested corrective measure.
- Documentation of correction (reference to inspection data sheets).
- Final results.
- Suggested methods to prevent similar problems.
- Signature of the appropriate CQA inspection personnel and concurrence by the CQAE.

Copies of the report shall be sent to the Engineer and the County for their comments and acceptance. These reports should not be submitted to the FDEP at that time unless they have been specifically requested. However, a summary of all data sheets and reports will be required by the FDEP upon completion of construction.

8.2.4 Acceptance of Completed Components

All daily inspection summary reports, inspection data sheets, and problem identification and corrective measures reports, shall be reviewed by the CQAE. The documentation shall be evaluated and analyzed for internal consistency and for consistency with similar work.

8.2.5 Final Documentation

At the completion of the project, the County will submit a final report to the FDEP. This report will include all of the daily inspection summary reports, inspection data sheets, problem identification and corrective measures reports, photographic supporting data, acceptance reports, deviations from design and material specifications (with justifying documentation), and record drawings. This document shall be certified correct by the CQAE and included as part of the CQA Plan documentation.

REFERENCES

EPA, October 1986, Technical Guidance Document: Construction Quality Assurance for Hazardous Waste Land Disposal Facilities.

EPA, May 1991, Technical Guidance Document: Inspection Techniques for the Fabrication of Geomembrane Field Seams.