DAILY REPORT#__

Low Temp:	**High Temp:**	**Wind:**

Date:	**On-Site:** **Off-Site:**
Project:	
Location: Deer Trail Facility, Deer Trail, Colorado	**Job No.:**
Owner: Clean Harbors	**Contractor:**
	Installer:

Cloud Cover:	**Precipitation:**

Personnel On Site/Company	**Responsibility**

CONTRACTOR EQUIPMENT ON-SITE:

-

CONSTRUCTION ACTIVITIES:

-

QA/QC ACTIVITIES:

-

RECORD SURVEYS:

-

PROBLEMS AND RESOLUTIONS:

-

MEETINGS AND DISCUSSIONS:

-

SUMMARY OF INCIDENTS/ACCIDENTS/H&S ISSUES:

-

SITE PHOTOGRAPHS (ATTACHED):

Signature: _____

Reviewer: _____

TELEPHONE MEMORANDUM

INCOMING ____ OUTGOING ____

JOB:	ROUTE TO:	JOB NO:
PERSON:		DATE:
FIRM:		TIME:
PHONE NO:		BY:

REMARKS:

ACTION REQUIRED:

CLEAN HARBOR / DEER TRAIL
IN-SITU MOISTURE DENSITY TESTING SUMMARY

Test No.	Date	Test Reference		Reference Elevation or Depth (Lift)	Test Type		In-Situ Values			CQA Acceptance Criteria	Pass/ Fail
		Grid Location	General Location		DC/ST	N	Wet Density (pcf)	Moisture Content (Nuclear)	Dry Density (pcf)		
Average											
Maximum											
Minimum											

	DATE:
Sample Location - General Description	**PROJECT:** Clean Harbors
	SUBCONTRACT NO:
	SUBCONTRACTOR:
Field Density Test Record **Drive Cylinder Method (ASTM D-2937)**	**LOWER TIER SUB:**
	TASK:

IN SITU DENSITY DETERMINATION

Cylinder Number	=		
Weight of Cylinder + Soil	=		g.
Weight of Cylinder	=		g.
Weight of Soil	=		g.
Cylinder Volume	=		cu.ft.
Wet Density	=		pcf.

OVEN MOISTURE INFORMATION

Dish ID:		
Dish Weight:		g.
Dish Weight + Wet Weight of sample =		g.
Dish Weight + Dry Weight of sample =		g.
Moisture content of sample =		%

DRIVE CYLINDER DENSITY TEST RESULTS

Wet density of sample =		pcf
Dry density of sample =		pcf
Moisture =		%

SAMPLE LOCATIONS AND TEST NUMBERS

Drive Cylinder Test #:	
Nuclear Density Test #:	
Grid:	
Northing:	
Easting:	
Elevation:	

NUCLEAR DENSITY TEST RESULTS

Troxler Gauge No.		
Wet density of sample =		pcf
Dry density of sample =		pcf
Moisture =		%

PERFORMED BY:		TITLE/COMPANY:	**CQA Monitor**
SIGNATURE:		DATE:	
DATA ENTERED BY:		TITLE/COMPANY:	**Laboratory (Offsite Lab Tests Only)**
SIGNATURE:		DATE:	
REVIEWED BY:		TITLE/COMPANY:	**CQA Manager**
SIGNATURE:		DATE:	

File Number:

Clean Harbors, Deer Trail
Nuclear Gauge vs Oven Moisture Content
Troxler Gauge Number __, Serial Number _____

		NUKE	OVEN		NUKE	DRIVE CYLINDER	
DATE	Test No.	MOISTURE CONTENT	MOISTURE CONTENT	DIFFERENCE	WET DENSITY	WET DENSITY	DIFFERENCE
		(%)	(%)		(pcf)	(pcf)	
		Average Difference				Average Difference	

GEOTECHNICAL LABORATORY SAMPLE TEST SCHEDULE AND TRANSMITTAL

DATE:_____ SAMPLED BY: ☐ = Requested Test

PROJECT NUMBER:____ PROJECT NAME: Clean Harbors / Deer Trail TSDF PROJECT MANAGER:

Sample Type: (J) - Jar, (T) - Tube, (CR) - Core, (B) - Bag, (P) - Pail, (O) - Other

SPECIAL INSTRUCTIONS TO LAB (★ Include Test Parameters)

SAMPLE NUMBER	MATERIAL TYPE	SAMPLE TYPE (TEST Method)	**SAMPLE TYPE**	WATER CONTENT D 2216	ATTERBERG LIMITS D 4318	SIEVE (3" THRU #200) D 422/C 136	- #200 SIEVE (Passing) D 1140	HYDROMETER & SIEVE D 422	UNIT WEIGHT D 2937	SPECIFIC GRAVITY D 854	PROCTOR **(Standard)** D 698	PROCTOR **(Modified)** D 1557	UNCONFINED COMPRESSION★ D 2166	TRIAXIAL U/U★ D 2850	TRIAXIAL C/U★ D 4767	DIRECT SHEAR★ D 3080	PERMEABILITY (Flex Wall)★ D 5084	PERMEABILITY (Rigid Wall)★ D 2434	SLURRY CONSOLIDATION★	CONSOLIDATION★ D 2435	SWELL★ D 4546	DIRECT SHEAR★ D 3080	pH LEVEL D 4648	ORGANIC CONTENT D 2974	10" CONSOLIDATION/PERM★	LINER LOAD★			REMARKS

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
RCRA PART B
PERMIT ATTACHMENT LF-10.3

CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN FOR SECURE CELL CONSTRUCTION (CELLS 3 THROUGH 7) AND SURFACE IMPOUNDMENT LINER AND COVER SYSTEM CONSTRUCTION (CELLS 2 THROUGH 7) CLEAN HARBORS DEER TRAIL,LLC TREATMENT, STORAGE, AND DISPOSAL FACILITY

ADAMS COUNTY, COLORADO

EPA IDENTIFICATION NUMBER COD991300484

NOTE: This permit attachment is a typical construction quality assurance plan. Modifications to the plan may be required prior to construction of each secure cell based on the final design drawings and specifications. The revisions required for each secure cell will be submitted to CDPHE for approval prior to construction.

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SECTION I - GENERAL

1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan for the Clean Harbors Deer Trail, LLC's hazardous waste treatment, storage, and disposal facility (Clean Harbors TSDF), in Adams County, Colorado, has been prepared to fulfill the requirements of Part II.E.1.b.i. of this Permit. The CQA Plan is Attachment LF-10.3 to the Part B Permit for the Clean Harbors TSDF.

The CQA Plan (Part B Permit Attachment LF-10.3) addresses the construction quality assurance of the soils, geosynthetics, and related liner system components for secure cells and surface impoundments at the Clean Harbors TSDF. The CQA Plan is divided into the following sections:

- Section I: General;
- Section II: Soils CQA;
- Section III: Geosynthetic Clay Liner CQA;
- Section IV: Geomembrane CQA;
- Section V: Geotextile CQA;
- Section VI: Geonet CQA;
- Section VII: Geocomposite CQA;
- Section VIII: Polyethylene Pipe and Fittings CQA; and,
- Section IX: CQA Documentation.

2.0 DEFINITIONS RELATING TO CONSTRUCTION QUALITY ASSURANCE

2.1 Construction Quality Assurance and Construction Quality Control

The CQA Plan is a site specific document which addresses the following: (i) CQA personnel responsibilities, authorities, and qualifications; (ii) inspection, monitoring, and testing activities necessary to ensure that the facility is constructed to meet or exceed design criteria, plans, and specifications; and (iii) CQA documentation requirements.

Construction Quality Assurance (CQA) - A planned and systematic pattern of the means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.

Construction Quality Control (CQC) - Those actions which provide a means to measure and control the characteristics of an item or service to meet contractual and regulatory requirements.

2.2 Use of the Terms in This Plan

In the context of this document:

- Construction Quality Assurance (CQA) refers to means and actions employed by the CQA Engineer to assure conformity of liner system preparation, production, and installation with this CQA Plan, the General Specifications (Part B Permit Attachment LF-1), and the Construction Drawings. CQA is provided by a party independent from the product Manufacturer and Contractor.

- Construction Quality Control (CQC) refers to those actions taken by Manufacturers, Suppliers, Contractors, or Owners, including their designated representatives, to ensure that the materials and the workmanship meet the requirements of the General Specifications, and the Construction Drawings. In the case of soils, and within this CQA Plan, CQC is typically made a part of the CQA requirements and is provided by the CQA Engineer. In the case of geosynthetic and other non-soil components, CQC is provided by the Manufacturers and installers of the various geosynthetics.

3.0 PARTIES TO CONSTRUCTION QUALITY ASSURANCE

3.1 Organization Chart

A typical project organization chart for construction of secure cells and surface impoundments is provided in Figure I-1.

3.2 Description of the Parties

3.2.1 Design Engineer

The Design Engineer is the individual, firm or corporation having direct responsibility for the design of the secure cell or surface impoundment structure. During construction, the Design Engineer must approve any significant deviation from the design requirements of the Contract Documents. The Design Engineer may be an employee of the Owner. An individual representing the Design Engineer directly responsible for the project must be registered as a Professional Engineer in the State of Colorado.

3.2.2 Contractor

The individual, firm, or corporation undertaking the execution of the work under the terms of the Contract Documents. The Contractor may be responsible for constructing the entire liner system (earthwork and geosynthetics), or only selected components of the

liner system. The reference to Contractor refers to the General Contractor and all subcontractors which the General Contractor may employ in meeting the requirements of the Contract Documents.

Figure I-1 Typical Project Organization

Note: To be submitted prior to commencing Secure Cell #4 construction.

3.2.3 Gravel Supplier

The Gravel Supplier excavates (or manufactures) and delivers gravel for the sump and pipe bedding layers to the Contractor at the Clean Harbors TSDF.

3.2.4 Granular Material Supplier

The Granular Material Supplier excavates (or manufactures) and delivers granular material for the granular leachate collection layer to the Contractor at the Clean Harbors TSDF.

3.2.5 Resin Supplier

The Resin Supplier produces and delivers resin to the Manufacturer of geosynthetic materials or polymer based products such as pipe.

3.2.6 Manufacturer

The Manufacturer manufactures a specific component (e.g., geomembrane, geosynthetic clay liner, geotextile, geocomposite, geonet, or pipe) of the proposed liner system and delivers the component to the Contractor at the site. In the General Specifications, the term Manufacturer may refer to the geomembrane Manufacturer, geotextile Manufacturer, geocomposite Manufacturer, geonet Manufacturer, or pipe Manufacturer.

3.2.7 Construction Quality Assurance (CQA) Engineer

The CQA Engineer is an individual, firm, or corporation, independent from the Owner, Contractor, and Manufacturer, that observes, tests, and documents activities related to the CQA of the earthworks at the site, and observes, tests, and documents activities related to the CQA of the installation of the geosynthetic components of the liner system. The CQA Engineer observes, tests, and documents activities related to the CQA of pipes and other liner system components. The CQA Engineer must provide an engineer which directly manages the CQA activities who is a Professional Engineer registered in the State of Colorado. The CQA Engineer may be the same as the Design Engineer, but must be independent from the Owner.

3.2.8 Soils Construction Quality Assurance (CQA) Laboratory

The Soils CQA Laboratory is independent from the Owner, Gravel Supplier, Granular Material Supplier, and Contractor. The Soils CQA Laboratory conducts tests in the laboratory (which may be on site or off site) on samples of soil taken from the borrow pits, stockpiles, or the liner system.

3.2.9 Geosynthetics Construction Quality Assurance (CQA) Laboratory

The Geosynthetics CQA Laboratory is independent from the Owner, Resin Supplier, Manufacturer, and Contractor. The Geosynthetics CQA Laboratory conducts tests on samples of geosynthetics taken from the site. The Geosynthetics CQA Laboratory may also conduct tests on pipes or other liner system components. The Geosynthetics CQA Laboratory service cannot be provided by any party involved with the manufacture or installation of any of the geosynthetic components.

3.2.10 Owner

The Owner owns and operates the secure cell or surface impoundment. In this CQA Plan, the term "Owner" refers specifically to the Clean Harbors TSDF.

3.3 Qualifications of the Parties

3.3.1 Design Engineer

The representative of the Design Engineer who is directly responsible for the project will be a qualified Professional Engineer registered in the State of Colorado. The Design Engineer will have a history which demonstrates familiarity with all liner system components, including detailed design methods and procedures.

3.3.2 Geomembrane Installer

The Geomembrane Installer (who may be either the Contractor or a subcontractor to the Contractor) will be trained and qualified to install geosynthetics, as well as other liner system components such as pipe, if necessary.

All personnel performing seaming operations will be qualified by experience (i.e., each seamer will have installed no less than 100,000 square feet of geomembrane using the same methods of seaming that will be used on this project). At least one seamer will have experience seaming a minimum of 1,000,000 square feet of geomembrane using the same method of seaming that will be used on this project. The most experienced seamer, the "master seamer", will provide direct supervision, as required, over less

experienced seamers. Field seaming may not take place without an approved master seamer being present.

The Contractor will provide the Owner and CQA Engineer with a list of proposed seaming personnel and their professional records. Any proposed seaming personnel deemed insufficiently experienced will not be accepted by the Owner or will be required to pass a seaming test prior to working on the Project.

3.3.3 Construction Quality Assurance (CQA) Engineer Personnel

Personnel representing the CQA Engineer shall be properly trained and qualified to test and inspect soils, including high and low permeability soils, geosynthetics, including geomembranes, geotextiles, geocomposites and geonets, and pipe. The CQA Engineer will predominately be represented by a Resident Engineer who has direct responsibility for management of the CQA activities. The CQA Resident Engineer will be experienced in construction, CQA of soils; CQA of geosynthetics and pipe; and preparation of CQA documentation including CQA forms, reports, and plans.

3.3.4 Soils Construction Quality Assurance (CQA) Laboratory

The Soils CQA Laboratory will have experience with the physical testing of soils, meet all applicable regulatory requirements, and be familiar with ASTM and other required test standards. The Soils CQA Laboratory will be capable of providing test results in accordance with the specifications.

3.3.5 Geosynthetics Construction Quality Assurance (CQA) Laboratory

The Geosynthetics CQA Laboratory will have experience in testing geosynthetics and other relevant liner system components and be familiar with ASTM and other applicable test standards.

3.4 Duties of Construction Quality Assurance Engineer

The overall responsibility of the CQA Engineer is to perform those activities specified in the CQA Plan (e.g., inspection, sampling, testing and documentation final certification). At a minimum, the CQA Engineer will be represented by a CQA Resident Engineer and the necessary supporting CQA inspection personnel. Specific responsibilities of the CQA Resident Engineer may include:

- Reviewing design criteria, plans, and specifications for clarity and completeness so that the CQA Plan can be implemented.

- Educating CQA inspection personnel on CQA requirements and procedures.

- Scheduling and coordinating CQA inspection activities.

- 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 adversely over time and verifying that changes do not adversely impact the inspection process;

  - confirming that the test data are accurately recorded and maintained; and,

  - verifying that the raw data are properly recorded, validated, reduced, summarized, and interpreted.

- Providing to the Owner reports on the inspection results including:

  - review and interpretation of data sheets and reports;

  - identification of work that the CQA Resident Engineer believes should be accepted, rejected, or uncovered for observation, or that may require special testing, inspection, or approval; and,

  - rejection of defective work and verification that corrective measures are implemented.

- Verifying that the Contractor's construction quality control plan, if required, is in accordance with the site specific CQA Plan.

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

- Providing the final report and certifications required by the CQA Plan.

For the supporting CQA inspection personnel, specific responsibilities may include:

- Performing independent on-site inspection of the work in progress to verify conformance 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; and,
- Reporting to the CQA Resident Engineer results of all inspections including work that is not of acceptable quality or that fails to meet the specified design.

4.0 SCOPE OF CONSTRUCTION QUALITY ASSURANCE

The scope of this CQA Plan includes the CQA of the subgrade, and soil, pipe, and geosynthetic components of the liner and cover system. The CQA Plan also includes the CQA of manufacturing, shipping, handling, and installing of all geosynthetics and pipe.

This CQA Plan does not address design guidelines, installation specifications, or selection of soils, geosynthetics, pipe or other liner system components, which are all described in the General Specifications.

The CQA Plan does not provide for Construction Quality Control which the Contractor may independently undertake to facilitate the Contractor's achieving his requirements under the General Specifications.

5.0 UNITS

In this CQA Plan, all properties and dimensions are expressed in customary U.S. units.

6.0 REFERENCES

6.1 Applicable Organizations

Organizations whose standards are referenced in the CQA Plan and the General Specifications are as follows:

- ASHTO - American Association of State Highway and Transportation Officials;
- CHS - Colorado Department of Highways (Standard Specifications for Road and Bridge Construction);

- ASTM - American Society for Testing and Materials;
- GRI - Geosynthetic Research Institute;
- OSHA - Occupational Safety and Health Administration; and,
- USEPA - United States Environmental Protection Agency.

6.2 Applicable Standards

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

6.3 Specific Standards

Specific test standards which may be cited in the CQA Plan and the General Specifications are given in Table I-1. These standards may be modified due to technological advances since compilation of Table I-1. All such modifications are to be approved by the Owner.

TABLE I_1
TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS	
AASHTO T96	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine.
AASHTO T104	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
AMERICAN SOCIETY OF TESTING AND MATERIALS	
ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 726	Standard Specification for Cold-Rolled Carbon Steel sheet, Magnetic Laminated Quality, types 1, 2, and 2S
ASTM D 374 C or D0 ASTM D 1777	Method for Measuring Thickness of Geotextile Materials.
ASTM D 422	Standard Method for Particle-Size Analysis of Soils.
ASTM D 570	Standard Test Method for Water Absorption of Plastics.
ASTM D 698	Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop.
ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
ASTM D 751	Standard Methods of Testing Coated Fabrics.
ASTM D 792	Standard Test Methods for Specific Gravity (Relative density) and Density of Plastics by Displacement.

TABLE I_1
TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN

ASTM D 1004	Standard Test Method of Initial Tear Resistance of Plastic film and Sheeting.
ASTM D 1204	Standard Plastics Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
ASTM D 1248	Standard Specification for Polyethylene Plastic Molding and extrusion Metals.
ASTM D 1505	Standard Test Methods for Density of Plastics by Density-Gradient Technique.
ASTM D 1556	Standard Test Method for Density of Soil In Place by the Sand-Cone Method.
ASTM D 1593	Standard Specification for Nonrigid Vinyl Chloride Plastic Sheeting.
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
ASTM D 2167	Standard Test Method for Density and Unit Weight of Soils in Place by Rubber Balloon Method.
ASTM D 2216 or D 4643	Standard Method for Laboratory Determination of water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
ASTM D 2487	Standard Test Method for Classification of Soils for Engineering Purposes.
ASTM D 2657	Standard Practice for Heat-Joining for Polyolefin Pipe and Fittings.
ASTM D 2663	Carbon-Black Dispersion in Rubber.
ASTM D 2837	Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
ASTM D 2922	Standard Test Method for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth).
ASTM D 3015	Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
ASTM D 3017	Standard Test Method for Moisture Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth).
ASTM D 3350	Standard Specifications for Polyethylene Plastic Pipe and Fittings Materials.
ASTM D 3776	Mass Per Unit Area (Weight) of Woven Fabric.
ASTM D 4253	Standard Test Method for Maximum Index Testing of Soils Using a Vibratory Table.
ASTM D 4254	Standard test Method for Minimum Index Density of Soils and Calculations of Relative Density.
ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D 4373	Standard Test Method for Calcium Carbonate Content of Soils.
ASTM D 4437	Standard Test Methods for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Geomembranes.
ASTM D 4491	Standard Test Method for Water Permeability of Geotextiles by the Permittivity Method.

TABLE I_1
TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN

ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
ASTM D 4632	Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Elongation Method and Peel Strength).
ASTM D 4643	Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTM D 5261	Measuring Mass Per Unit Area of Geotextile
ASTM D 5321	Coefficient of Soil and Geosynthetics or Geosynthetics and Geosynthetics Friction by Direct Shear.
ASTM D 5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Contanct tensile Load Test
ASTM D 5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
ASTM D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane
ASTM D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D 6693	Standard Test Method for Bulk Solids Characterization by Carr Indices
ASTM D 6747	Standard Guide for Selection of Technics for Electrical Detection of Potential Leak Paths in Geomembranes
ASTM D 7007	Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earth Materials
ASTM E 11	Specification for Wire-Cloth Sieves for Testing Purposes.
ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ASTM F 904	Standard Test Method for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials.
GEOSYNTHETIC RESEARCH INSTITUTE	
GRI-GMI	Standard Test Method for Ductile/Brittle Transition Time for Notched Polyethylene Specimen under Constant Stress.
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
USEPA Method 9090 Compatibility Test for Wastes and Membrane Liners.	

SECTION II -
SOILS CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

This section of the CQA Plan addresses the soils components of the liner and cover systems and specifies the soils CQA program to be implemented with regard to materials selection and evaluation, laboratory test requirements, field test requirements, and treatment of problems.

This section of the CQA Plan also addresses for construction of the foundation subgrade, clay liners, clay covers granular drainage layers, sump and pipe bedding gravel, the protective soil layer, and general fill cover soil.

2.0 FOUNDATION SUBGRADE

2.1 Verification of Subgrade Continuity

When the excavation of the secure cell or surface impoundment is completed, the CQA Engineer will:

- Obtain thin-walled tube or other appropriate undisturbed sampling technique (Shelby tube samples) of the subgrade material and perform permeability testing (secure cells only), at the frequency specified in Table II-1, samples taken from unweathered Pierre shale may require extra care to retrieve; the Shelby tubes will be pushed perpendicular to the soil using available on-site equipment provided by the Contractor;

- Inspect the subgrade on the side slopes and base of the secure cell or surface impoundment and note areas of weak or excessively weathered subgrade materials and areas with soils with a Unified Soil Classification System (USCS) gradation coarser than SM; and,

- Observe the proof rolling of the base of the secure cell or surface impoundment and note areas that exhibit excessive rutting, heaving, or softening.

In accordance with Clean Harbors TSDF's Part B Permit, the Contractor will be required to remove soils with a USCS gradation coarser than SM. The backfill material in the excavation will be structural fill or clay liner material that will be placed and compacted so as to exhibit an equal or lower hydraulic conductivity than the adjacent undisturbed soil. The scope of the testing program implemented to demonstrate lower hydraulic conductivity will be established by the CQA Engineer and Owner after the nature and extent of the excavated material is known. The testing program will be submitted to

CDPHE prior to backfilling over-excavated areas. The CQA Engineer will observe any excavation and backfilling operations.

The scope of the testing program implemented to demonstrate lower hydraulic conductivity will be established by the CQA Engineer and Owner after the nature and extent of the excavated material is known. The testing program will be submitted to CDPHE prior to backfilling over-excavated areas. The CQA Engineer will observe any excavation and backfilling operations.

After the areas identified above are repaired, the CQA Engineer will verify and document scarification and compaction of selected portions of the subgrade designated by the Owner on the base of the secure cell or surface impoundment. Scarification will generally be to a depth of not less than 8 inches. The CQA Engineer will verify and document that the compaction of the scarified surface is performed in accordance with the requirements for structural fill, provided in the General Specifications.

The CQA Engineer will report any problems or deviations from the above requirements to the Owner.

2.2 Fill Placement and Compaction

The General Specifications will be followed for the placement and compaction of fill. The CQA Engineer will monitor the fill placement and compaction to verify and document the following:

- The soil being placed meets the General Specification requirements for fill as determined by the test methods and frequencies specified within this CQA Plan;
- The compacted lift thickness is in accordance with the requirements of the General Specifications;
- The previous lift is scarified as specified in the General Specifications before placing the next lift;
- Fill is moisture conditioned, as required in the General Specifications; and,
- The compacted moisture content and dry unit weight of the fill meets specifications as determined by the test methods and frequencies described below.

2.3 Construction Quality Assurance Evaluation

The minimum frequency of soils testing for CQA purposes will conform to the minimum frequencies presented in Table II-2.

Nuclear density meter test methods will be used for the field testing of the in-situ dry unit weight and moisture content of the in-place, compacted fill. Sand cone tests and/or rubber balloon tests and oven moisture content tests will be conducted to calibrate the results of the nuclear density meter and in cases of uncertainty with the nuclear density meter test results. Any conflict over the test results will be resolved by the CQA Engineer and the Owner. All perforations in the fill will be backfilled in accordance with the General Specifications.

If an in-place density test results fails to meet specifications, a confirmatory test will be performed immediately adjacent to the failed test. If the confirmatory test meets or exceeds specifications then a second confirmatory test will be performed at a second location immediately next to the failed test. If the second confirmatory test also meets or exceeds specifications then the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, then additional testing will be performed to identify the limits of the area that does not meet project specifications.

If a defective area is discovered in the fill, the CQA Engineer will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Engineer will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Engineer deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA Engineer will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined, the CQA Engineer will notify the Owner, and verify that the deficiency is corrected by the Contractor before any additional work is performed in the area of the deficiency.

2.4 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform the CQA survey. The CQA Surveyor will independently survey the excavation and to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. CQA Surveys will be conducted in accordance with the requirements described in Part 8 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer. The CQA Engineer and the Owner will review and approve the survey results before the next phase of the lining system is constructed.

3.0 PERMANENT SUMP

3.1 Placement, Installation, and Compaction

The Contractor will be required to construct a permanent sump below the secure cell liner system. The CQA Engineer will monitor the excavation of the permanent sump and verify and document that the procedures for handling, placement, installation, and compaction of each material used to construct the permanent sump are the same as the procedures given in the General Specifications for liner system construction for that respective material.

3.2 Construction Quality Assurance Evaluation

Field quality assurance procedures for each material used to construct the sump will be the same as the procedures given in the CQA Plan for liner system construction for that respective material.

3.3 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform the CQA Survey. The CQA surveyor will independently survey the elevations and grades of the excavation of the permanent sump, the top of subgrade of the permanent sump and the top of the gravel collection layer shown on the Construction Drawings.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer. The CQA Engineer and Owner will approve the survey results before the next phase of the lining system construction.

Surveying will be conducted in accordance with requirements described in Part 8 of Section II.

4.0 CLAY LINERS AND COVERS

4.1 Secondary Clay Liner Placement and Compaction

The CQA Engineer will verify and document that the secondary clay liner is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the secondary clay liner, the CQA Engineer will verify and document that:

- All or an approved portion of the excavation, subgrade foundation and permanent sump (for secure cells only) are complete, and that a survey has been conducted to verify that the subgrade grades and elevations conform to the Construction Drawings;
- The subgrade meets specifications as determined by the test requirements of this CQA Plan;
- The surface of the subgrade is free of debris, wet and soft areas, ponded water, vegetation, mud, ice or frozen material; and,
- If frozen subgrade material is encountered, it is removed and replaced in accordance with the General Specifications.

During placement and compaction of the secondary clay liner, the CQA Engineer will verify and document that:

- In accordance with the Clean Harbors TSDF Part B Permit, continuous close inspection of the placement and compaction of clay liner material with earthmoving equipment is performed by the CQA Engineer;
- The clay liner material meets the requirements of the General Specifications as determined by the CQA testing methods and frequency in Table II-3;
- The secondary clay liner is placed in accordance with the conditions and minimum requirements of the General Specifications;
- Each lift is compacted to the required thickness and minimum dry unit weight within the range of moisture contents established by the General Specifications as determined by the CQA testing methods and frequency in Table II-3;
- The Contractor uses the compaction equipment and the number of passes specified in the General Specifications;
- Thin-walled (i.e., Shelby tube) samples of secondary clay liner material are collected and laboratory permeability testing is performed at the frequency specified in Table II-3; and,

- Perforations in the clay liner at testing and sampling locations are backfilled in accordance with the General Specifications.

The CQA Engineer will document the properties of the clay soil as determined by the test methods and frequency prescribed by this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

4.2 Primary Clay Liner Placement and Compaction

The CQA Engineer will verify and document that the primary clay liner is constructed to the elevations, grades, and thicknesses shown on the Construction Drawings, with material meeting the requirements of the General Specifications as determined by the test methods and frequencies specified within this CQA Plan.

Prior to the placement of the primary clay liner, the CQA Engineer will verify and document that:

- All, or an approved portion, of the leak detection layer, the leak detection system sump, and any associated piping are complete, and that all conformance sampling, testing, and documenting has been conducted to verify that the Contractor's work is in conformance with the Contract Documents; and,

- The leak detection layer is free of debris, ponded water, rocks, mud, ice, or other deleterious material, and that excessive wrinkles in the geosynthetic components of the leak detection layer have been "worked out".

All of the CQA activities identified for the secondary clay liner in Section 4.1 above are also required during placement and compaction of the primary clay liner. In addition, the CQA Engineer will verify and document that the first lift of primary clay liner material above the leak detection system is placed with extreme care using low ground pressure equipment as described in the General Specifications (compaction requirements will be waived to assure that no damage to the underlying geosynthetics occurs):

- For the remaining lifts, the lift thicknesses correspond to the requirements of the General Specifications; and,

- On the side slopes, mechanized equipment does not operate within the minimum distance specified in the General Specifications and that field quality control tests are not performed within a 1 foot zone of the slope face.

The CQA Engineer will document the properties of the clay soil in the primary liner as determined by the test methods and frequencies prescribed within this CQA Plan and will report any nonconformance with the General Specifications to the Owner.

4.3 Sand Layer Clay Plug Placement and Compaction

All of the CQA activities identified for the secondary clay liner in Section 4.1 above are also required during placement and compaction of the sand layer clay plug, with the following exceptions:

- The sand layer clay plug will be constructed to the requirements of Section 2019 of the General Specifications

- The intent of the clay plug is to provide a barrier of a given thickness and permeability that will result in a travel time equal to clay 100 feet thick with a permeability of 1 x 10^{-7} cm/sec. Other combinations of permeability and thickness that result in an equal travel time are acceptable such as 10 feet of clay at 1 x 10^{-8} cm/sec, 20 feet of clay at 2 X 10^{-8} CM/SEC, ETC.

4.4 Construction Quality Assurance Evaluation

Extensive construction quality assurance testing is required of the clay liners, and the Contractor must take quality assurance testing into account when planning his construction schedule. Nuclear density meter test methods will be used for testing the in-situ compacted dry unit weight and moisture content of the clay materials. Sand cone and/or Rubber Balloon tests and oven moisture content tests will be used to calibrate the reading of the nuclear density meter and in cases of uncertainty with the nuclear density meter readings. Any discrepancies between test results will be resolved by the CQA Engineer and the Owner. Thin-walled (i.e., Shelby) tube samples will be collected for hydraulic conductivity testing. At the request of the CQA Engineer, on-site construction equipment operated by the Contractor will be used to slowly push the sample tube through the clay layer. The CQA Engineer will conduct moisture, density, and hydraulic conductivity tests as specified in Table II-3.

The testing frequency during clay liner construction may be increased or modified at the discretion of the CQA Engineer when visual observations of construction performance indicate potential problems.

During construction, the frequency of testing may be increased by the CQA Engineer during adverse weather conditions, if equipment breaks down, at the start and finish of grading, if the material fails to meet the requirements of the General Specifications, or the extent of the work area is reduced.

All perforations in the clay liner at nuclear density test probe locations will be backfilled by the CQA Engineer with bentonite (sodium montmorillonite) powder or flakes or a soil-bentonite mixture and compacted by hand tamping. All perforations at sand cone or rubber balloon test locations, Shelby tube sample locations, and test pit locations will be backfilled by the Contractor with clay liner material and compacted in accordance with the specifications for clay liner.

If an in-place density test results fail to meet specifications, a confirmatory test will be performed immediately adjacent to the failed test. If the confirmatory test meets or exceeds specifications then a second confirmatory test will be performed at a second location immediately next to the failed test. If the second confirmatory test also meets or exceeds specifications then the area will be declared as meeting project specifications and the confirmatory tests will be reported. In the event that either confirmatory test fails to meet specifications, then additional testing will be performed to identify the limits of the area that does not meet project specifications.

If a defective area is discovered in the clay liner, the CQA Engineer will determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Engineer will determine the extent of the defective area by additional tests, observations, a review of records, or other means that the CQA Engineer deems appropriate. If the defect is related to adverse site conditions, such as excessively wet soils or surface desiccation, the CQA Engineer will define the limits and nature of the defect by testing or observation. After the extent and nature of a defect is determined and has been remedied by the Contractor, the CQA Engineer will verify that the deficiency is corrected by retesting repaired areas before any additional work is performed by the Contractor in the area of the deficiency.

Based on the requirements of the General Specifications, the Contractor will be required to use all means necessary to protect all prior work, as well as all materials and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repaired.

4.5 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform the CQA surveys. The CQA Surveyor will independently survey the elevations and grades of the secondary and primary clay liner surfaces, and to confirm that the lines and elevations in the field agree with those shown on the Construction Drawings. CQA surveys will be conducted in accordance with the requirements described in Part 8 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner.

The Owner and the CQA Engineer will approve the survey results before the next phase of the liner system (geomembrane installation) is constructed.

4.6 Permeability Tests

Two thin-walled (i.e. Shelby) tube samples will be collected for hydraulic testing, one for testing and another for archive. In the event that a sample fails the permeability test the archive sample may be used to perform a second permeability test. If both samples fail two additional Shelby tubes will be collected and tested after delineation and repair to the non-conforming area. Acceptance of a passing test for the secondary or primary clay liner is based on the original sample or archive sample meeting the required permeability. The archive sample shall only be accepted only be tested and used for acceptance if there is visible and documented evidence of sample disturbance.

5.0 GRANULAR LEACHATE COLLECTION LAYER

5.1 Supplier

The Contractor will require that the granular material Supplier provide the CQA Engineer with quality control test results and a written certification signed by a responsible party of the Supplier that the tests required by the General Specifications have been performed on the material to be delivered to the site.

The CQA Engineer will examine the tests results and report any deviations to the Owner. If the gravel supplier cannot provide test results required by the General Specifications, then the CQA Engineer may perform or arrange to perform the tests.

5.2 Conformance Evaluation

The test methods and frequency for CQA conformance testing of the granular leachate collection material are specified in Table II-4. If the granular material fails to meet the requirements of the General Specifications, the CQA Engineer will perform sufficient sampling and testing to identify the extent of the nonconforming material at the expense of the Contractor. Nonconforming material will be removed from the site.

5.3 Placement and Compaction

Prior to the placement of the granular leachate collection layer, the CQA Engineer will verify and document that:

- The underlying geomembrane liner or geosynthetic layer is free of holes, tears, excessive wrinkles, or foreign objects; and,
- All work on underlying layers is complete and accepted by the Owner.

During placement and compaction of the granular leachate collection layer, the CQA Engineer will verify and document that:

- Granular material satisfies the requirements of the General Specifications as determined by the testing prescribed within the CQA Plan;
- Granular material is spread before 12:00 noon, unless otherwise approved by the Owner;
- The equipment wheel ground pressure versus the material thickness requirements given in the General Specifications are complied with;
- The granular material is placed in a manner so that the maximum material drop height is in accordance with the General Specifications;
- In accordance with Part II.E.1.b.ii. of the Clean Harbors TSDF Part B Permit, continuous close inspection of the placement and compaction of granular leachate collection layer material with earth moving equipment is performed; and,
- The granular material is compacted utilizing the equipment and number of passes specified in the General Specifications.

5.4 Construction Quality Assurance Evaluation

No density tests will be conducted on the granular leachate collection layer. If the CQA Engineer suspects damage to pipes or underlying geosynthetic, the contractor will be required to expose the potentially damaged materials and repair any observed damage.

5.5 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform CQA surveys. The CQA surveyor will independently survey the elevations and grades of the top of the granular leachate collection layer, and to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. The CQA surveys will be performed in accordance with the requirements described in Part 8 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner. The Owner and CQA Engineer will approve the survey results before the next phase of the lining system is constructed.

6.0 SUMP AND PIPE BEDDING GRAVEL AND ROAD BASE AGGREGATE GRAVEL

6.1 Supplier

The Contractor will provide the CQA Engineer with quality control test results and a written certification signed by a responsible party of the Gravel Supplier that the tests required by the General Specifications have been performed on material representative of that which is to be delivered to the site.

The CQA Engineer will examine the tests results and report any deviations from the General Specifications to the Owner. If the Gravel Supplier cannot provide test results required by the General Specifications, then the CQA Engineer may perform or arrange to perform the tests.

6.2 Conformance Evaluation

The test methods and frequency for CQA testing of the gravel is specified in Table II-5.

If the gravel fails to meet the requirements of the General Specifications, the CQA Engineer will perform sufficient sampling and testing to identify the extent of the nonconforming material with the cost of such tests borne by the Contractor. Nonconforming material will be removed from the site.

6.3 Placement

Prior to the placement of the gravel, the CQA Engineer will verify and document that:

- The underlying geotextile is free of holes, tears, excessive wrinkles, or foreign objects; and,
- All work on underlying layers is complete and accepted by the Owner.

During placement of the gravel, the CQA Engineer will verify and document that:

- In accordance with the Clean Harbors TSDF Part B Permit, continuous close inspection of the placement of gravel with earth-moving equipment is performed;
- The gravel is suitable and meets the requirements of the General Specifications as determined by the test methods and frequency prescribed within this CQA Plan; and,
- The gravel is placed in accordance with the General Specifications.

6.4 Construction Quality Assurance Evaluation

No density tests will be conducted on the sump and pipe bedding gravel, or road base gravel. If the CQA Engineer suspects damage to pipes or underlying geosynthetics, the Contractor will be required to expose the potentially damaged materials and repair any observed damage.

7.0 PROTECTIVE SOIL LAYER

7.1 Placement and Compaction

Prior to the placement of the protective soil layer, the CQA Engineer will verify and document that:

- The underlying geocomposite is free of holes, tears, excessive wrinkles, or foreign objects; and,
- All work on underlying layers is complete and accepted by the Owner.

During placement of the protective soil layer, the CQA Engineer will verify and document that:

- The soil is suitable and satisfies the requirements of the General Specifications as determined by the test methods and frequencies prescribed within this CQA Plan;
- The protective soil is placed in accordance with the General Specifications;
- The lift thicknesses and total thickness of the protective soil layer agree with the requirements of the General Specifications;
- If excessive wrinkles begin to develop in the underlying geosynthetics during material placement or spreading, the wrinkles are worked out prior to continued placement operations;
- The protective soil layer is lightly compacted as described in the General Specifications;
- The protective soil is placed on the side slopes to the limits shown on the construction drawings; and,
- No protective soil layer material is placed or compacted during periods of unfavorable weather conditions.

7.2 Conformance Evaluation

There are no CQA testing requirements for the protective soil layer, other than thickness requirements.

If damage to underlying geosynthetics is expected, the CQA Engineer will require that the overlying protective soil layer material be removed to expose the geosynthetics.

The Contractor will be required to use all means necessary to protect all prior work, as well as all materials and completed work of other Sections. In the event of damage, the Contractor will be required to immediately make all repairs and replacements necessary. The CQA Engineer will verify and document that all damages are repaired.

7.3 Surveying

A Professional Land Surveyor registered in the State of Colorado will perform the CQA surveys. The CQA surveyor will independently survey the elevations and grades of the top of the protective soil layer on the base and side-slopes of the secure cell, and to confirm that the grades and elevations in the field agree with those shown on the Construction Drawings. The CQA surveys will be performed in accordance with the requirements described in Part 8 of Section II.

The results of the survey conducted by the CQA Surveyor will be compiled in a report signed by the CQA Surveyor and the CQA Engineer, and will be reviewed by the Owner.

8.0 SURVEYING

The Surveyor will be required to survey each soil layer of the liner system and cover system (except the vegetative soil cover) for the secure cell or surface impoundment in accordance with the requirements of the General Specifications. If required by the Owner, a Record Drawing will be submitted by the Surveyor before the placement of the next liner system layer. The surveys will be conducted at a 100 foot grid for slopes greater than 25 percent and at 50 foot grid for slopes less than 25 percent. All pipes for leachate detection, collection and/or removal will be surveyed at start and end points and at 50 foot intervals in between. The CQA survey will include enough information to confirm that the following features of the secure cell or surface impoundment are constructed in accordance with the Construction Drawings:

- Toe of slope;
- Crest of slope;
- Grade breaks;
- Anchor trench;
- Leachate collection sump;
- Leak detection sump;

- Permanent sump (secure cells only); and,
- Perimeter drainage ditches.

The CQA results will be submitted to the Owner for final approval to proceed on the liner system construction.

TABLE II-1
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF FOUNDATION SUBGRADE

Test	Frequency	Standard Test Method
Permeability		
Shelby Tube or other appropriate undisturbed samples	3 from base of excavation	ASTM D 5084

TABLE II-2
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF STRUCTURAL AND GENERAL FILL

Test	Frequency	Standard Test Method
Material Properties		
Standard Proctor	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 698
Sieve Analysis	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 5,000 cy placed (minimum 1 per source)	ASTM D 4318
In Place		
Nuclear Density Meter (50 ft. grid)		
In-Situ Moisture Content	1 per 2,500 ft^2 per lift	ASTM D 3017
In-Situ Dry Unit Weight	1 per 2,500 ft^2 per lift	ASTM D 292
Calibration and Check		
Sand Cone (In-Situ Density)	1 per day of fill placement	ASTM D 1556
Oven Moisture Contents (In-Situ Moisture Content)	1 per day of fill placement	ASTM D 2216

TABLE II-3:
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF CLAY LINER MATERIAL AND COMPACTION

Test	Frequency	Standard Test Method
Material Properties		
Standard Proctor	1 per 3,000 cy placed (minimum 1 per source)	ASTM D 698
Sieve Analysis	1 per 3,000 cy placed (minimum 1 per source)	ASTM D 422
Atterberg Limits	1 per 3,000 cy placed (minimum 1 per source)	ASTM D 4318
In Place		
Lift Thickness Before Compaction	1 per 2,500 ft^2 per lift	Field Measurement
Nuclear Density Meter[(1)] (50 ft. grid)		
In-Situ Moisture Content	1 per 2,500 ft2 per lift	ASTM D 3017
In-Situ Dry Unit Weight	1 per 2,500 ft^2 per lift	ASTM D 292
Calibration and Check		
Sand Cone or Rubber Balloon (In-Situ Density)	1 per day of fill placement	ASTM D 1556/D 2167
Oven Moisture Contents (In-situ Moisture Content)	1 per day of fill placement	ASTM D 2216
Permeability[(1)]		
Shelby tube Samples (Cell Base)	1 per acre per lift	ASTM D 5084
Shelby tube Samples (Side Slopes)	1 per acre – every other lift or 1 test per every 1610 yds^3 placed	ASTM D5084
Shelby tube Samples (Clay Plug)	1 per 2000 yds^3 placed	ASTM D 5084

[(1)]The Shelby tube sampling and nuclear density testing frequency does not include clay placed as overbuild material on the cell side-slopes.

TABLE II-4:
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF GRANULAR LEACHATE COLLECTION LAYER

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 500 cy placed (minimum 1 per source)	ASTM D 422
Permeability	1 per source	ASTM D 2434

TABLE II-5
MINIMUM FREQUENCY OF TESTING FOR CQA EVALUATION OF SUMP AND PIPE BEDDING GRAVEL AND ROAD BASE GRAVEL

Test	Frequency	Standard Test Method
Material Properties		
Sieve Analysis	1 per 100 cy placed (minimum 1 per source)	ASTM D 422

SECTION III - GEOSYNTHETIC CLAY LINER CONSTRUCTION QUALITY ASSURANCE

1.0 GEOSYNTHETIC CLAY LINER MANUFACTURE AND DELIVERY

1.1 Manufacture and Quality Control

Prior to the installation of the Geosynthetic Clay Liner (GCL), the Contractor will be required to provide the CQA Engineer with the following information from the GCL Manufacturer:

- The certification required by the General Specifications signed by a responsible party employed by the GCL Manufacturer based on sampling interval of 1/ 40,000 ft^2; and,

- The manufacturing quality control certificates for each shift's production of GCL, signed by a responsible party employed by the GCL Manufacturer (such as the production manager). The quality control certificates will include:

  - Roll numbers and identification; and,

  - Sampling procedures and results of quality control tests specified by the General Specifications including descriptions of the test methods used for GCL rolls assigned to the Clean Harbors project.

The CQA Engineer will verify and document that:

- The property values certified by the GCL Manufacturer meet all of the specified values listed in the General Specifications;

- The measurements of properties by the GCL Manufacturer are properly documented and the test methods used are in accordance with the General Specifications; and,

- The quality control certificates have been provided at the specified frequency for GCL rolls, and each certificate identifies the rolls or batch number related to that certificate.

The CQA Engineer will report deviations from the above requirements to the Owner prior to installation of the GCL.

1.2 Labeling

The CQA Engineer will verify and document that the GCL Manufacturer has labeled each roll of GCL as specified in the General Specifications.

The CQA Engineer will examine GCL rolls upon delivery and deviation from the above requirements will be reported to the Owner prior to installation of the GCL.

1.3 Transportation and Handling

The CQA engineer will observe and document the type of GCL handling equipment used by the installer is consistent with handling equipment identified in the general specifications.

Upon delivery at the site, the CQA Engineer will conduct a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA Engineer will indicate to the Owner:

- Any rolls that should be unrolled to allow for their inspection;
- Any rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and,
- Any rolls which include minor repairable flaws.

1.4 Storage

The CQA Engineer will verify and document that storage of the GCL is in accordance with the General Specifications.

1.5 Quality Assurance Conformance Testing

Either at the Manufacturer's plant or upon delivery of the rolls of GCL, the CQA Engineer will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the General Specifications.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 ft^2 whichever is greater. These samples will be tested for:

- Bentonite Moisture Content ASTM D 4643
- GCL Grab Strength ASTM D 4632
- GCL Peel Strength ASTM D 4632 of ASTM D 6496

- GCL Permeability ASTM D 5084
- GCL Interface Shear Strength ASTM D 5321

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the length of the roll. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA Engineer will Mark the machine direction on the samples with an arrow.

The CQA Engineer will examine all results from laboratory conformance testing and will compare the results to the specifications presented in Table 02780-1 of the Specifications. In addition, the CQA Engineer will report any nonconformance to the Owner as soon practical after the test results become available.

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

- The Contractor will be required to replace the roll (or rolls) of geotextile that is not in conformance with the specifications with a roll that meets the requiremnts of the General Specificaitons.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fail to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed samples and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geotextile on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of all such tests are to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

2.0 GEOSYNTHETIC CLAY LINER INSTALLATION

2.1 Earthworks

2.1.1 Surface Preparation

The Contractor or subcontractor responsible for GCL installation will be required to certify in writing that the surface on which the GCL will be installed is acceptable. The certificate

of acceptance will be required to be given by the Contractor to the CQA Engineer, who will then verify to the Owner that the subgrade and/or geocomposite installation is accepted immediately prior to commencement of GCL installation in the area under consideration.

After the surface on which the GCL is to be installed has been accepted by the Contractor responsible for GCL installation, it will be the CQA Engineer's responsibility to indicate to the Owner any change in the underlying layer that may, in accordance with the General Specifications, require repair work. If the Owner requires repair work, then it will be the responsibility of the Contractor to repair the underlying layer.

2.1.2 Anchor Trenches

The CQA Engineer will verify and document that the anchor trench backfill meets the requirements of the General Specifications and that the backfill is placed in accordance with the General Specifications.

2.2 Geosynthetic Clay Liner Deployment

2.2.1 Field Panel Identification

A field panel is the unit area of GCL which is to be placed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

The CQA Engineer will verify that each field panel is given an identification code (number or letter and number) consistent with the layout plan. This identification code will be agreed upon by the Owner, and the Contractor. This field panel identification code should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the Contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA Engineer will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

2.2.2 Field Panel Placement

2.2.2.1 Installation Schedule

The CQA Engineer will evaluate significant changes in the schedule proposed by the Contractor and advise the Owner on the acceptability of that change. The CQA Engineer will verify and document that the condition of the underlying layer has not changed

detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the Contractor in accordance with the General Specifications.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

2.2.2.2 Weather Conditions

The CQA Engineer will verify and document that GCL is not placed during inclement weather conditions as specified within the General Specifications.

Additionally, the CQA Engineer will verify and document that the underlying layer has not been damaged by weather conditions.

2.2.2.3 Damage

The CQA Engineer will visually observe each panel, after placement, for damage. The CQA Engineer will advise the Owner which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected by the Owner will be marked, and their removal from the work area will be documented by the CQA Engineer.

2.2.2.4 Seam Overlap and Bentonite Seal

The CQA engineer will observe and document that the seam overlaps and bentonite material placed between panels along the seams meet specification guidelines. The CQA engineer will verify overlap width and will observe bentonite seal placement.

2.3 Defects and Repairs

2.3.1 Identification

All seams and non-seam areas of the GCL will be inspected by the CQA Engineer for evidence of defects, holes, decontamination of geotextiles, displaced panels, premature hydration, and any sign of contamination by foreign matter. The CQA Engineer will observe and document repair procedures described below.

2.3.2 Repair Procedures

Prior to cover material placement, damage to the GCL shall be identified and repaired by the installer.

2.3.2.1 Rip and Tear Repair (Flat Surfaces)

Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges.

Accessory bentonite should be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal foot of edge spread in a continuous six inch layer.

2.3.2.2 Rip and Tear Repair (Slopes)

Damaged GCL material on slopes shall be repaired by the same procedures above, however, the overlapped edges of the patch should be wide enough to ensure the patch will keep its position during backfill or cover operations.

2.3.2.3 Displaced Panels

Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

2.3.2.4 Premature Hydration

If the GCL is subjected to premature hydration, the GCL installer shall notify the QA/QC technician and project engineer for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design.

SECTION IV
GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE

1.0 GEOMEMBRANE MANUFACTURE AND DELIVERY

1.1 Resin

Prior to the installation of the HDPE geomembrane material, the Contractor will be required to provide the CQA Engineer with the following information from the geomembrane Manufacturer:

- A copy of the quality control certificates issued by the resin Supplier that includes the origin (resin Supplier's name and resin production plant), identification (brand name, number) the production date of the resin used in the manufacture of the geomembrane shipped to the site, and the results of tests conducted to verify that the quality of the resin used to manufacture the geomembrane rolls assigned to the project meets the General Specifications; and

- Certification from the geomembrane Manufacturer that no reclaimed polymer is added to the resin during the manufacture of the geomembrane to be used in this project; the use of polymer recycled during the manufacturing process is permitted if the recycled polymer does not exceed 2 percent by weight of the total polymer weight.

The CQA Engineer will review these documents and report any discrepancies with the above requirements to the Owner.

1.2 Geomembrane Manufacturing Quality Control

Prior to the installation of the HDPE geomembrane, the Contractor will be required to provide the CQA Engineer with the following information from the geomembrane Manufacturer:

- The certification required by the General Specifications signed by a responsible party employed by the geomembrane Manufacturer based on sampling interval of 1/40,000 ft^2; and,

- The manufacturing quality control certificates for each shift's production of geomembrane, signed by a responsible party employed by the geomembrane Manufacturer (such as the production manager). The quality control certificates will include:

- Roll numbers and identification; and,

- Sampling procedures and results of quality control tests specified by the General Specifications including descriptions of the test methods used for geomembrane rolls assigned to the Clean Harbors project.

The CQA Engineer will verify and document that:

- The property values certified by the geomembrane Manufacturer meet all of the specified values listed in the General Specifications;

- The measurements of properties by the geomembrane Manufacturer are properly documented and the test methods used are in accordance with the General Specifications; and,

- The quality control certificates have been provided at the specified frequency for geomembrane rolls, and each certificate identifies the rolls or batch number related to that certificate.

The CQA Engineer will report deviations from the above requirements to the Owner prior to installation of the geomembrane.

1.3 Labeling

The CQA Engineer will verify and document that the geomembrane Manufacturer has labeled each roll of geomembrane as specified in the General Specifications.

The CQA Engineer will examine geomembrane rolls upon delivery and deviation from the above requirements will be reported to the Owner prior to installation of the geomembrane.

1.4 Transportation and Handling

Upon delivery at the site, the CQA Engineer will conduct a visual inspection of all rolls for defects and for damage. This examination will be conducted without unrolling rolls unless visible defects or damages are found. The CQA Engineer will indicate to the Owner:

- Any rolls that should be unrolled to allow for their inspection;
- Any rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and,
- Any rolls which include minor repairable flaws.

1.5 Storage

The CQA Engineer will verify and document that storage of the geomembrane is in accordance with the General Specifications.

1.6 Quality Assurance Conformance Testing

Either at the Manufacturer's plant or upon delivery of the rolls of geomembrane, the CQA Engineer will ensure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the General Specifications.

Conformance samples will be taken by the CQA Engineer across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA Engineer will mark the direction of the machine used to cut the samples with an arrow.

Unless otherwise specified, samples will be taken at a rate of one per lot or one per 100,000 ft^2 whichever is greater. These samples will be tested for:

- Specific gravity (ASTM D 1505);
- Thickness (ASTM D 1593 Par. 8.1.3 for smooth and ASTM D 751 for textured);
- Yield strength and yield elongation (ASTM D 638);
- Tensile strength and tensile elongation at break (ASTM D 638);
- Carbon black content (ASTM D 1603); and,
- Carbon black dispersion (ASTM D 3015 and ASTM D 2663).

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon practical after the test results become available.

The following procedure will apply whenever a sample fails a conformance test that is conducted by the CQA Engineer:

- The Contractor will be required to replace the roll (or rolls) of geomembrane that is in nonconformance with the General Specifications with a roll that meets the General Specifications.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geomembrane on site and every roll subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory; the cost of all such additional tests are to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

2.0 GEOMEMBRANE INSTALLATION

2.1 Earthwork

2.1.1 Surface Preparation

The Contractor or subcontractor responsible for geomembrane installation will be required to certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance will be required to be given by the Contractor to the CQA Engineer, who will then verify to the Owner that the subgrade is accepted immediately prior to commencement of geomembrane installation in the area under consideration.

After the surface on which the geomembrane is to be installed has been accepted by the Contractor responsible for geomembrane installation, it will be the CQA Engineer's responsibility to indicate to the Owner any change in the underlying layer that may, in accordance with the General Specifications, require repair work. If the Owner requires repair work, then it will be the responsibility of the Contractor to repair the underlying layer.

2.1.2 Anchor Trenches

The CQA Engineer will verify and document that the anchor trench backfill meets the requirements of the General Specifications and that the backfill is placed in accordance with the General Specifications.

2.2 Geomembrane Deployment

2.2.1 Layout Drawing

The Contractor will be required to produce layout drawings which show the geomembrane panel configuration, dimensions, details, seam locations, etc. The layout drawings must be approved by the Owner prior to the installation of the geomembrane. The layout drawings, as modified and/or approved by the Owner will be part of the specifications, and a copy will be furnished to the CQA Engineer. The CQA Engineer will become familiar with the layout drawings.

2.2.2 Field Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

The CQA Engineer will verify that each field panel is given an identification code (number or letter and number) consistent with the layout plan. This identification code will be agreed upon by the Owner, and the Contractor. This field panel identification code should be as simple and logical as possible. (Note: manufacturing plant roll numbers are usually cumbersome and are not related to location in the field.) It will be the responsibility of the Contractor to ensure that each field panel placed is marked with the manufacturing plant roll number. The roll number will be marked in the center of the panel in a color to allow for easy inspection.

The CQA Engineer will establish a table or chart showing correspondence between manufacturing plant roll numbers and field panel identification codes. The field panel identification code will be used for all CQA records.

2.2.3 Field Panel Placement

2.2.3.1 Location

The CQA Engineer will verify and document that field panels are installed at the locations and positions indicated in the Contractor's layout plan, as approved or modified by the Owner.

2.2.3.2 Installation Schedule

The CQA Engineer will evaluate significant changes in the schedule proposed by the Contractor and advise the Owner on the acceptability of that change. The CQA Engineer will verify and document that the condition of the underlying layer has not changed detrimentally during installation. Any damage to the surface of the underlying layer will be repaired by the Contractor in accordance with the General Specifications.

The CQA Engineer will record the identification code, location, and date of installation of each field panel.

2.2.3.3 Weather Conditions

The CQA Engineer will verify and document that geomembrane is not placed during inclement weather conditions as specified within the General Specifications.

Additionally, the CQA Engineer will verify and document that the underlying layer has not been damaged by weather conditions.

2.2.3.4 Damage

The CQA Engineer will visually observe each panel, after placement and prior to seaming, for damage (e.g., holes, blisters, creases). The CQA Engineer will advise the Owner which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected by the Owner will be marked, and their removal from the work area will be documented by the CQA Engineer.

2.3 Field Seaming

2.3.1 Seam Layout

The CQA Engineer will verify and document that the seam layout shown on the Panel Layout Drawing (Part 2.2.1) is consistent with the General Specifications. No panels may be seamed in the field without the Owner's approval. In addition, seams not specifically shown on the seam layout drawing may not be made without the Owner's prior approval.

A seam numbering system compatible with the panel numbering system will be agreed upon by the Contractor, the Owner, and CQA Engineer.

2.3.2 Seaming Equipment and Products

Processes approved by the General Specifications for field seaming are: (i) extrusion seaming; and (ii) fusion seaming. Proposed alternate processes will be required to be documented and submitted to the Owner for approval. Only seaming apparatus which the Owner has specifically approved by make and model will be used. The Contractor will be required to use a pyrometer to ensure that accurate temperatures of the extrudate and seamer nozzle are being achieved.

The extrusion seaming apparatus will be equipped with gauges indicating the temperatures of the extrudate and nozzle. The Contractor will be required to provide to

the CQA Engineer the Manufacturer's certification that the extrudate is compatible with the General Specifications and is comprised of the same resin as the geomembrane.

The CQA Engineer will log ambient temperatures, seaming apparatus temperatures, and extrudate temperatures or fusionseaming apparatus speeds. Ambient temperatures will be measured as specified in the General Specifications.

2.3.3 Seam Preparation

The CQA Engineer will verify and document that:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris, and foreign material; and,
- Preparation of seams is in accordance with the General Specifications.

2.3.4 Weather Conditions for Seaming

The CQA Engineer will verify and document that weather conditions for seaming are within the limits specified in the General Conditions.

2.3.5 Trial Seams

The Contractor will be required to make trial seams on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. The Contractor will be required to make and test trial seams at the frequency and in accordance with the methods specified in the General Specifications.

The CQA Engineer will observe all trial seam procedures. The successful trial seam sample will be assigned a number and marked accordingly by the CQA Engineer, who will log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The sample itself will be retained only until the construction of the liner is complete and the liner has been accepted by the Owner.

2.3.6 Nondestructive Seam Continuity Testing

Except as otherwise noted in the General Specifications, the Contractor will nondestructively test all field seams over their full length in accordance with the General Specifications. The purpose of nondestructive tests is to check the continuity of seams. Continuity testing will be carried out as the seaming work progresses, not at the completion of all field seaming. Nondestructive testing will not be permitted before sunrise or after sunset unless the Contractor demonstrates to the Owner that the Contractor has the capabilities to perform continuity testing under reduced light conditions.

The CQA Engineer will:

- Observe the continuity testing;
- Record location, date, test unit number, name of tester, and outcome of all testing; and,
- Document and inform the Contractor of any required repairs.

The Contractor will be required to complete any required repairs in accordance with the General Specifications.

The CQA Engineer will:

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

The CQA Engineer will verify and document the procedures specified in the General Specifications where seams cannot be nondestructively tested.

The location, date of visual observation, name of tester, and outcome of the test or observation will be recorded by the CQA Engineer and reported to the Owner.

2.3.7 Destructive Seam Testing

2.3.7.1 Concept

Destructive seam tests will be performed at selected locations. The purpose of these tests is to evaluate seam strength and integrity. Seam strength testing will be done as the seaming work progresses, not at the completion of all field seaming.

2.3.7.2 Location and Frequency

The CQA Engineer will select locations where seam samples will be cut out for laboratory testing. The test frequency and locations will be established as follows:

- Samples will be collected at a minimum frequency of one test location per 500 ft of seam length (this minimum frequency is to be determined as an average taken throughout the entire secure cell or surface impoundment project); and,

- Test locations will be determined during seaming at the CQA Engineer's discretion; selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming.

The Contractor will not be informed in advance of the locations where the seam samples will be taken.

2.3.7.3 Sampling Procedure

The Contractor will be required to cut samples as directed by the CQA Engineer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The CQA Engineer will:

- Observe sample cutting;
- Assign a number to each sample and mark it accordingly;
- Record the sample number and location on the panel layout drawing; and,
- Record the reason for taking the sample at this location (e.g., routine testing, suspicious feature of the geomembrane, etc.).

All holes in the geomembrane resulting from destructive seam sampling will be covered by the Contractor immediately after sampling and repaired in accordance with the repair procedures described in the General Specifications. The continuity of the new seams in the repaired area will be nondestructively tested according to the General Specifications.

2.3.7.4 Size of Samples

At a given sampling location, two types of samples will be required to be taken by the Contractor.

First, two specimens for field testing will be taken. Each of these specimens will be 1 inch wide by 6 to 12 inches long, with the seam centered parallel to the width. The distance between these two specimens will be approximately 42 inches. If both specimens pass the field test described in the General Specifications, a sample for laboratory testing will be taken.

The sample for laboratory testing will be required to be taken between the two specimens for field testing. The destructive sample will be 12 inches wide by 42 inches long with the

seam centered lengthwise. The sample will be cut into three parts and distributed as follows:

- One portion to the Contractor, 12 inches long;
- One portion to the CQA Engineer for archive storage, 12 inches long; and,
- One portion to the CQA Engineer for CQA Laboratory testing, 18 inches long.

Final determination of the sample sizes will be made at the preconstruction meeting.

2.3.7.5 Field Testing

The two 1-inch wide specimens specified above will be required to be tested in the field, by the Contractor, by tensiometer for peel and should not fail in the seam. If any field test sample fails to pass, then the procedures outlined in the General Specifications will be required to be followed.

The CQA Engineer will observe field tests and mark all samples and portions with their number, date, and time.

2.3.7.6 Geosynthetic Construction Quality Assurance Laboratory Testing

Laboratory destructive test samples will be packaged and shipped to the CQA Laboratory by the CQA Engineer in a manner which will not damage the test sample. The CQA Engineer will store the archive samples until the completion of the project. Laboratory destructive test samples will be tested by the Geosynthetics CQA Laboratory.

Testing will include "Shear Strength", "Peel Strength", and "Shear Strain at Yield" (ASTM D 3083 and ASTM D 413 respectively with 1-inch wide strip, tested at 2 inches per minute). The minimum acceptable values to be obtained in these tests are those indicated in Table 02775-2 of Section 02775 of the General Specifications. At least 5 specimens will be tested for each test method. Specimens will be selected alternately by test from the samples (i.e., peel, shear, peel, shear...). At least 4 out of 5 of the specimens must pass.

The Geosynthetics CQA Laboratory will provide test results verbally to the CQA Engineer in a timely manner after they receive the samples. The CQA Engineer will review laboratory test results as soon as they become available, and inform the Owner of the test results.

2.3.7.7 Procedures for Destructive Test Failure

The procedures specified within the General Specifications will be required whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory, the Contractor's laboratory (if required), or by field tensiometer. The CQA Engineer will verify and document that one of the options specified within the General Specifications is followed.

The CQA Engineer will document all actions taken in conjunction with destructive test failures.

2.4 Defects and Repairs

2.4.1 Identification

All seams and non-seam areas of the geomembrane will be inspected by the CQA Engineer for evidence of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be required to be clean at the time of examination. The geomembrane surface will be required to be broomed or washed by the Contractor if the amount of dust or mud inhibits examination.

2.4.2 Evaluation

Each suspect location both in seam and non-seam areas will be required to be either non-destructively tested using the methods described in the General Specifications, or repaired as appropriate as determined by the CQA Engineer. Each location which fails the non-destructive testing will be marked by the CQA Engineer and will be required to be repaired by the Contractor. Materials should not be placed over geomembrane locations that have been repaired until the CQA Engineer has approved the repair.

2.4.3 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQA Engineer will visually inspect the geomembrane for wrinkles. The CQA Engineer will indicate to the Contractor which wrinkles, if any, should be cut and reseamed. The seam thus produced will be tested like any other seam.

2.4.4 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test will be repaired by the Contractor in accordance with the applicable method specified within the General Conditions.

2.4.5 Testing of Repairs

Each repair will be located and logged by the CQA Engineer. Each repair will be non-destructively tested using the methods described in the General Specifications as appropriate. Repairs which pass the non-destructive test will be considered as an adequate repair. Large caps may be of sufficient extent to require destructive testing, at the discretion of the CQA Engineer. Failed tests will require the repair to be redone and retested until passing test results are obtained. The CQA Engineer will observe the non-destructive testing of repairs and will document the date of the repair and test outcome.

2.5. Appurtenances

The CQA Engineer will verify and document that:

- Installation of the geomembrane around, and connection of geomembrane to appurtenances have been made according to the General Specifications;

- Extreme care is taken while seaming around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas; and,

- The geomembrane has not been visibly damaged while being connected to appurtenances.

The CQA Engineer will inform the Owner if the above conditions are not fulfilled.

3.0 SURVEYING

The CQA Engineer, in conjunction with the Surveyor, will be required to prepare an "as-built" Record Drawing for geomembrane installations. It will include the surveyed location of field panels, seams (factory and field), repairs, and test locations.

The CQA results (Record Drawing and certification of Contractor's work) will be submitted to the Owner for final review and approval prior to proceeding with construction of any subsequent liner system components.

SECTION V -
GEOTEXTILE CONSTRUCTION QUALITY ASSURANCE

1.0 GEOTEXTILES

1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geotextile Manufacturer:

- Certification required by the General Specifications signed by a responsible party employed by the geotextile Manufacturer; and,

- The manufacturing quality control certificates for each shift's production of geotextile rolls, which include geotextile roll numbers and identification, sampling procedures, and descriptions and results of the quality control tests specified in the General Specifications signed by a responsible party employed by the geotextile Manufacturer.

The CQA Engineer will examine all geotextile Manufacturer's certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geotextile Manufacturer for all geotextile used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner prior to installation of the geotextile.

1.2 Labeling

The CQA Engineer will verify and document that the geotextile Manufacturer has labeled all rolls of geotextile with the information specified in the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geotextile.

1.3 Shipment and Storage

The CQA Engineer will observe rolls of geotextile upon delivery at the site and any deviation from the requirements specified within the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and required to be repaired or replaced by the Contractor.

1.4 Conformance Testing

Either at the Manufacturer's factory or upon delivery of the geotextile rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet along the length of the roll. Unless otherwise specified, samples will be 1.5 feet (minimum) long by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 ft^2, whichever is greater. These samples will be tested for:

- Mass per unit area (ASTM D 3776);
- Grab strength (ASTM D 4632);
- Tear strength (ASTM D 4533);
- Puncture strength (ASTM D 4833); and,
- Permittivity (ASTM D 4491).

If the geotextile is being used as a filter, cushion or separator, the samples will also be tested for apparent opening size (ASTM D 4751).

The CQA Engineer will examine all results of laboratory conformance testing and report any nonconformance to the Owner as soon as results become available.

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

- The Contractor will be required to replace the roll (or rolls) of geotextile that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the roll from which the failing sample was obtained. These two samples must pass the above conformance tests. If either of these samples fail to meet the requirements, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples

fail, a sample from every roll of geotextile on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of all such tests is to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions taken to the Owner.

1.5 Handling and Placement

The Geosynthetics Contractor will be required to handle all geotextile in such a manner as to ensure the geotextile is not damaged in any way. The CQA Engineer will verify and document compliance with the following:

- Just prior to geotextile placement, the layer that underlies the geotextile, if it is a geosynthetic, is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the liner system.

- In the presence of excessive wind, the geotextile is weighted with sandbags (or equivalent weight approved by the CQA Engineer).

- Geotextile is kept under tension to minimize the presence of wrinkles in the geotextile. If necessary, the geotextile is positioned by hand after being unrolled to minimize wrinkles.

- Geotextiles are cut using a geotextile cutter approved by the geotextile Manufacturer and the CQA Engineer. If in place, special care is taken to protect other materials (such as underlying geosynthetics) from damage which could be caused by the cutting of the geotextiles.

- The Contractor takes any necessary precautions to prevent damage to the underlying layers during placement of the geotextile.

- During placement of geotextiles, care is taken not to entrap in the geotextile stones, excessive dust, or moisture that could damage the underlying layers, generate clogging of drains or filters, or hamper subsequent seaming.

- Geotextile is not left exposed for a period in excess of 30 days after placement unless a longer exposure period is approved by the CQA Engineer and Owner.

The CQA Engineer will document any noncompliance with the above requirements and report them to the Owner.

1.6 Seams and Overlaps

The CQA Engineer will verify and document that all geotextile seams are oriented, overlapped and sewn in accordance with the General Specifications.

The Contractor will be required to pay close attention at seams to ensure that no protective soil layer material could be inadvertently placed beneath the geotextile.

Sewing will be required to be performed as required in the General Specifications.

1.7 Repair

The CQA Engineer will verify and document that any holes or tears in the geotextile are repaired in accordance with the requirements of the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

SECTION VI -
GEONET CONSTRUCTION QUALITY ASSURANCE

1.0 GEONET

1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geonet Manufacturer:

- Certifications required by the General Specifications signed by a responsible party employed by the geonet Manufacturer;
- The certification from the geonet Manufacturer that no reclaimed polymer was added to the resin during the manufacture of the geonet rolls assigned to this project; and,
- The manufacturing quality control certificates for each shift's production of geonet rolls, which include geonet roll numbers and identification, sampling procedures, and descriptions and results of quality control tests for polymer specified in the General Specifications signed by a responsible party employed by the geonet Manufacturer.

The CQA Engineer will examine all geonet Manufacturer's certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geonet Manufacturer for all geonet used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner.

1.2 Labeling

The CQA Engineer will verify and document that the geonet Manufacturer has labeled all rolls of geonet as specified within the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geonet.

1.3 Shipment and Storage

The CQA Engineer will observe the rolls of geonet upon delivery at the site and any deviations from the requirements specified within the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and will be required to be repaired or replaced by the Contractor.

1.4 Conformance Testing

Either at the Manufacturer's plant or upon delivery of the geonet rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetic CQA Laboratory for testing, to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet long (minimum) by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 ft^2, whichever is greater. These samples will be tested for:

- Polymer specific gravity (ASTM D 1505);
- Carbon black (ASTM D 1603);
- Thickness (ASTM D 374C or D1777); and,
- Transmissivity (ASTM D 4716).

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon as the results become available.

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

- The Contractor will be required to replace the roll (or rolls) of geonet that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the five numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geonet on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of such tests is to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions taken to the Owner.

1.5 Handling and Placement

The Contractor will handle all geonet in such a manner as to ensure the geonet is not damaged. The CQA Engineer will verify and document compliance with the following:

- The geonet is free of dirt or excessive dust just before installation.
- Just prior to geonet placement, the geomembrane liner that will underlie the geonet is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the geomembrane or clog the drainage system.
- On side slopes, the geonet is secured at the top of the slope then rolled down the slope in such a manner as to keep the geonet sheet in tension. If necessary, the geonet is positioned by hand after being unrolled to minimize wrinkles. Geonet can be place in the horizontal direction (i.e., across the slope) in some special locations (e.g., at the toe of a slope). If an extra layer of geonet is required, this extra layer of geonet can be placed in the horizontal direction. Such locations will be identified on the Construction Drawings.
- In the presence of excessive wind, the geonet is weighted with sandbags or the equivalent.
- Unless otherwise specified, geonet is not welded to geomembrane.
- Geonet will only be cut using a cutter approved by the geonet Manufacturer and the CQA Engineer. If in place, special care is taken to protect underlying geosynthetics from damage that could be caused by cutting of the geonet.
- The Geosynthetics Contractor takes any necessary precautions to prevent damage to underlying layers during placement of the geonet.
- During placement of geonets, care is taken not to entrap in the geonet dirt or excessive dust 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, it is hosed clean prior to placement of the next material on top of it. In this regard, care should be taken with the handling or sandbags, to prevent rupture or damage of the sandbag.
- Geonet is not placed in direct contact with textured geomembrane liner unless specifically called for in the Construction Drawings.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

1.6 Stacking and Joining

Geonet will be stacked and joined in accordance with the Construction Drawings and the General Specifications. As a minimum, the CQA Engineer will verify and document that staking, joining and overlapping is in accordance with the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

1.7 Repair

The CQA Engineer will verify and document that any holes or tears in the geonet are repaired in accordance with the General Specifications.

The CQA Engineer will observe any repair, note any noncompliance with the above requirements and report them to the Owner.

SECTION VII -
GEOCOMPOSITE CONSTRUCTION QUALITY ASSURANCE

1.0 GEOCOMPOSITES

1.1 Manufacturing

The Geosynthetics Contractor will be required to provide the CQA Engineer with the following information from the geocomposite Manufacturer:

- Certification required by the General Specifications signed by a responsible party employed by the geocomposite Manufacturer;
- The certification from the geocomposite Manufacturer that no reclaimed polymer was added to the resin during the manufacture of the geonet component of the geocomposite rolls assigned this project; and,
- The manufacturing quality control certificates for each shift's production of geocomposite rolls which include geocomposite roll numbers and identification, sampling procedures, and descriptions and results of quality control tests for the geonet specified in the General Specifications signed by a responsible party employed by the geocomposite Manufacturer.

The CQA Engineer will examine all of the geocomposite Manufacturer certifications to verify and document that the property values listed on the certifications meet or exceed those specified within the General Specifications and that proper and complete documentation has been provided by the geocomposite Manufacturer for all geocomposite used at the site. The CQA Engineer will report any deviations from the above requirements to the Owner prior to installation of the geocomposite.

1.2 Labeling

The CQA Engineer will verify and document that the geocomposite Manufacturer has labeled all rolls of geocomposite as specified within the General Specifications.

The CQA Engineer will examine rolls upon delivery and any deviation from the above requirements will be reported to the Owner prior to installation of the geocomposite.

1.3 Shipment and Storage

The CQA Engineer will observe rolls of geocomposite upon delivery at the site and any deviation from the requirements of the General Specifications will be reported to the Owner. Any damaged rolls will be rejected by the CQA Engineer and required to be repaired or replaced by the Contractor.

1.4 Conformance Testing

Either at the Manufacturer's plant or upon delivery of the geocomposite rolls, the CQA Engineer will ensure that samples are removed and forwarded to the Geosynthetics CQA Laboratory for testing to verify and document conformance with the requirements of the General Specifications.

Conformance samples will be taken across the entire width of the roll and will not include the first 3 feet. Unless otherwise specified, samples will be 1.5 feet long (minimum) by the roll width. The CQA Engineer will mark the machine direction on the samples with an arrow.

Samples will be taken at a rate of one per lot or one per 100,000 ft^2, whichever is greater. These samples will be tested for: peel strength (ASTM F 904); and hydraulic transmissivity (ASTM D 4716).

The CQA Engineer will examine all results from laboratory conformance testing and will report any nonconformance to the Owner as soon as the results are become available.

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

- The Contractor will be required to replace the roll (or rolls) of geocomposite that is not in conformance with the specifications with a roll that meets the requirements of the General Specifications.

- The CQA Engineer will ensure that conformance samples are removed for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must pass the above conformance tests. If either of these samples fail, samples will be collected from the 5 numerically closest untested rolls on both sides of the failed sample and tested by the Geosynthetics CQA Laboratory. These ten samples must pass the above conformance tests. If any of these samples fail, a sample from every roll of geocomposite on site and a sample from every roll that is subsequently delivered from the same Manufacturer must be conformance tested by the Geosynthetics CQA Laboratory. The cost of such tests is to be borne by the Contractor.

The CQA Engineer will document actions taken in conjunction with conformance test failures and report all actions to the Owner.

1.5 Handling and Placement

The Contractor will be required to handle all geocomposite in such a manner as to ensure it is not damaged. The CQA Engineer will verify and document compliance with the following:

- Just prior to geocomposite placement, the layer that will underlie the geocomposite is clean and free of excessive amounts of dust, dirt, stones, rocks, or other obstructions that could potentially damage the underlying layers or clog the drainage system.

- In the presence of excessive wind, the geocomposite is weighted with sandbags (or equivalent weight approved by the CQA Engineer).

- Geocomposite is kept under tension to minimize the presence of wrinkles in the geocomposite. If necessary, the geocomposite is positioned by hand after being unrolled to minimize wrinkles.

- Geocomposites are cut using a geocomposite cutter approved by the geocomposite Manufacturer and the CQA Engineer. If in place, special care is taken to protect other materials from damage which could be caused by the cutting of the geocomposites.

- The Geosynthetics Contractor takes all necessary precautions to prevent damage to the underlying layers during placement of the geocomposite.

- Geocomposite is not welded to geomembranes.

- During placement of clean geocomposite, care is taken not to entrap stones, excessive dust, or moisture that could damage the underlying geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.

- A visual examination of the geocomposite is carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

- Geocomposite is not left exposed for a period in excess of 30 days after placement unless a longer exposure period is approved by the CQA Engineer and the Owner.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

1.6 Seams and Overlaps

The components of the geocomposite (e.g., geotextile-geonet-geotextile) are not bonded together at the ends and edges of the rolls. The CQA Engineer will document that the geocomposite is overlapped and secured or seamed in accordance with the General Specifications.

1.7 Repair

The CQA Engineer will verify that any holes or tears in the geocomposite are repaired in accordance with the General Specifications.

The CQA Engineer will observe any repair, document any noncompliance with the above requirements, and report the noncompliance to the Owner.

SECTION VIII -
POLYETHYLENE PIPE AND FITTINGS
CONSTRUCTION QUALITY ASSURANCE

1.0 POLYETHYLENE PIPE MANUFACTURE AND DELIVERY

1.1 Manufacturing

Prior to incorporating the polyethylene pipe and fittings into the work the Contractor will be required to provide the CQA Engineer with the certifications required by the General Specifications signed by a responsible party employed by the pipe Manufacturer.

The CQA Engineer will verify and document that the property values certified by the pipe Manufacturer meet the requirements of the General Specifications based on a sampling interval of one sample per lot. The CQA Engineer will report any deviations from the above requirements to the Owner.

1.2 Labeling

The CQA Engineer will verify that the pipe is labeled with the information specified in the General Specification. Any deviations from the labeling requirements will be reported to the Owner prior to pipe installation.

1.3 Shipment and Storage

The CQA Engineer will verify and document that the pipe and fittings are stored in accordance with the General Specifications.

The CQA Engineer will visual inspect the pipe upon delivery at the site and any deviations from the requirements of the General Specifications will be reported to the Owner.

1.4 Conformance Testing

No conformance testing will be conducted on the materials delivered to the site.

2.0 PIPE INSTALLATION

2.1 Handling and Laying

The CQA Engineer will verify and document that the pipe is installed at the specified locations and grades and that placement of backfill around and over the pipe is conducted in accordance with the requirements of the General Specifications, and in a manner intended to prevent damage to the pipe.

The pipe and fittings will be carefully examined before installation by the CQA Engineer. The CQA Engineer will verify and document that cracks, damage or defects are not present in the pipe and fittings in excess of that allowed by the General Specifications.

The CQA Engineer will also note the condition of the interior of pipes and fittings. Foreign material shall be removed from the pipe interior before it is moved into final position. No pipe will be permitted to be placed until the CQA Engineer has observed the condition of the pipe.

The CQA Engineer will document any deviation from the above requirements and report it to the Owner.

2.2 Joints and Connections

Lengths of pipe will be required to be assembled into suitable installation lengths by the butt-fusion process. Butt-fusion refers to the butt-joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure.

The CQA Engineer will spot monitor butt-fusion welding operations to ensure that the Contractor follows the General Specifications.

The CQA Engineer will document any noncompliance with the above requirements and report it to the Owner.

2.3 Surveying

A Professional Land Surveyor registered in the State of Colorado will provide the CQA Surveys. The CQA Surveyor will independently survey the final elevation of the invert of all polyethylene leachate collection pipe (excluding laterals).

The results of the survey will be compiled in a report signed by the CQA Surveyor and the CQA Engineer and will be reviewed by the Owner. The Owner and the CQA Engineer will approve the results contained in the report before any subsequent construction that completely covers the pipe occurs.

SECTION IX -
CONSTRUCTION QUALITY ASSURANCE DOCUMENTATION

1.0 DOCUMENTATION

1.1 Introduction

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

The CQA Engineer will provide the Owner with signed descriptive remarks, data sheets, and logs to verify and document that all monitoring activities have been carried out. The Owner will maintain at the site a complete file of Construction Drawings, the CQA plan (Part B Permit Attachment LF-10), the General Specifications (Part B Permit Attachment LF-1), test procedures, daily reports, testing logs, and other pertinent forms and documents. The forms to be used for CQA documentation should include, at a minimum, those presented in this CQA Plan. The forms presented in this CQA Plan may be revised as necessary by the CQA Engineer.

1.2 Daily Record Keeping

1.2.1 Overview

Daily records will be completed in the field documenting CQA project administration, soils CQA, geosynthetics CQA, and other required CQA activities. The forms to be completed that pertain to each of these categories of records are discussed below.

1.2.2 Project Administration Records

Most project administration records are completed daily by the CQA Engineer and submitted weekly to the Owner. Examples of these forms are included in Appendices A, B, and C and are briefly described below.

Daily Field Report

The Daily Field Report will be prepared by the CQA Engineer and submitted weekly to the Owner. At a minimum, the Daily Field Report will include the following information:

- The date, project name, location, and other identification;
- A narrative of the events and activities, including meetings and observations which occurred during a given day;

- The weather conditions;
- Source and amount of water used to construct the clay liner, if any;
- The name of parties to any discussions;
- The relevant subject matter or issues;
- The activities planned and performed;
- The schedule; and,
- The signature of the CQA Engineer.

Daily Temperature Log

Ambient temperatures and liner temperatures will be recorded on the Daily Temperature Log by the CQA Engineer at various times during the day. This log will be available for review at the site and will be issued as part of the Final Report.

Personnel Daily Log

The Personnel Daily Log will be prepared at the beginning of the project and updated each day by the CQA Engineer. This log will list the Contractor's and CQA Engineer's personnel involved with the project and is a record of attendance for each day of the project. This log will be available for review at the site and will be issued as part of the Final Report.

Contractor Personnel Log

The Contractor Personnel Log will be prepared at the beginning of the project and updated as required by the CQA Engineer. This log will provide a summary of the Contractor's and CQA Engineer's personnel involved in the project (on site and off site), describes their position, and lists the time periods of involvement with site work. This log will be available for review at the site and will be issued as part of the Final Report.

Weekly Field Report

On a weekly basis, the CQA Engineer will summarize in a Weekly Field Report the activities recorded on the Daily Field Reports. This report will be submitted each week to the Owner along with the Daily Field Reports, and will include, at a minimum, the following information:

- The date, project name, location, and other information;
- A summary of work activities during reporting period;

- A summary of construction situations, deficiencies, and/or defects occurring during the reporting period;
- A summary of actions taken to remedy such situations, deficiencies and/or defects;
- A summary of test results, failures and retests; and,
- The signature of the CQA Resident Engineer.

1.2.3 Soils CQA Records

Records kept for soils related activities will be completed by the CQA Engineer. The information will be recorded as testing is done in the field or as results are received from the laboratory. The records will be available for review on site, and copies will be issued as part of the Final Report. Examples of the relevant forms are included in Appendix B and are briefly described below.

Field Laboratory Compaction Test Log (ASTM D 698 Method A, B, C, D and ASTM D 1557 Method A, B, C).

The results of field compaction tests will be recorded on the Field Laboratory Compaction Test Log. Separate forms are available for each test method used.

Field Sand Cone and Rubber Balloon Density Test Log

The results of the sand cone and rubber balloon in-situ density test on soils will be recorded on the Field Sand Cone or rubber balloon Density Test Log. The results will be used for comparison or calibration with nuclear density test results.

Summary of Sieve Analysis Test Data

This form will provide a summary of sieve analysis test results for soils.

Summary of Field Density Test

This form will provide a summary of field nuclear density test results and sand cone test results for soils.

Summary of Index Laboratory Test Data

This form will provide a summary of index test results performed as required for soils.

Summary of Permeability Laboratory Data

This form will provide a summary of laboratory permeability test data required for clay liners.

1.2.4 Geosynthetics CQA Records

Records for the installation of geosynthetics will be completed by the CQA Engineer. The information will be recorded as the work progresses. The records will be available for review on site and copies will be issued as part of the final CQA report. Examples of the CQA forms to be completed for geosynthetics are included in Appendix C and briefly described below.

Material Inventory

The identifying roll number and pertinent information of each roll of geosynthetic received at the site will be recorded on this form as the materials arrive at the site. This information will be used to track manufacturer's quality control information, conformance test samples, and other CQA documentation.

Nondestructive Test Log

This form will be used to record the time, date, equipment operator, and results of vacuum box or air pressure testing of production geomembrane seaming operations.

Panel Placement Monitoring Log

This form will be used to record geomembrane panel numbers as they are placed in the field and to cross-reference the assigned panel numbers with roll numbers. The weather conditions, time, and temperature at placement will be recorded on the log. Measured dimensions used to calculate the area of the geomembrane will be recorded on the log.

Repair Summary Log

Information on repairs to geomembrane panels and seams will be recorded on this form. The information recorded will include a code to describe the type of repair, the name of the operator making the repair, the location (i.e., seam or panel location) of the repair, nondestructive testing results of the repair, and initials of the CQA Engineer observing the repair.

Seam and Panel Repair Location Log

The relative location of repairs to geomembrane panels and seams described in the Repair Summary Log will be recorded on this form. The results of destructive tests and nondestructive can be indicated in this log, as well as, locations and results of thickness measurements taken for each panel.

Destructive Test Log

This form will be used to record the results from testing performed on geomembrane seams at the Geosynthetics CQA Laboratory (an independent testing laboratory). The results for both peel and shear will be recorded. The form will be completed as data becomes available.

Trial Seam and Seaming Log

This form will be used to record results of trial geomembrane seam testing and to track production seaming activities. The time, temperature, type of seaming equipment used, name of seamer, and length of seam will be recorded.

Certificate of Acceptance Subgrade Surface

The Certificate of Acceptance is required to be signed by the Contractor prior to the installation of the geomembrane. The area being accepted must be described on the certificate.

1.2.5 Survey Records

Record Drawings resulting from surveying performed by the CQA Surveyor and will be reviewed by the CQA Engineer and the Owner. The Record Drawings will be available for review on-site, and copies will be issued as part of the final CQA Report issued by the CQA Engineer. At a minimum, these Record Drawings will include as-built survey data for the following liner system components:

- Excavated subgrade;
- Structural fill;
- Secondary clay liner;
- Primary clay liner;
- Polyethylene pipe and fittings;
- Geomembrane liners;
- Geocomposite liners;
- Granular leachate collection layer; and,
- Protective soil layer.

1.3 Photographic Documentation

Photographic documentation will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will also be stored in a separate file in chronological order. These photographs will be available for review by the Owner, the CQA Engineer, and other interested parties. Selected photographs will be reproduced as part of the Final Report. The remaining photographs will be transmitted to the Owner and archived by the Owner as part of the operating records.

1.4 Design and/or Specifications Changes

Design and/or specification changes may be required during construction. In such cases, the CQA Engineer will notify the Owner. The Owner will notify CDPHE, and when necessary, the Design Engineer.

Major design and/or specifications changes will be made only with the written agreement of the Design Engineer and the Owner and will take the form of an addendum to the General Specifications.

1.5 Signatures and Final Report

At the completion of the work, the CQA Engineer will submit a Final CQA Report ("the Final Report") to the Owner.

At a minimum, this report will include: (a) summaries of all construction activities; (b) sources and amounts of water used to construct the clay liners; (c) results of chemical quality analyses of construction water from each source; (d) observation logs and testing data sheets including sample location plans; (e) a discussion of any changes from design and material specifications; (f) CQA Record Drawings; and, (g) a summary statement sealed and signed by a Professional Engineer registered in the State of Colorado that construction quality assurance was conducted as provided in the CQA Plan and, based on visual observations and data generated in accordance with the CQA Plan, the secure cell or surface impoundment was constructed in accordance with the Construction Drawings, the CQA Plan, and the General Specifications, except as properly authorized and documented in the CQA final report. The CQA Record Drawings will include the following: primary and secondary geomembrane panel layout drawings; all drawings (including cross-sections) depicting any deviations from the Construction Drawings; and all survey conformance data.

APPENDIX A

PROJECT ADMINISTRATION RECORDS

APPENDIX B

SOILS CQA RECORDS

APPENDIX C

GEOSYNTHETICS CQA RECORDS

APPENDIX A

PROJECT ADMINISTRATION RECORDS

GEOMEMBRANE DAILY TEMPERATURE LOG

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY** **DATE:** _____
(Circle One) **SHEET NUMBER:** **of**

	TIME	LOCATION	AMBIENT TEMPERATURE	TEMPERATURE 6 INCHES ABOVE LINER	CQA MONITOR
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

Comments: (Refer to line number)	

FILE NUMBER:

GEOMEMBRANE DEFECT LOG

Project:
Project Number:
Owner:
Installer:
Location:

PRIMARY **SECONDARY**

(Circle One)

DATE:____________

SHEET:__________**of**___________

CQA MONITOR:________________

DEFECT CODE	DEFECT LOCATION SEAM OR PANEL	DEFECT LOCATION DEFECT LOCATION DESCRIPTION	DEFECT TYPE	CQA MON.	REMARKS	** REPAIR DATE	** TEST DATE

AD - ANIMAL RELATED DAMAGE
BO - FUSION WELDER BURN
BS - BOOT/SKIRT FOR FML PENETRATION
CR - CREASE
D - INSTALLATION DAMAGE
DS-# - DESTRUCTIVE TEST NUMBER
EE - EARTHWORK EQUIPMENT DAMAGE
FP = FOUR PANEL INTERSECTION

EXT - EXTENSION
FM - FISHMOUTH
FS - FAILED SEAM LENGTH
FTS - FIELD TEST STRIP
HT - HEAT TACK BURN
IO - INSUFFICIENT OVERLAP (UNDER SPEC.)
MD - MANUFACTURER / DELIVERY DAMAGE

PT - PRESSURE TEST CUT
SI - SOIL SURFACE IRREGULARITY
T - THREE PANEL INTERSECTION
VL - VACUUM TEST LEAK
WR - WRINKLE
WS - WELDER RESTART
OTHER ____________________

** COLUMNS TO BE USED BY THE DATA REVIEWER ONLY.

File Number:

GEOMEMBRANE PANEL DEPLOYMENT LOG

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY** (CIRCLE ONE) **DATE:** ______________

SHEET NUMBER: ______ **of** ______

DESCRIPTION	PANEL NUMBER ___________		PANEL NUMBER ___________		PANEL NUMBER ___________	
ROLL NUMBER		SKETCH		SKETCH		SKETCH
LENGTH AND WIDTH (FT)						
TIME						
VISUAL OBS.						
CQA MONITOR						
AREA (SF)						

DESCRIPTION	PANEL NUMBER ___________		PANEL NUMBER ___________		PANEL NUMBER ___________	
ROLL NUMBER		SKETCH		SKETCH		SKETCH
LENGTH AND WIDTH (FT)						
TIME						
VISUAL OBS.						
CQA MONITOR						
AREA (SF)						

DESCRIPTION	PANEL NUMBER ___________		PANEL NUMBER ___________		PANEL NUMBER ___________	
ROLL NUMBER		SKETCH		SKETCH		SKETCH
LENGTH AND WIDTH (FT)						
TIME						
VISUAL OBS.						
CQA MONITOR						
AREA (SF)						

DESCRIPTION	PANEL NUMBER ___________		PANEL NUMBER ___________		PANEL NUMBER ___________	
ROLL NUMBER		SKETCH		SKETCH		SKETCH
LENGTH AND WIDTH (FT)						
TIME						
VISUAL OBS.						
CQA MONITOR						
AREA (SF)						

TOTAL AREA DEPLOYED:

Comments: (Refer to panel number)

NOTE: Panels are rectangular in shape per dimensions unless noted by sketch

FILE NUMBER:

EXTRUSION SEAM DESTRUCTIVE TEST

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY**
(Circle One)

Sample Number: _____ **Machine #:** _____ **Date Removed:** _____
Date Seamed: _____ **Weld Tech:** _____ **Tested By:** _____
Seam Number: _____ **Nozzle Temp:** _____ **Checked By:** _____
Location: _____ **Preheat:** _____ **Date Tested:** _____
Defect Code: _____ **6" Temp:** _____
CQAE Monitor: _____ **Top Sheet:** _____

Specimen Number:	PEEL			Specimen Number:	SHEAR			
	Strength (PPI)	Break Mode	Pass / Fail		Strength (PPI)	Break Mode	Percent Elong.	Pass / Fail
P1				S1				
P2				S2				
P3				S3				
P4				S4				
P5				S5				

Pass / Fail:

Comments: _____

FUSION SEAM DESTRUCTIVE TEST

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY**
(Circle One)

Sample Number:		**Machine #:**		**Date Removed:**	
Date Seamed:		**Weld Tech:**		**Tested By:**	
Seam Number:		**Mach. Temp:**		**Checked By:**	
Location:		**Mach. Speed:**		**Date Tested:**	
Defect Code:		**6" Temp:**			
CQAE Monitor:		**Top Sheet:**			

Specimen Number:	**P E E L**			**Specimen Number:**	**S H E A R**			
	Strength (PPI)	**Break Mode**	**Pass / Fail**		**Strength (PPI)**	**Break Mode**	**Percent Elong.**	**Pass / Fail**
P1 - Inside				S1				
P1 - Outside								
P2 - Inside				S2				
P2 - Outside								
P3 - Inside				S3				
P3 - Outside								
P4 - Inside				S4				
P4 - Outside								
P5 - Inside				S5				
P5 - Outside								

Pass / Fail:

Comments:

File Number:

GEOSYNTHETIC INVENTORY CONTROL LOG

Project Title: **Project Number:**

Owner: **Installer:**

Location:

SHEET NUMBER: _____of_____

MATERIAL TYPE: GEOMEMBRANE GEOCOMPOSITE GEOTEXTILE OTHER _____

DATE OF ARRIVAL: _____ **DATE OF INVENTORY _____**

MATERIAL MANUFACTURER: _____ **INVENTORY MONITOR _____**

PRODUCT IDENTIFICATION: _____ **CONDITION IN TRUCK _____**

TRUCK TYPE: _____ **UNLOADING METHOD _____**

	ROLL NUMBER	BATCH OR LOT NO.	MATERIAL DIMENSIONS		CONF SAMP. Y / N	REMARKS
			LENGTH	WIDTH		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

File Number:

GEOMEMBRANE REPAIR LOG

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY** **DATE:**_____
(Circle One) **SHEET NUMBER:**_____**of**_____

MACHINE NUMBER _____

PASSING TRIAL SEAMS

NO.	TIME	TYPE	TEMP

	DEFECT CODE	APPROX. TIME	REPAIR TYPE*	APPROX. DIMENSIONS	WELD TECH.	CQA MONITOR
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

*** P=Patch; G/W=Grind/Weld (bead); C= Cap**

Comments: (Refer to line number)	

File Number:

GEOMEMBRANE SEAM LOG

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY**
(Circle One)

☐ **FUSION**

☐ **EXTRUSION**

MACHINE # _____

PASSING TRIAL SEAMS

NO.	TIME	TYPE	TEMP

DESTRUCTIVE LENGTH CARRY-OVER
FROM PREVIOUS LOG _____

DATE: _____

SHEET: _____ **of** _____

	SEAM NUMBER	SEAM SECTION START POINT	SEAM SECTION FINISH POINT	TYPE	APPROX. START TIME	6 in. AIR TEMP	WELD TECH	PREHEAT OR MACH. SPEED	MACHINE TEMPERATURES DIGITAL SET	MACHINE TEMPERATURES INDICATOR	APPROX. LENGTH WELDED	LENGTH FROM PREVIOUS DESTR.	DESTR. NUMBER	CQA MON.	NON - DESTRUCTIVE TEST DATE	NON - DESTRUCTIVE CQA MON.
1	/	-								-						
2	/	-								-						
3	/	-								-						
4	/	-								-						
5	/	-								-						
6	/	-								-						
7	/	-								-						
8	/	-								-						
9	/	-								-						
10	/	-								-						
11	/	-								-						
12	/	-								-						
13	/	-								-						
14	/	-								-						
15	/	-								-						

*** REFERENCE SEAM ENDPOINTS FROM AN END OF SEAM (NE,SE.ETC.)**

A REPAIR NUMBER, OR A POINT LOCATION ON THE SEAM.

DAILY TOTALS

DESTRUCTIVE LENGTH CARRY-OVER

COMMENTS: (REFER TO LINE NUMBER)

File Number:

GEOMEMBRANE SEAM PRESSURE TEST LOG

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY**
(Circle One)

DATE: _____
SHEET NUMBER: **of**

	SEAM NUMBER	SEAM SECTION* FROM	TO	TECH ID	TIME START	FINISH	PRESSURE INITIAL	FINAL	OBS TESTS Y/N	RESULTS PASS / FAIL	SEAM COMPLETE NO	YES	CQA MONITOR
1	/	-			:		:				/		
2	/	-			:		:				/		
3	/	-			:		:				/		
4	/	-			:		:				/		
5	/	-			:		:				/		
6	/	-			:		:				/		
7	/	-			:		:				/		
8	/	-			:		:				/		
9	/	-			:		:				/		
10	/	-			:		:				/		
11	/	-			:		:				/		
12	/	-			:		:				/		
13	/	-			:		:				/		
14	/	-			:		:				/		
15	/	-			:		:				/		

*** REFERENCE SEAM ENDPOINTS FROM AN END OF SEAM (NORTH END ((NE)), SOUTH END ((SE)), ETC.),**
A REPAIR NUMBER OR A POINT LOCATION ON THE SEAM (i.e. REFERENCE POINT, DISTANCE AND DIRECTION FROM REF. PT.)

COMMENTS: (Refer to line number)	**REVIEWED BY:**
	ENTERED BY:

File Number:

SGA Number: _____

CERTIFICATE OF ACCEPTANCE OF SOIL SURFACE BASED UPON VISUAL OBSERVATION ONLY

CONTRACTOR **GEOSYNTHETICS INSTALLER**

Project:
Number:
Project Title:
Location:
Owner:

I, the Undersigned, the duly authorized representative of _____ do hereby determine the soil surface area bounded by the points listed below as acceptable for geomembrane installation upon it.

_____

_____

_____

_____

_____

_____

_____

NAME (INSTALLER)	SIGNATURE	TITLE	DATE

_____shall be responsible for maintaining the integrity and suitability of the soil surface in accordance with the technical specifications from this date to the completion of the installation.

NAME (CONTRACTOR)	SIGNATURE	TITLE	DATE

I, the Undersigned, the duly authorized representative of the ***CQA Engineer***, do hereby accept the area of soil surface referenced above.

NAME (CQAE Group)	SIGNATURE	TITLE	DATE

GEOMEMBRANE SPARK TEST-REPAIR LOG

Project Title:
Owner:
Location:

Project Number:
Installer:
Use: Around Pipe Boots where VT Not Practical

PRIMARY **SECONDARY**
(Circle One)

DATE:
SHEET NUMBER: **of**

	DEFECT CODE	TEST TIME	TECH INITIALS	NUMBER OF DEFECTS*	OBSERVED TESTS Y/N	PASS/FAIL (P/F)	CQA MONITOR
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

*** RECORD NUMBER OF DEFECTS DETECTED AND REFERENCE NEW DEFECT CODE IN REMARKS.**

Comments: (Refer to line number)	

FILE NUMBER:

EXTRUSION GEOMEMBRANE TRIAL SEAM LOG

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY** **DATE:** _____

(Circle One) **SHEET NUMBER:** **of**

	SAMPLE NUMBER	SAMPLE TYPE	APPROX TIME	MACH. NUMBER	WELD TECH / TEST TECH	6" TEMP	PREHEAT TEMP.	NOZZLE TEMP.	TEST RESULTS PEEL STRENGTH / MODE	TEST RESULTS SHEAR STRENGTH / MODE	P / F	CQA MON.
1									/ / / /	/ / / /		
									/ / / /	/ / / /		
2									/ / / /	/ / / /		
									/ / / /	/ / / /		
3									/ / / /	/ / / /		
									/ / / /	/ / / /		
4									/ / / /	/ / / /		
									/ / / /	/ / / /		
5									/ / / /	/ / / /		
									/ / / /	/ / / /		
6									/ / / /	/ / / /		
									/ / / /	/ / / /		
7									/ / / /	/ / / /		
									/ / / /	/ / / /		
8									/ / / /	/ / / /		
									/ / / /	/ / / /		

Note: % Elongation for each shear test equals or exceeds 50% unless otherwise noted.

Comments: (Refer to line number)		

FILE NUMBER:

FUSION GEOMEMBRANE TRIAL SEAM LOG

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY** **DATE:**
(Circle One) **SHEET NUMBER:** **of**

	SAMPLE NUMBER	SAMPLE TYPE	APPROX TIME	MACH. #	WELD TECH / TEST TECH	6" TEMP	MACH. SPEED	WEDGE TEMP.	TEST RESULTS: INSIDE PEEL STRENGTH / MODE	TEST RESULTS: OUTSIDE PEEL STRENGTH / MODE	TEST RESULTS: SHEAR STRENGTH / MODE	P / F	CQA MON.
1									/ / / /	/ / / /	/ / / /		
									/ / / /	/ / / /	/ / / /		
2									/ / / /	/ / / /	/ / / /		
									/ / / /	/ / / /	/ / / /		
3									/ / / /	/ / / /	/ / / /		
									/ / / /	/ / / /	/ / / /		
4									/ / / /	/ / / /	/ / / /		
									/ / / /	/ / / /	/ / / /		
5									/ / / /	/ / / /	/ / / /		
									/ / / /	/ / / /	/ / / /		
6									/ / / /	/ / / /	/ / / /		
									/ / / /	/ / / /	/ / / /		
7									/ / / /	/ / / /	/ / / /		
									/ / / /	/ / / /	/ / / /		
8									/ / / /	/ / / /	/ / / /		
									/ / / /	/ / / /	/ / / /		

Note: % Elongation for each shear test equals or exceeds 50% unless otherwise noted.

Comments: (Refer to line number)		

FILE NUMBER:

GEOMEMBRANE VACUUM TEST-REPAIR LOG

Project Title: **Project Number:**
Owner: **Installer:**
Location:

PRIMARY **SECONDARY** **DATE:**
(Circle One) **SHEET NUMBER:** **of**

	DEFECT CODE	TEST TIME	TECH INITIALS	NUMBER OF DEFECTS*	OBSERVED TESTS Y/N	PASS/FAIL (P/F)	CQA MONITOR
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

*** RECORD NUMBER OF DEFECTS DETECTED AND REFERENCE NEW DEFECT CODE IN REMARKS.**

Comments: (Refer to line number)	

FILE NUMBER:

CARRY OVER LOG

DATE: _____

MACHINE

_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft

PANEL __- _____
DF__ # _____
DXs__ # _____

COMMENTS _____
_____
_____
_____
_____
_____

CARRY OVER LOG

DATE: _____

MACHINE

_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft
_____ _____ ft

PANEL __- _____
DF__ # _____
DXs__ # _____

COMMENTS _____
_____
_____
_____
_____
_____