

CONSTRUCTION QUALITY ASSURANCE MANUAL
WOODVILLE MUNICIPAL SOLID WASTE LANDFILL
UNIT II PHASE 1 CONSTRUCTION

Prepared for:

County of Tulare
Solid Waste Department



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Attachment F-1: CQA Documentation Sample Forms List
Attachment F-2: Sample Forms

Construction Quality Assurance Manual

Unit II, Phase 1 Construction Woodville Landfill Tulare County, California

The material and data in this manual were prepared under the supervision and direction of the undersigned. This manual was prepared consistent with current and generally accepted principles and practices for civil and geotechnical quality assurance for this area and within the limitations provided herein.

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1.0 Introduction

This manual addresses the Construction Quality Assurance (CQA) procedures required during the construction of Unit II, Phase 1 at the Woodville Landfill in Tulare County, California. This CQA Manual establishes procedures to verify that construction is in accordance with the approved engineering standards, construction drawings, and specifications, meets the appropriate regulatory requirements, and develops the necessary documentation for submittal to the regulatory agencies.

The objective of this manual is to establish:

- Duties of parties responsible for the CQA program
- Qualification requirements of the CQA Officer and others on the CQA team
- Monitoring activities
- Sampling strategies
- Document control measures
- Procedures for approving the materials supplied for construction
- Methods for assuring compliance to design standards and specifications during construction
- Procedures for resolving issues that may occur concerning construction
- Documentation of construction and testing for submittal to the regulatory agency for their review

The intent of the CQA Manual is to provide independent third-party verification and testing to demonstrate that the contractors and installers have met their obligations in the supply and installation of components and materials according to the approved design documents, project specifications, and regulatory requirements. Quality control is provided by the manufacturers, installers, and contractors and refers only to their actions taken to ensure that materials and workmanship meet the requirements of the construction drawings and specifications.

The work for Unit II is primarily related to the construction of an approximate 33.2-acre liner system. The work will include site preparation activities; construction of a composite liner system composed of a geosynthetic clay liner (GCL), geomembrane, and geocomposite; a leachate collection and removal system (LRCS); drainage facilities; access roads; and stockpile grading.

Other work to be constructed during this project include drainage ditches, culverts, inlets and erosion protection; leachate extraction, pumping and storage systems; aggregate, soil and asphalt roads; fencing, electrical service and vegetation.

2.0 Definitions - Parties Involved in Construction Quality Assurance

The following section provides descriptions of the parties referenced in this CQA Manual, including their responsibilities and qualifications.

2.1 Owner/Operator

Tulare County (County), is the Owner and Operator of this landfill. For the purposes of this CQA Manual and the specifications, all references to the Owner or Operator shall mean Tulare County, California.

2.2 Resident Engineer

The Resident Engineer is the official representative of the County and is responsible for construction activities at the facility, including oversight and construction management. The Resident Engineer is responsible for coordinating construction and quality assurance activities for the project. The Resident Engineer shall be responsible for the resolution of all quality assurance issues that arise during the construction and must be involved in any decision that may affect future operations at the landfill.

2.3 Design Engineer

The Design Engineer, also referred to as the “Designer” or “Engineer”, is the individual or firm responsible for the design and preparation of the project construction drawings (Drawings) and the technical specifications (Project Specifications). The Designer is responsible for approving all design and project specification changes, modifications, or clarifications encountered during construction. During the course of the project, the Design Engineer shall remain in communication with the Resident Engineer.

2.4 CQA Officer and CQA Monitor(s)

The CQA Officer and CQA Monitor(s) will be responsible for understanding and implementing this CQA Manual and shall conduct CQA testing, monitoring, documentation, and reporting, as required by this CQA Manual. One or more CQA Officers may be involved with this project. Responsibilities would typically be divided between soil and geosynthetics components with the Soil CQA Officer being responsible for all sections of this Manual except Sections 5 and 6. The Geosynthetics CQA Officer would be responsible for all sections except Sections 4 and 7. Each CQA Officer would prepare his own reports and final certification. The Design Engineer will compile the final document into a report for submittal to the Owner and any State agencies. Where CQA Officer is discussed in this Manual, it shall mean the CQA Officer responsible for that section of the work.

The CQA Officer will certify the final report. The CQA Officer shall provide supervision for CQA Monitors performing CQA activities. The CQA Officer shall be a California registered civil engineer or engineering geologist experienced in the construction of landfill liner systems. The CQA Officer will communicate directly with the Resident Engineer.

CQA Monitor(s) execute the CQA Manual by observing the Contractor's work activities. The CQA Monitor(s) perform tests to verify that characteristics of the materials and services meet the requirements of the construction documents. Documentation of observations and tests shall be in sufficient detail to allow acceptance by the regulatory agencies that construction was in accordance with the Construction Documents and CQA Manual.

2.5 General Contractor

The General Contractor, also referred to as the "Contractor," shall hold a current California Class A contractor's license and will be responsible for completion of the site work as defined by contract with the County and in accordance with the Construction Drawings and Specifications, except for any materials provided by the County. The Contractor shall have previous experience constructing similar landfill projects. The Contractor will be responsible for retaining a surveyor to set lines and grades required for excavation and construction. The Contractor will be contracted with the County and will communicate directly with the Resident Engineer.

2.6 Geosynthetics Manufacturer

The geosynthetics manufacturer(s), also referred to as the "Manufacturer," is responsible for production of the geosynthetic components outlined in this manual. The Manufacturer may be affiliated with the Geosynthetics Installer. Each Manufacturer must pre-qualify that they are able to produce material that meets the requirements of the Project Specifications. The Geosynthetics Manufacturer will submit materials and documentation to the Resident Engineer and Geosynthetics Installer.

2.7 Geosynthetics Installer

The Geosynthetics Installer, also referred to as the "Geosynthetics Installation Contractor" or the "Installer," is responsible for proper installation of the geosynthetic components, in accordance with the Project Drawings and Specifications. The Installer shall also be responsible for procurement of the geosynthetic materials in conformance with the Project Specifications unless otherwise arranged by the County. The Installer may be affiliated with the Manufacturer. The Installer will work as a subcontractor to the General Contractor.

The Installer must meet the experience requirements outlined in the Project Specifications. The Installer shall provide a qualified Superintendent who will provide full-time technical guidance to

the field crew. The Superintendent will represent the Installer at all site meetings and will act as the spokesman for the Installer on the project.

Welding technicians will be evaluated based on experience and performance. The CQA Officer, through the Resident Engineer, reserves the right to reject any welding technician whose performance is unsatisfactory.

2.8 CQA Surveyor

The CQA Surveyor is the firm or individual responsible for performing the quality assurance surveying tasks outlined in this manual, including the preparation of stamped as-built survey record drawings to be included in the CQA Certification Report. CQA surveying shall be performed under the direction of a California State Licensed Land Surveyor. The CQA Surveyor will be retained by the Contractor. The CQA Surveyor will communicate directly with the Contractor.

2.9 Independent CQA Laboratory

The Independent CQA Laboratory (CQA Lab) is the third-party laboratory responsible for performing the quality assurance soils and/or geosynthetics laboratory testing listed in this CQA Manual in accordance with the specified methodology. Standards for testing include but are not limited to American Society for Testing and Materials (ASTM), California Department of Transportation (Caltrans) California Test Methods (CTM), or Geosynthetic Institute (GSI) methods. The CQA Laboratory services are coordinated by the CQA Officer and may be affiliated with the CQA Consultant firm or company. The geosynthetics-testing laboratory shall be accredited by the Geosynthetics Accreditation Institute Laboratory Accreditation Program (GAI-LAP). The CQA Laboratory shall not be affiliated with the General Contractor or Geosynthetics Installer. The CQA Laboratory will communicate directly with the CQA Officer.

2.10 Electric Leak Location Surveyor (ELLS)

The ELLS is a third-party firm responsible for performing the quality assurance electrical leak location survey task listed in this manual. The ELLS shall be retained by the General Contractor. The ELLS services will be observed by the CQA Officer and/or CQA Monitors. The ELLS will communicate directly with the CQA Officer.

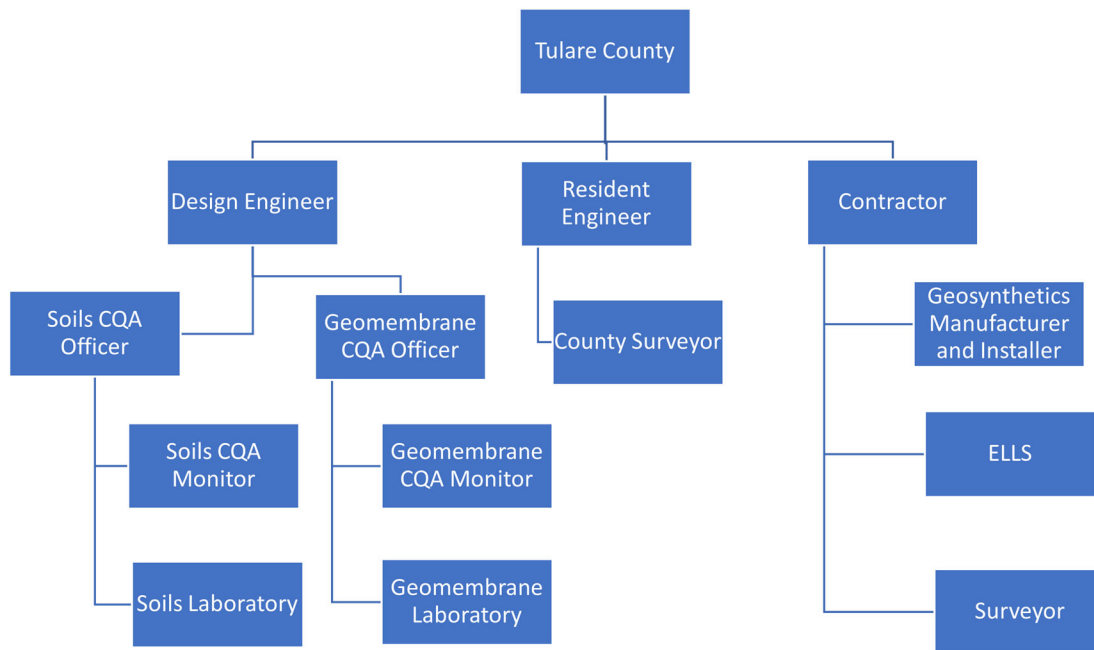
2.11 Tulare County CQA Survey

All aspects of construction will be verified by Tulare County surveyors. The surveyors will verify line, grade, and dimensions, as shown on the Construction Plans as well as the Technical Specifications. These verifications will take place during all steps of the construction project. Once an area of the project is completed, line, grade and dimensions must be verified by County survey before covering up or moving on to the next step of the project. All aspects will be verified

including subgrade floors and slopes, leachate collection trenches and sumps, anchor trenches, drainage channels, drainage pipes, plywood placement on trenches along the north and west anchor trenches, cement forms, road subgrades, finish roads, subgrade and operations layer thickness, etc. Not all aspects have been included in this description. Any areas that do not meet the tolerances in the Construction Plans and Technical Specifications, will be corrected by the contractor at no cost to the county.

County surveyors will also perform a preconstruction topographic survey with contractor for quantity calculations. County surveyors may be used to verify any and /or all construction quantities.

Three (3) days notice must be given to request County surveyors' verification checks.



Typical Organization Chart

3.0 Meetings

Meetings shall be held during the duration of the project to enhance coordination among the various parties involved. Meetings will include a Pre-construction Meeting, Progress Meetings and Resolution Meetings as necessary.

Include a pre-bid meeting. L.L.

3.1 Pre-Construction Meeting

A pre-construction meeting will be held at the site prior to the General Contractor start of construction. The Design Engineer, Resident Engineer, CQA Officer, CQA Monitor, General Contractor, Geosynthetics Installer, CQA Surveyor, Contractor's Surveyor, and others designated by the Resident Engineer shall attend this meeting. The purpose of this meeting will be to address the following, at a minimum:

- Define lines of communication, responsibility, and authority;
- Conduct a site inspection to discuss work areas, work plans, stockpiling, lay-down areas, access roads, haul roads, and related items;
- Review the project schedule;
- Review the Construction Drawings, CQA Manual, and Project Specifications; and
- Review work area security and safety protocol.

The Resident Engineer or his designee will document this meeting and copies of the meeting minutes will be distributed to all parties.

3.2 Progress Meetings

Weekly progress meetings, or as required by the Resident Engineer, will be held. At a minimum, the CQA Officer, the Resident Engineer and the Contractor(s) will attend these meetings. Relevant subcontractors, for the work to be discussed, should also be in attendance. The Resident Engineer is responsible for organizing and conducting the progress meetings. The purpose of these meetings will be to:

- Review the previous week's accomplishments and activities;
- Review upcoming scheduled work and project milestones;
- Discuss any problems or potential construction issues; and
- Review the results and status of CQA field and laboratory testing.

The Resident Engineer will document these meetings and the minutes shall be transmitted to all in attendance.

3.3 Preparatory Meetings

The Resident Engineer will schedule and administer one or more, as needed, informal preparatory meetings prior to each of the steps in the sequence of operations, as listed in Specification 01039 Meetings. The objective of these preparatory meetings is to establish a complete understanding of the upcoming construction activities and CQA procedures and testing that will be implemented during construction. The following agenda will be addressed:

- Review “Products” section of the applicable Technical Specifications
- Review “Execution” section of the applicable Technical Specification
- Discuss any construction and grade control staking needed to complete the work
- Discuss CQA testing, observation, and surveying to be performed
- Verify that all submittals have been or will be received and approved in accordance with the schedule
- Discuss Contractor’s coordination, scheduling, and sequencing of the work
- Discuss Contractor’s proposed equipment and manpower

4.0 Earthwork Construction Quality Assurance

Construction of the landfill facility must be in accordance with the approved Drawings and Project Specifications. This CQA Manual establishes the construction quality assurance monitoring and testing program designed to ensure construction compliance. The earthwork quality assurance testing program consists of testing of materials used in the facility construction. Quality assurance testing and observation is required during construction of all aspects of the liner system, including the earthwork portions. A listing of CQA forms is located in Attachment F-1 and sample forms are located in Attachment F-2. The CQA Officer may provide similar forms to be used so long as the appropriate information is collected and documented.

4.1 Construction Monitoring and Testing

All components of the construction shall be observed and tested as required by the CQA Monitor(s) to verify that the construction is in accordance with the Project Specifications. The CQA Officer(s) shall review the work performed by the CQA Monitor and identify inadequate construction methodologies or materials that may adversely impact the performance of the facility being constructed and/or existing structures. Visual observations and verification of the independent survey (CQA Surveyor) required for specific layers throughout the construction process shall be made to evaluate whether the materials are placed to the lines and grades as shown on the Drawings. Verification survey, if deemed to be required will be performed under the direction of the Resident Engineer. All aspects of construction will be verified by Tulare County surveyors. The surveyors will verify line, grade, and dimensions, as shown on the Construction Plans as well as the Technical Specifications. These verifications will take place during all steps of the construction project. Once an area of the project is completed, line, grade and dimensions must be verified by County survey before covering up or moving on to the next step of the project.

The CQA Officer or CQA Monitor will give the Resident Engineer sufficient notice of anticipated completion of the construction components so that related CQA documentation may be reviewed and accepted without delay to the Contractor. Specific CQA observations and/or testing addressed by this Section are discussed below. The geosynthetics portions of the Liner System are referenced below for clarity.

Liner System

- General fill;
- Subgrade preparation layer;
- Geosynthetic Clay Liner (GCL) including seams (**Section 5**);
- Geomembrane liner including seams (**Section 5**);

- Geocomposite drainage layer including seams (**Section 5**) and LCRS and Sump gravel;
- Geotextile filter layer (**Section 5**);
- HDPE piping (LCRS and lysimeter) (**Section 5**);
- Anchor Trench;
- Operations layer.

Other Components

- Roadways
 - Class II Aggregate Road
 - Operation Layer Soil Cell Access Road
 - Hot Mix Asphalt (HMA) Road (over existing base)
- Fencing
- Vegetation

4.2 Earthwork Construction Testing

The earthwork components of the liner system construction will include general fill, subgrade preparation layer, Operations Layer soil and Operations Layer soil access road. Aggregate materials, drainage and sump gravel, grouted riprap and road materials (Class II aggregate and HMA) are covered in other specifications. These specified materials will be obtained from site excavations or off-site sources approved by the CQA Officer and Resident Engineer. The Contractor shall provide the drainage gravel, sump gravel, and road base materials (aggregate, HMA). CQA observation and/or testing are required during construction to verify that all materials and construction are in accordance with the Project Specifications. The tests to be performed, including testing frequency and placement requirements for each material type, are presented in Tables 02200-1 through 4 (from Technical Specification 02200 – Earthwork) and Tables 02207-1 through 4 (from Technical Specification 02207 – Aggregate Material). The testing frequencies specified in the tables may be increased when construction conditions warrant additional tests. Additional tests shall be recommended by the CQA Monitor and approved by the CQA Officer and Resident Engineer.

Table 02200-1
Material Evaluation Testing Frequency
See Table 4 for Material Property Requirements

Test Designations ¹	General Fill (cy)	Subgrade Preparation Layer (cy)	Operations Layer (cy)	Access Road (Ops Layer Soil) (cy)
D2488 (Visual Soil Description)	5,000	10,000	15,000	5,000
D2487 (Soil Classification)	5,000	5,000	15,000	5,000
D1557 (Moisture/Density)	5,000	5,000	---	5,000
D7928/D6913 (Particle Size)	5,000	10,000	15,000	5,000
D1140 (#200 Sieve Wash)	5,000	10,000	15,000	5,000
D4318 (Atterberg Limits)	5,000	10,000	---	5,000

¹ Minimum one test per material type.

Table 02200-2
Soil Construction Testing Frequency

ASTM Test Designations ¹	General Fill/ Road Base (cy)	Subgrade and Subgrade Preparation Layer (cy)	Drainage Gravel/ Sump Gravel (cy)	Operations Layer (cy)	Access Road (Ops Layer Soil) (cy)
D2937 (Drive-Cylinder) ²	1 per every 40 Nuclear Gage	1 per every 40 Nuclear Gage	---	---	1 per every 40 Nuclear Gage
D2216/D4643 (Moisture Content) ²	1 per every 20 Nuclear Gage	1 per every 20 Nuclear Gage	---	---	1 per every 20 Nuclear Gage
D6938 (Nuclear Moisture-Density) ³	250	250	---	---	250

¹ Minimum one test per material type.

² Verification of Nuclear Density gauge.

³ A minimum of four tests per day.

**Table 02200-3
Fill Placement and Compaction**

Fill	Maximum Loose Lift Thickness (in.)	Moisture Content	Minimum Subgrade and Lift Density	Method of Test	Finished Grade Tolerance (ft)
Subgrade	8	±3% of Optimum	90%	ASTM D1557	±0.1
General Earthfill	8	±3% of Optimum	90%	ASTM D1557	±0.2
Subgrade Preparation Layer	8	+1 to +4% of Optimum	90%	ASTM D1557	0.0 to +0.1
Operations Layer	24	---	---	---	0.0 to +0.2
Soil Access Road	8	±3% of Optimum	90%	ASTM D1557	±0.1

**Table 02200-4
Properties for Earthwork Materials**

Material and Property	Test ¹	Requirements
General Earthfills Material Gradation - Maximum Particle Size - Maximum Particle Size within 6" of Geosynthetic - USCS Classification	D7928/D6913 D7928/D6913 D2488	3 inches 1/2 inch; otherwise 3" maximum nonexpansive sand, silt, clay or mixtures thereof
Subgrade Preparation :Layer - Maximum Particle Size - Gradation	D7928/D6913 D7928/D6913	1/2 inch Minimum 30% passing No. 200 Sieve
Operations Layer, Base and Side Slope and Cell Access Road - Material Gradation - USCS Classification	D7928/D6913 D2488	Maximum particle size = 3/4 inch; 1/2 inch within 6-inches of geosynthetic materials sand, silt, clay, and mixtures thereof

¹ Minimum one test per material type.

4.3 Earthwork Monitoring

General Fill/Aggregate Road Base and Subgrade Preparation Layer Placement:
Construction observation and monitoring during general fill/aggregate road base and subgrade preparation layer placement includes:

- Monitoring the stripping of vegetated soil and growth media within areas of fill placements;
- Monitoring that appropriate dust control measures are implemented;
- Visually observing stripped areas for soft or excessively wet areas, and unstable slopes;
- Monitoring and confirming that the surface of the subgrade is free of soft, organic, and otherwise deleterious materials, and that the surface is firm and unyielding;
- Monitoring soil borrow to ensure that the Contractor obtains specified soil materials from the site excavation and/or approved stockpile locations;
- Monitoring soil borrow and placement of the 12-inch-thick Subgrade Preparation Layer to ensure that this layer consists of nonexpansive silt, clay soils or clay mixtures, has a maximum particle size of ½-inch and has a minimum content of material, by dry unit weight passing the no. 200 sieve of 30 percent.
- Verify that the Contractor adequately moisture conditions the borrow soils and road base;
- Verify that fills are placed in loose lifts that result in obtaining density requirements of the specifications;
- Observe construction staking to verify that the general fill, road base and subgrade preparation layer soils are placed to the lines, grades, and elevations shown on the Drawings;
- Perform field and laboratory testing in accordance with Tables 02200-1 and 02200-2 to verify that the fill materials meet the specifications (Table 02200-3) and are placed to the moisture and density requirements of the specifications (Table 0220-4);
- Promptly notify the Contractor of test results that affect the work. Notify the Resident Engineer of construction progress and of the results of all testing. In the event of failing tests, verify that the Contractor adequately reworks the areas which do not meet the Project Specifications;
- Verify that the Paving Fabric (reinforcement geotextile) has been approved for use and has been properly installed under all areas to receive Class II aggregate base, and as shown on the plans and Technical specifications; and
- Verify that the CQA Survey has been completed and that the Record Drawing furnished by the surveyor indicates compliance with the lines, grades, elevations, and tolerances as indicated by the Drawings and Specifications.

Gravel Placement: Gravel components utilized for the liner system (lysimeter, primary sump and LCRS) consist of a rounded to subrounded, well-sorted gravel material for the lysimeter and sump gravel, and the drainage gravel as indicated by the specifications. Aggregate base shall conform to the requirements of Section 26, “Aggregate Bases” of the Standard Specifications and the Technical Specifications. Aggregate base shall meet the requirements for Class 2, 3/4" maximum per the Standard Specifications (Caltrans 2018).

Both pre-construction and construction testing are required for the gravel materials. Pre-construction testing consists of testing proposed materials from samples obtained at the aggregate source(s). Construction testing consists of the testing performed on samples obtained during delivery of materials. The tests to be performed, including testing frequency, for each material type are presented in Tables 2207-1 through 4.

The CQA Monitor shall observe that care is taken when placing gravel on the geosynthetic components and that the components are not punctured or damaged during placement operations. The CQA Monitor shall observe and document that appropriate light ground pressure equipment is used and that such equipment avoids sharp turns. If the equipment or gravel component placement procedures do not comply with the Project Specifications, the geomembrane shall be exposed and inspected for potential damage.

Construction observation and monitoring required during the lysimeter and primary sump, and LCRS drainage layer placement includes:

- Verification that all pre-construction testing has been performed and that laboratory test results indicate compliance with the Project Specifications. The CQA Monitor shall assure that the Resident Engineer and the Contractor receive prompt notification of material conformance;
- Verify that the material upon which the gravel components will be placed (HDPE geomembrane, geocomposite, etc.) has been installed in accordance with the Project Drawings and Specifications, and that all required testing, and as-built documentation have been completed;
- Observation and monitoring of hauling equipment and spreading equipment to verify that (in the case of the LCRS drainage gravel placement) the minimum thickness is maintained for spreading and hauling equipment above the geosynthetics;
- Collect and transmit to the laboratory the required number of gravel component samples for testing. Communicate with the laboratory to verify that the materials tested comply with the Project Specifications;
- Visually observe the gravel component materials as delivered to the site to observe for any variability in the aggregate, taking care to observe for variation in gradation, excess fines, excess angular material, or any deleterious material present in the aggregate; and

- Verify that the CQA Survey has been completed and that the Record Drawings furnished by the surveyor indicate compliance with the lines, grades, elevations, and tolerances as indicated by the Project Drawings and Specifications.

Table 02207-1
Aggregate Material Evaluation Testing Frequency

ASTM Test Designation ¹	Class 2 Road Base (cy)	LCRS Drainage Gravel / Sump Gravel ² (cy)	Grouted Rip-Rap ² (cy)
D2488 (Visual Soil Description)	5,000	1,000	---
D2487 (Soil Classification)	5,000	1,000	---
D1557 (Moisture-Density)	5,000	---	---
C136 (Sieve Analysis)	5,000	1,000	1,000
D4318 (Atterberg Limits)	---	---	---
D2434 Permeability	---	1,000 ³	---

¹ Minimum one test per material type.

² Quarry certification required for drainage layer and sump gravel.

³ Constant-head, rigid wall permeability test D2434.

Table 02207-2
Aggregate Construction Testing Frequency

ASTM Test Designation ¹	Class 2 Road Base (cy)	LCRS Drainage Gravel / Sump Gravel (cy)	Grouted Rip-Rap (cy)
D2216/D4643 (Moisture Content) ³	1 per every 20 Nuclear Gage	---	---
D6938 (Nuclear Moisture-Density) ²	250 ²	---	---

¹ Minimum one test per material type.

² A minimum of four test per 250 cubic yard or four (4) per day, whichever is greater.

³ Verification of Nuclear Density gauge

**Table 02207-3
Aggregate Placement and Compaction**

Fill	Maximum Loose Lift Thickness (in.)	Moisture Content	Minimum Lift Density	Method of Test	Finished Grade Tolerance (ft)
Drainage Gravel / Sump Gravel	12	---	---	---	0.0 to +0.1
Class 2 Road Aggregate	8	±3% of Optimum	95%	ASTM D6938	0.0 to +0.2
Grouted Rip-Rap	---	---	--	---	---

**Table 02207-4
Properties for Aggregate Materials**

Material and Property	Test	Requirements
LCRS and Sump Gravel		
– Material Gradation	C 136	<3% passing No. 200 sieve, maximum particle size = 1 1/2 inch, no more than one fractured face See Gradation requirement below.
– USCS Classification	D2488	GP, GW containing no limestone or other material that could adversely react with the landfill leachate
– Minimum Laboratory Permeability	D2434	1.0 cm/sec
Class 2 Road Base	C 136	See Section 26, Caltrans Standard Specifications, 3/4 inch maximum particle size
Grouted Rip-Rap	C 136	See Section 72, Caltrans Standard Specifications, Class 1 rock and Class 8 RSP Fabric

LCRS and Sump Gravel Gradation	
U.S. Standard Sieve	% Passing (by weight)
2-in. (50.8 mm)	100
1 1/2-in. (38.0 mm)	90-100
1-in. (25.4 mm)	5-40
3/4-in. (19.0 mm)	0-15
3/8-in. (9.5 mm)	0-5
No. 200	0-2

Operations Layer Placement: Construction observation and monitoring required during Operations Layer soil placement includes:

- Verification that all pre-construction testing has been performed and that laboratory test results indicate compliance with the Project Specifications. The CQA Monitor shall assure that the Resident Engineer and the Contractor receive prompt notification of material conformance;
- Observation and monitoring of hauling and spreading equipment to verify that the minimum thickness is maintained between equipment and the underlying geosynthetic materials;
- Verify the integrity of the geotextile layer by final inspection of all seams and geotextile panels;
- Observe that Operations Layer fill materials are pushed upslope on the side slope areas;
- Verify with the County Surveyor that the thickness of Operations Layer required by the Drawings and Technical Specifications is achieved; and verify that the soil Operations Layer materials are placed to the limits indicated in the Drawings.

Cell Access Road: Construction observation and monitoring required during placement of the Operations Layer soil material in the lined area for access to the cell includes:

- Verify that survey has been performed of the Operations Layer for use as a baseline for road construction;
- Verify that the soil meets the requirements outlined in Table 02200-4;
- Test the placed material for density and moisture in accordance with Table 02200-3. Have material re-worked as needed until passing; and
- Verify that the correct number of lifts are placed and tested and that the final thickness meets or exceed 12-inches and is to the width required by the Drawings and Technical Specifications.

Hot Mix Asphalt: Construction observation and monitoring required during placement of the Hot Mix Asphalt (HMA) includes:

- Verify the existing base has been proof rolled and is smooth;
- Verify that tack coats are applied according to Section 39 of the Standard Specifications;
- Verify that the 0.2-foot leveling course and 0.2-foot wearing course are placed to the correct thickness and tested for density in accordance with Tables 2 and 3;

Fencing: Construction observation and monitoring required during construction of the barbed wire fence includes:

- Verification that material submittals have been approved and the material onsite meets the project requirements;

- Observe that the fence posts are set plumb and to the correct spacing;
- Verify that the correct number of fence strands are placed and are properly spaced and secured to the posts; and
- Observe that the new fence is connected to the existing fence at both ends.

Anchor Trench Backfill: Construction observation and monitoring required during Anchor Trench construction and filling includes:

- Verify that the location and dimensions of each Anchor Trench is constructed according to the Construction Drawings;
- Observe that all geosynthetic components are neatly laid to the side and bottom of the trench;
- Verify compaction requirements of soil backfill is in accordance with Technical Specification 02225 – Trenching and Backfilling and test according to the Tables above, at a rate of one test per 250 linear feet of trench per 6-inch lift;
- Verify that plywood is properly placed on the North and West sides according to the Construction Drawings; and
- Verify that all required survey has been completed.

Vegetation: Construction observation and monitoring required during the establishment of vegetation includes:

- Verify that submittals for seed, fertilizer and erosion control mat are approved;
- Collect seed and fertilizer tags as needed;
- Observe that all disturbed areas, inside and outside of Project Limits; are included in the areas to be vegetated; and
- Document that vegetated coverage has been established according to the Specifications and as directed by the Resident Engineer.

4.4 CQA Surveying

CQA surveying shall be conducted such that all applicable standards are followed. The CQA Surveyor shall furnish “As-built Survey Record Drawings” (also referred to as “as-built” drawings) for review by the CQA Officer. The CQA Surveyor shall provide confirmation that surveyed materials are constructed to the lines, grades and minimum thickness identified in the Project Drawings and Specifications. The CQA Officer shall review and approve the drawings prior to placement of a new system component over the work. Required Record Drawings shall be as specified in the Project Specifications. All CQA surveying shall be performed under the direction of a surveyor licensed to perform such work in the State of California. All Record Drawings shall be signed and sealed by the licensed surveyor who directed the CQA record survey

work. Record drawings shall be at a scale not smaller than 1 inch = 100 feet. The accuracy of the surveying shall be sufficient to determine if the measurements are within the tolerances specified in the Project Specifications and Drawings.

The required surveying of the liner system elevations shall be carried out on a maximum 100-foot square grid. The grid points for each successive earthworks layer shall have the same horizontal locations for comparison of layer thickness. The surveyed thickness, perpendicular to the slope, must account for the required thickness determined by surveying at the same horizontal location. Additional survey locations shall be recorded to define the following features in the liner system: toe of slope, hinge of slope, grade breaks, sumps, anchor trench, drainage system piping, and perimeter drainage ditch. The thicknesses of the geosynthetic liner system components on the Design Drawings shall be interpreted as negligible.

The CQA Officer(s) shall coordinate with the CQA Surveyor to verify that all required surveying has been completed and proper record documentation delivered prior to covering any area with subsequent work.

5.0 Geosynthetics Construction Quality Assurance

Construction of the specified geosynthetics must be in accordance with the approved Design Drawings and Project Specifications. This Quality Assurance program consists of reviewing Geosynthetic Manufacturer's and Installer's Quality Control submittals, material conformance testing, construction monitoring and testing.

Geosynthetic materials used in the liner system construction include the geomembrane, GCL, geotextile, geocomposite drainage material, and HDPE pipe and fittings. These geosynthetic materials are defined in the Project Specifications. Prior to and during construction, these materials shall be sampled and tested to determine if they conform to Project Specifications. All geosynthetic conformance testing shall be the responsibility of the CQA Officer. The Contractor shall aid the CQA Officer in obtaining samples for testing.

A listing of CQA forms is located in Attachment F-1 and sample forms are located in Attachment F-2. The CQA Officer may provide similar forms to be used so long as the appropriate information is collected and documented.

5.1 Review Quality Control Submittals

Prior to geosynthetic materials installation, the CQA Officer shall review the Geosynthetic Installation Contractor's Quality Control submittals to confirm that materials meet Project Specifications. The CQA Officer shall review the following submittals for each geosynthetic material specified for the project:

- Geosynthetic material samples, name of Manufacturer, and minimum material certifications which shall include the Manufacturer's minimum physical properties of the material, test methods (ASTM and GSI Standards) used, and factory and site seaming methods;
- Manufacturer's Quality Control Manual followed during the manufacturing process;
- The origin (supplier's name and production plant), identification (brand name and lot number) and material properties of the resin used to manufacture the product;
- Geosynthetics Installation Contractor's Quality Control Manual, for the installation and testing of the geosynthetics;
- Resumes of the Installation Superintendent, Certified Welding Technician, Master Seamers, and other Seamers to be assigned to this project (geomembrane only);
- Certification that both the Installation Superintendent and the Certified Welding Technician and Master Seamers have reviewed this Construction Quality Assurance Manual, Project Specifications and Drawings;

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- A copy of the Quality Control Certificates on each lot of resin issued by the resin Supplier for the specific material for this project. Geomembrane submittals shall include certification of the resin for extrusion welding rod;
- The result of quality control testing conducted on the resin used in manufacturing the specific material for this project;
- A listing which correlates the resin to the individual geosynthetic rolls and extrudate materials;
- Certification that the extrusion welding rod to be used is comprised of the same resin type as the geomembrane to be used (geomembrane only);
- A copy of the geosynthetic roll Quality Control Certificates which shall be supplied at a minimum frequency of one (1) per every fifty thousand (50,000) square feet of geosynthetic material continuously produced and supplied to the project unless otherwise presented in the Project Specifications;
- Shear test results for the geosynthetic clay liner material and the entire liner system tested as a composite;
- Panel layout drawings for the geosynthetic clay liner and geomembrane layers showing the proposed installation layout identifying field seams as well as any variance or additional details which deviate from the Design Drawings; and
- A detailed installation schedule for the project.

5.2 Conformance Testing

Prior to any geosynthetic material shipment, the CQA Officer shall issue written acceptance of the product based on conformance testing, including shear tests, that demonstrates these materials meet Project Specifications. The conformance samples shall be obtained at the Manufacturer's plant by a representative of the Third-Party Laboratory. Conformance testing shall be done in accordance with the specifications. Samples shall be taken across the entire width of the roll and shall not include the first 2 feet, or outer wrap if GCL. The samples shall be a minimum of 3 feet long by the roll width. The sampler shall mark on the sample the machine direction, lot and roll number, and the date the sample was obtained, and forward the sample to the geosynthetic laboratory.

All conformance tests shall be performed in accordance with the Project Specifications. The CQA Officer shall review the test results and shall report any nonconformance to the CQA Monitor, the Resident Engineer, and the Geosynthetics Installation Contractor.

Conformance test shall be as shown in the Specification Sections listed:

Material	Specification Section
Geosynthetic Clay Liner	02774
HDPE Geomembrane	02772
Geocomposite Drainage	02773
Geotextile: • Paving Fabric • Rock Slope Protection Fabric • Drainage Fabric	02771

5.3 Geosynthetics Construction Monitoring and Testing

All geosynthetic components of the construction shall be monitored and tested to verify that the construction is in accordance with the Project Specifications. The CQA Officer shall identify inadequate construction methodologies or materials that may adversely impact the performance of the facility being constructed and existing structures. Visual observations throughout the construction process shall be made to evaluate whether materials are placed to the lines and grades as shown on the Drawings. If needed, survey verification will be performed by the Contractor and provided to the CQA Officer.

The CQA Monitor shall review the following submittals provided by the Geosynthetics Installation Contractor during the project:

- Quality control documentation recorded during installation;
- Daily reports detailing arrival and departure times, the personnel present on-site, the progress of the work, the arrival of materials, and any problems encountered; and
- Subgrade surface acceptance certificates for each area to be covered by the liner system, signed by the Geosynthetics Installation Contractor's Superintendent, Contractor, and CQA Monitor.

The CQA Monitor shall observe and document the geosynthetic installation including:

- Delivery and unloading of geosynthetic materials at the site to verify that the materials are not damaged and are properly labeled;
- Obtaining geosynthetic packaging identification slips for verification and generation of an on-site materials inventory;

- Subgrade conditions prior to liner installation and verify that any deficiencies (e.g. surface irregularities, protrusions, excessively soft areas, stones, desiccation cracks) noted are corrected;
- Verification that the CQA Surveyor has verified all lines and grades;
- Handling of geosynthetic materials from storage to the work area;
- Temporary and permanent anchoring and protection of geosynthetics to verify that design and Project Specifications are met; and
- Verification that required overlap distances are met.

5.3.1 Geosynthetic Clay Liner (GCL)

Before GCL installation, the CQA Staff will verify that:

- All lines and grades have been verified by a qualified licensed surveyor and the County surveyors.
- All required testing, including shear, have been performed and passing results have been achieved.
- All documentation for any underlying components has been completed (subgrade acceptance form).

CQA conformance tests will be performed to verify compliance with Specification Section 02774.

Confirm Shear Testing – The CQA Officer shall confirm shear testing per Specification Section 2772, Table 2772-1 has been performed and meets project requirements.

Panel Placement. During GCL panel placement, the CQA Staff shall:

- Observe the underlying surface for entrapped particles that may impact the GCL.
- Observe the surface of the GCL for needles, punctures, tearing, thinning, or other evidence that the material may not meet specification requirements.
- Inspect GCL for evidence of premature hydration, such as wet areas or swelling. Hydrated areas shall be removed and replaced with dry material.
- Verify that equipment used in deployment does not damage the GCL or underlying components.
- Verify that GCL panels are deployed down, not across slopes and are shingled downslope.
- Observe proper overlap of material, side and end overlaps;
- Observe that the proper amount of granular bentonite is continuously placed at all seams and overlaps.
- Verify that GCL panels deployed will be covered the same day. GCL shall be inspected and approved by CQA Monitors before covering.

- Verify that the GCL is placed with the correct sides facing up and down as required by Section 02774 of the Specifications.
- Verify that adequate anchor trenches are constructed and promptly backfilled and tested for compaction.

The CQA Staff shall inform the CQA Officer and the Resident Engineer if the above conditions are not met. The Resident Engineer will notify the Contractor. If the Resident Engineer is not available, the CQA staff shall notify the Contractor.

Field Seaming. During GCL placement, the CQA Staff shall verify that:

- The panels are overlapped using lapline and matchline guides, a minimum of six inches along the length and a minimum of 12 inches along the width.
- Bentonite is applied at the specified rate of a minimum of 4 ounces per linear foot and not disturbed.
- Two bentonite seams, each a minimum of 4 ounces per linear foot, are placed along the edge where the lysimeter GCL and Primary GCL are overlapped.

Repairs. Any portion of the GCL with a flaw shall be repaired by the Contractor's qualified representative(s) consistent with Section 02774 of the Specifications. The CQA Staff shall verify that:

- All punctured, torn, or hydrated material is removed.
- The GCL "patch" is placed with the same side up as the originally placed material.
- The patch overlaps the repair area a minimum of 12 inches in all directions.
- The patch is secured in-place using adhesive tape, if necessary.
- Bentonite is applied on all overlaps at the rate specified.

Moisture Verification. The CQA Staff shall verify that the GCL does not exhibit evidence of hydration, such as wet areas or swelling before it is covered with geomembrane. Water hydrated areas shall be removed and replaced with dry material.

5.3.2 Geomembrane

During geomembrane installation, the CQA Monitor(s) shall observe and document the geomembrane deployment, trial seams, field seaming, non-destructive and destructive seam testing, and repairs to verify the installation is in accordance with the Project Specifications.

CQA conformance tests will be performed to verify compliance with Specification Section 02773.

Storage and Handling – Geomembrane shall be stored at a location selected by the Resident Engineer. Rolls shall be off loaded using the appropriate equipment and straps. Rolls shall not be placed directly on the ground and shall be stacked no higher than three rolls. Only soft-sole shoes will be allowed on the deployed geomembrane and rub sheets shall be placed under all equipment

Confirm Shear Testing – The CQA Officer shall confirm shear testing per Specification Section 2772, Table 2772-1 has been performed and meets project requirements.

Deployment – The CQA Monitor shall verify that only approved materials are used, that each panel is given a unique panel number, that no geomembrane is placed during inclement or unsuitable weather conditions, that the geomembrane is not damaged during installation, that excessive wrinkles are not present, and that anchoring is performed in accordance with the Project Specifications and Drawings. The CQA Monitor shall record the deployment on a deployment log form.

Trial Seams – The CQA Monitor shall verify that seaming conditions are adequate, tests are performed at required intervals, specified test procedures are followed, and that re-testing is performed in accordance with the Project Specifications. The Geosynthetic Installer shall perform pre-weld testing at the beginning of each crew shift and immediately following any work stoppage (e.g., for lunch, weather, etc.) of 30 minutes or more. Seaming operation shall not commence until the CQA Monitor has determined that the seaming process meets the Project Specifications. Testing shall include visual observation of a trial seam a minimum of 36 inches long on the geomembrane material. The Installer shall mark the trial seam with date, ambient temperature, welding machine number, welding technician's initials, machine temperature, and speed. For extrusion welding, the Installer shall record the nozzle and extrusion settings and for fusion welding, the wedge temperature and machine speed shall be recorded. A one-foot portion of each trial seam sample shall be archived by the CQA Monitor at the site. The CQA Monitor shall record the trial seam test results on a trial seam log form.

Field Seaming – The CQA Monitor shall verify that only approved equipment and personnel perform welding. A Master Welder must be on-site during all welding operations as discussed in Technical Specification 02772. Verify that all welding is performed under suitable conditions as specified in the Project Specifications, specified overlaps are achieved, seams are oriented in accordance with project requirements, and that grinding techniques and extrudate meet project requirements for extrusion welding. The CQA Monitor shall record all field seaming on the field seaming log forms.

Seaming shall not proceed at an ambient temperature below 32°F or above 104°F unless the Installer demonstrates he is capable of achieving acceptable results through the utilization of special seaming techniques. Such cold or hot weather seaming shall be proven by an approved

program presented in the Project Specifications or presented otherwise by the Design Engineer. If seaming operations are conducted at night, lighting equipment shall be sufficient to allow the Installer and CQA Monitor to perform their duties adequately and safely.

Verify that sandbags are placed end-to-end along the entire length of the flow or toe line (toe of slope) to prevent stress-bridging at those locations.

Verify that geomembrane panels are not overlapped or seamed perpendicular to the slope on slopes with a gradient of more than 10 percent, within 20 feet of the top of any slope, and unless the geomembrane is anchored within a backfilled anchor trench.

Non-Destructive Seam Continuity Testing – The CQA Monitor shall verify that all seams are non-destructively tested in accordance with the Project Specifications. If the seam cannot be tested, the CQA Monitor shall observe cap strip operations and verify that test equipment and gauges are functioning properly and that test procedures are in accordance with the project requirements. The CQA Monitor shall verify that all failing tests are repaired and re-tested until passing results are achieved. The CQA Monitor shall record all non-destructive test locations on the vacuum test and pressure test log forms.

Destructive Seam Testing – The Geosynthetic Installer shall obtain samples, at locations selected and marked by the CQA Monitor, of the field-seamed geomembrane. The samples shall be taken centered over the seam and prioritized as follows:

- All areas identified as suspect during non-destructive testing/monitoring;
- Seams that appear suspect to the CQA Monitor;
- A minimum of one sample per day;
- A minimum of one sample for each geomembrane seaming apparatus.
- A minimum of one sample for each representative working conditions (e.g. weather conditions); and
- A minimum of one sample every 500 feet (average) of seaming for each apparatus.
- A minimum of one sample per 500 linear feet of seam. Repair and cap strip lengths count toward the 500-foot average test requirement;

Each destructive sample shall be 12-inches wide by 48-inches long with the seam centered lengthwise. Two 1-inch-wide strips shall be cut from each end of the sample (4 total) and tested and evaluated for peel and shear strength in the field by the installer using a calibrated field tensiometer, as described in Article 3.04, Paragraph C.6 and Table 02772-4 of the Project Specifications. The CQA Monitor shall observe all field tests and record the test results. If one or both of the specimens fail, the Installer shall take additional test samples 10 feet from the point of

the failed test in each direction and repeat the field test procedure. If these additional tests fail, then the procedure shall be repeated until the length of the poor-quality seam is established.

If the initial field tests pass, the remaining sample shall be cut into three (3) parts for distribution as follows:

- One portion for the Installer: 12 inches by 12 inches;
- One portion for Third-Party Laboratory or CQA Monitor testing: 12 inches by 18 inches; and
- One portion for the County to archive: 12 inches by 12 inches.

Each sample shall be subject to the following destructive tests at the Third-Party Laboratory, or by the CQA Monitor, tested per ASTM D6392 with appropriate calibrated equipment:

- Seam shear strength (five tests); and
- Seam peel strength (five tests).

For fusion seams, one peel strength test refers to testing of both sides of the seam.

The Installer is responsible for collecting and shipping the samples to the laboratory and for the costs associated with the testing, including any required re-testing. Failed destructive tests shall be subject to additional testing until the failing test is bound on both ends by passing tests. The Installer shall take another test sample 10 feet from the point of the failed test in each direction and repeat the field test procedure. If subsequent tests fail, then the procedure is repeated until the length of the poor-quality seam is established. Once the field tests have passed, a second sample shall be taken between the passing specimens and tested by the Independent CQA Laboratory or by the CQA Officer. Failed seams shall be tracked according to the welding apparatus and the machine operator. All failed seams shall be bounded by locations from which passing Independent CQA Laboratory tests have been taken.

The Installer shall be responsible for patching all areas cut for test samples in accordance with the Project Specifications and the Manufacturer's recommended procedures, and for non-destructive testing (e.g. vacuum box, etc.) of the patch seams. The CQA Monitor shall record all test locations, results, actions taken in conjunction with destructive test failures, and repairs.

Repairs – The CQA Monitor shall observe and document that all repair materials, techniques, and procedures used for repairs are approved in advance and meet the requirements of the Project Specifications. The CQA Monitor shall verify that all repairs are marked, recorded, repaired, tested, and that wrinkles are addressed, prior to being covered by other materials; and that repairs are performed as specified, including specified type of repair according to type of damage and

proper patch size or dimension. The CQA Monitor shall record defects and repairs on a repair log form.

Acceptance – The CQA Officer shall accept areas of the geomembrane prior to coverage of the geomembrane by other materials. Acceptance of areas shall follow these procedures:

- As-built panel layout survey;
- Full documentation of all seams;
- Full documentation of nondestructive testing on all seams and repairs;
- Full documentation of repairs on all defects;
- Full documentation of passing destructive tests and repairs; and
- A final “walk-over” of the area to observe any subsequent damages or non-addressed items.

5.3.3 Geotextile

During geotextile installation, the CQA Monitor shall observe and document deployment, adequate overlap, seaming, and repairs to evaluate whether the installation is in accordance with the Project Specifications. Refer to Tables 02771-1 and 02771-2 of Technical Specification 02771 – Geotextile for test requirements.

Deployment – The CQA Monitor shall verify that the underlying layers are clean and free of deleterious materials prior to deployment, and anchoring is achieved as specified. The CQA Monitor shall make observations to inspect for the presence of damaged material or the presence of broken needles used in the manufacturing process. The geotextile shall be installed with the machine direction (lengthwise) of the roll oriented down the slope.

Seams – The CQA Monitor shall verify sufficient overlap and that the specified seam procedures were followed and that the proper equipment and personnel were used as required in the Project Specifications. All geotextile seams are to be sewn.

Repairs – The CQA Monitor shall verify that all repairs are performed in accordance with Project Specifications.

Protection – The CQA Monitor shall verify that deployment methods and equipment do not damage underlying materials. The CQA Monitor shall observe and document that all geotextile materials are covered with the approved material and that traffic or hauling equipment does not damage the geotextile during installation of the overlying materials. In the presence of wind, the geotextile shall be securely anchored with sandbags or equivalent. Verify that rocks, excessive dust, excessive moisture, or other matter that could cause damage, hamper sewing operations, or clog the geotextile are not trapped under the geotextile or within the overlap.

5.3.4 Geocomposite

During geocomposite installation, the CQA Monitor shall observe and document deployment, adequate overlap, seaming, and repairs to evaluate whether the installation is in accordance with the Project Specifications.

CQA conformance tests will be performed to verify compliance with Specification Section 02773.

Confirm Shear Testing – The CQA Officer shall confirm shear testing per Specification Section 2772, Table 2772-1 has been performed and meets project requirements.

Deployment – The CQA Monitor shall verify that the underlying layers are clean and free of deleterious materials prior to deployment, and that anchoring is achieved as specified. The CQA Monitor shall verify that the geocomposite is installed to drain to the LCRS trenches and LCRS sumps.

Seams and Repairs – The CQA Monitor shall verify sufficient overlap and that the specified seam procedures were followed as required in the Project Specifications. The CQA Monitor shall verify that all repairs are performed in accordance with Project Specifications.

Protection – The CQA Monitor shall verify that deployment methods and equipment do not damage underlying materials. The CQA Monitor shall observe and document that all geocomposite materials are covered with the approved material and that traffic or hauling equipment does not damage or displace the geocomposite during installation of the overlying materials. In the presence of wind, the geocomposite shall be securely anchored with sandbags or equivalent.

5.3.5 HDPE Pipe and Fittings

During polyethylene pipe installation, the CQA Monitor shall observe and document that the installation is in accordance with the Project Specifications. Monitoring shall include:

Placement – Observing that the handling procedures used do not damage the pipe or underlying materials, embedment and backfill is placed in accordance with the requirements of the Project Specifications so as not to damage the pipe, any foreign material is removed from the interior of the pipe, and indentations on the pipe are within the allowable limits.

Joints and Connections - Monitoring of the jointing and connection operations to verify that the Contractor or Installer follows the Project Specifications and the Pipe Manufacturer's recommendations, verification that the pipes are clean when installed, and that perforated sections of pipe are aligned properly prior to connection. Reference ASTM D2657.

Non-destructive Testing – Observe any required testing of the pipe to verify conformance with the Project Specifications.

5.3.6 Electrical Leak Location Survey

An electrical leak location survey (ELLS) shall be completed by a third-party being retained by the General Contractor in the Unit II, Phase 1 liner area following the placement of the soil Operations Layer on the floor and on the slopes. The CQA Officer/Monitor shall ensure that the liner is properly prepared for the ELLS and shall verify that adequate moisture is added to the gravel or geocomposite and Operations Layer soil prior to conducting the test. All edges of the liner must be “electrically isolated” prior to completing the test. The ELLS shall conform to the applicable requirements of ASTM D7007.

In the event that ELLS identifies anomalies that are indicative of a defect in the liner system, the CQA Monitor shall document the location of the suspect area, and then observe and document the exposure of the liner system and any subsequent repairs that may be necessary. The CQA Monitor will photograph the area after it is exposed, and after any repairs are completed.

The ELLS Surveyor shall submit a report detailing the procedures used and the results of their survey.

5.4 CQA Surveying

CQA surveying shall be conducted such that all applicable standards are followed. The CQA Surveyor shall furnish “As-built Survey Record Drawings” (also referred to as “as-built” drawings) for review by the CQA Officer. The CQA Surveyor shall provide confirmation that surveyed materials are constructed to the lines, grades and minimum thickness identified in the Project Drawings and Specifications. The CQA Officer shall review and approve the drawings prior to placement of a new system component over the work. Required Record Drawings shall be as specified in the Project Specifications. All CQA surveying shall be performed under the direction of a surveyor licensed to perform such work in the State of California. All Record Drawings shall be signed and sealed by the licensed surveyor who directed the CQA record survey work. Record drawings shall be at a scale not smaller than 1 inch = 100 feet. The accuracy of the surveying shall be sufficient to determine if the measurements are within the tolerances specified in the Project Specifications and Drawings.

The required surveying of the liner system elevations shall be carried out on a maximum 100-foot square grid. The grid points for each successive earthworks layer shall have the same horizontal locations for comparison of layer thickness. The surveyed thickness, perpendicular to the slope, must account for the required thickness determined by surveying at the same horizontal location. Additional survey locations shall be recorded to define the following features in the liner system: toe of slope, hinge of slope, grade breaks, sumps, anchor trench, drainage system piping, and

perimeter drainage ditch. The thicknesses of the geosynthetic liner system components on the Design Drawings shall be interpreted as negligible.

The CQA Officer(s) shall coordinate with the CQA Surveyor to verify that all required surveying has been completed and proper record documentation delivered prior to covering any area with subsequent work.

5.5 *Tulare County CQA Surveying*

All aspects of construction will be verified by Tulare County surveyors. The surveyors will verify line, grade, and dimensions, as shown on the Construction Plans as well as the Technical Specifications. These verifications will take place during all steps of the construction project. Once an area of the project is completed, line, grade and dimensions must be verified by County survey before covering up or moving on to the next step of the project. All aspects will be verified including subgrade floors and slopes, leachate collection trenches and sumps, anchor trenches, drainage channels, drainage pipes, plywood placement on trenches along the north and west anchor trenches, cement forms, road subgrades, finish roads, operations layer thickness, etc. Not all aspects have been included in this description. Any areas that do not meet the tolerances in the Construction Plans and Technical Specifications, will be corrected by the contractor at no cost to the county.

County surveyors will also perform a preconstruction topographic survey with the contractor for quantity calculations. County surveyors may be used to verify any and /or all construction quantities.

Three (3) days notice must be given to request County surveyors' verification checks.

6.0 Leachate Removal and Storage Facilities Construction Quality Assurance

Construction of the leachate removal and storage facilities must be in accordance with the approved Design Drawings and Project Specifications. This Quality Assurance program consists of reviewing Manufacturer's and Contractor's Quality Control submittals, material conformance testing, construction monitoring and testing.

The types of materials used in the leachate removal and storage facilities construction include pumps, valves, piping, tanks, concrete, and electrical components and other equipment. These materials are defined in the Project Specifications. Prior to and during construction, these materials shall be reviewed to determine if they conform to Project Specifications. Conformance testing shall be the responsibility of the CQA Officer, unless addressed otherwise in the Project Specifications.

6.1 Review Quality Control Submittals

Prior to materials installation, the CQA Officer shall review the Contractor's Quality Control submittals to confirm that materials meet Project Specifications. The CQA Officer shall review the following submittals for each material specified for the project:

- Material samples, name of Manufacturer, and minimum material certifications which shall include the Manufacturer's minimum physical properties of the material, test methods used;
- The origin (supplier's name and production plant), identification (brand name and lot number) and material properties;
- Manufacturer's Quality Control and/or Installation Manual; and
- Applicable Quality Control Certificates.

6.2 Conformance Testing

Prior to installation, the CQA Officer shall obtain samples of specified materials for conformance testing to evaluate or confirm that these materials meet Project Specifications.

All conformance tests shall be performed in accordance with the Project Specifications. The CQA Officer shall review all tests, samples, cut sheets and other product information necessary to confirm the product meets the Project Specifications and shall report any nonconformance to the CQA Monitor, the Resident Engineer, and the Contractor.

6.3 Construction Monitoring and Testing

All components of the construction shall be monitored, and tested when specified, to verify that the construction is in accordance with the Project Specifications. The CQA Officer shall identify inadequate construction methodologies or materials that may adversely impact the performance of the facility being constructed. Visual observations throughout the construction process shall be made to evaluate whether materials are placed to the lines and grades as shown on the Drawings. If needed, survey verification will be performed by the Contractor and provided to the CQA Officer. All aspects of construction will be verified by Tulare County surveyors. The surveyors will verify line, grade, and dimensions, as shown on the Construction Plans as well as the Technical Specifications. These verifications will take place during all steps of the construction project. Once an area of the project is completed, line, grade and dimensions must be verified by County survey before covering up or moving on to the next step of the project. All aspects will be verified including subgrade floors and slopes, leachate collection trenches and sumps, anchor trenches, drainage channels, drainage pipes, plywood placement on trenches along the north and west anchor trenches, cement forms, road subgrades, finish roads, operations layer thickness, etc. Not all aspects have been included in this description. Any areas that do not meet the tolerances in the Construction Plans and Technical Specifications, will be corrected by the contractor at no cost to the county.

The CQA Monitor shall review all submittals, product information, mix designs, etc. provided by the Contractor during the project, including quality control documentation recorded during installation. The CQA Monitor shall prepare reports detailing the progress of the work.

The CQA Monitor shall:

- Review conditions prior to material installations and verify that any deficiencies noted are corrected;
- Assess that the CQA Surveyor has verified all lines and grades;
- Obtain concrete samples and perform slump and compressive strength tests per Specification 03300;
- Observe reinforcement and water stop placement;
- Observe proper concrete finish;
- Observe and verify that all installations, control box location and orientation, anchoring and piping conform to the Project Plans and Specifications;
- Observe electrical trench and conduit burial and warning tape installation;
- Confirm all electrical testing performed by an independent testing firm;
- Observe electrical has been connected to the final supply prior to final testing and acceptance;

- Observe and verify that all on-site testing, operation and training have been performed and the systems meet operational requirements; and
- Verify that all operations and maintenance manuals are completed and delivered to the County and that factory field assistance has been completed for startup, calibration and training.

7.0 Drainage and Erosion Control Facilities Construction Quality Assurance

Construction of the specified drainage and erosion control facilities must be in accordance with the approved Drawings and Project Specifications. This Quality Assurance program consists of reviewing Manufacturer's and Contractor's Quality Control submittals, material conformance testing, and construction monitoring and testing.

The types of materials used in drainage and erosion control construction include inlets, grates, corrugated metal pipe, reinforced concrete pipe, concrete, erosion control materials, and revegetation. These materials are defined in the Project Specifications. Prior to and during construction, these materials shall be reviewed to determine if they conform to Project Specifications. Conformance testing shall be the responsibility of the CQA Officer, unless addressed otherwise in the Project Specifications.

7.1 Review Quality Control Submittals

Prior to materials installation, the CQA Officer shall review the Contractor's Quality Control submittals to confirm that materials meet Project Specifications. The CQA Officer shall review the following submittals for each material specified for the project:

- Material samples, name of Manufacturer, and minimum material certifications which shall include the Manufacturer's minimum physical properties of the material, and test methods used.
- The origin (supplier's name and production plant), identification (brand name and lot number) and material properties.
- Manufacturer's Quality Control Installation and/or Operations Manual.
- Applicable Quality Control Certificates.

7.2 Conformance Testing

Prior to installation, the CQA Officer shall obtain samples of specified materials for conformance testing to evaluate or confirm that these materials meet Project Specifications.

All conformance tests shall be performed in accordance with the Project Specifications. The CQA Officer shall review the test results and shall report any nonconformance to the CQA Monitor, the Resident Engineer, and the Contractor.

7.3 Construction Monitoring and Testing

All components of the construction shall be monitored and tested, when specified, to verify that the construction is in accordance with the Project Specifications. The CQA Officer shall identify inadequate construction methodologies or materials that may adversely impact the performance of the facility being constructed. Visual observations throughout the construction process shall be made to evaluate whether materials are placed to the lines and grades as shown on the Drawings. If needed, survey verification will be performed by the Contractor and provided to the CQA Officer. All aspects of construction will be verified by Tulare County surveyors. The surveyors will verify line, grade, and dimensions, as shown on the Construction Plans as well as the Technical Specifications. These verifications will take place during all steps of the construction project. Once an area of the project is completed, line, grade and dimensions must be verified by County survey before covering up or moving on to the next step of the project. All aspects will be verified including subgrade floors and slopes, leachate collection trenches and sumps, anchor trenches, drainage channels, drainage pipes, plywood placement on trenches along the north and west anchor trenches, cement forms, road subgrades, finish roads, operations layer thickness, etc. Not all aspects have been included in this description. Any areas that do not meet the tolerances in the Construction Plans and Technical Specifications, will be corrected by the contractor at no cost to the county.

The CQA Monitor shall review all submittals provided by the Contractor during the project, including quality control documentation recorded during installation. The CQA Monitor shall prepare reports detailing the progress of the work.

The CQA Monitor shall also:

- Review ditch excavation and embankments to verify the correct cross sections and elevations prior to culvert placement;
- Verify that the correct class, diameter and length of pipes are provided at each culvert location;
- Observe placement of drop inlet and area grading to verify drainage requirements;
- Verify that the vegetated seed mixture proposed meet the Project Specifications;
- Review test results and proposed fertilizer recommendations;
- Review subgrade conditions prior to material installations and verify that any deficiencies (e.g. surface irregularities, excessively soft areas, stones) noted are corrected;
- Assess that the CQA surveyor has verified all lines and grades;
- Observe and verify that all on-site testing has been performed; and
- Observe and verify that all installations conform to the Project Plans and Specifications.

8.0 Documentation

An effective Quality Assurance Program depends on thorough monitoring and documentation of all construction activities during all phases of construction. Documentation shall consist of daily record keeping, construction problem resolutions, design and specification changes, photographic records, weekly progress reports, chain of custody forms for test sample tracking, and a certification and summary report. During construction, all documentation shall be kept on site and will be available for review by the Resident Engineer, CQA Officer, or CQA Monitors.

No section of the project may be covered up until the CQA Monitor or CQA Officer observes, approves and documents the completed section and verifies that all requirements have been met by the Contractor.

8.1 Daily Record Keeping

Daily records shall consist of field notes, observation and testing data sheets, summary of the daily meetings with the Installer and Contractor, and reporting of construction problems and resolutions. This information shall be submitted weekly along with a weekly CQA Summary Report to the CQA Officer. Copies of all CQA documentation shall be maintained at the site and be made available for review by the Resident Engineer.

8.2 Soils Observation and Testing Data Sheets

Soils observation and testing data sheets generally include the following information:

- Date, project name, location, and weather data;
- A reduced-scale site plan, or full-scale plots, showing work areas and test locations;
- Descriptions of ongoing construction;
- Summary of test results and samples taken, with locations and elevations;
- Off-site materials received including quarry certificates;
- Test equipment calibrations, if necessary; and
- Signature or initials of the CQA Monitor.

8.3 Geosynthetic Observation and Testing Forms

Geosynthetic observation and testing forms generally include the following information:

- Date, project name, location, and weather data;
- Identification of panel or seam number;
- Numbering system identifying test or sample number;

- Location and identification of repairs and date of repair;
- Length and/or thickness measurements for geosynthetic panels or seams;
- Welding machine temperatures and settings;
- Welding machine and technician identifications;
- Location of tests and test results;
- Identification of testing technicians and time of tests; and
- Signature or initials of the CQA Monitor.

8.4 Construction Problem and Resolution Documentation

Any construction problem which cannot be resolved between the Installer, Contractor, and CQA Monitor may require a special meeting in order to resolve the problem. The problem should be discussed with the Resident Engineer, CQA Officer, and Design Engineer if a design issue is involved. Specific written documentation of any problem or construction issue should be prepared, if warranted, and will generally include the following information:

- Detailed description of the problem;
- Location and cause of the problem;
- How and when the situation or deficiency was identified;
- How the problem was resolved;
- Any measures taken to prevent similar problems in the future; and
- Signature of the CQA Officer and CQA Monitor.

Copies of all Construction Problem and Resolution Sheets requiring a Resolution Meeting will be submitted to the Resident Engineer.

8.5 Photo Documentation

All phases of construction shall be sufficiently photographed by the CQA Monitor. Photographs shall be identified by separate photographic log by location, time, date, and name of the person taking the photograph. A camera that records the time and date on the photograph shall be used. Representative photographs will be included in the certification report.

8.6 Design and Specification Changes

If it is necessary to address design and specification changes, modifications, or clarifications during construction, the CQA Monitor or CQA Officer will inform the Resident Engineer who will notify the Design Engineer. Design and specification changes shall only be made with written agreement from the Resident Engineer and Design Engineer.

8.7 Certification Report

At the completion of construction, a certification report shall be prepared and signed by the CQA Officer(s) to certify that the work has been performed in compliance with the Design Drawings and Project Specifications and will contain the following general information:

- Summary of construction activities;
- Observation and test data summary sheets;
- Sampling, testing locations, and test results;
- A description of significant construction problems and the resolution of these problems;
- Changes to the Drawings or Project Specifications and the justification for these changes;
- Record drawings;
- Complete Geosynthetics MQC and CQA testing data; and
- A certification statement signed and sealed by a civil engineer (PE) or engineering geologist (CEG) registered in the State of California, by whom the CQA activities were supervised.

The as-built record drawings shall be prepared by the CQA Surveyor and shall accurately locate all construction items including the lines, grades, and thickness of all soil components for the liner system.

9.0 References

Note: Reference sources for the CQA firm(s) are as follows:

ASTM and other Specifications and Test Methods on the Quality Assurance of Landfill Liner systems, identified by: PCN: 03-435193-38. ISBN: 08031-1784-1.

U. S. Environmental Protection Agency, Quality Assurance and Quality Control for Waste Containment Facilities. EPA/600/R-93/182. September, 1993.

ATTACHMENT F-1 CQA DOCUMENTATION FORMS LIST

EARTHWORK	GEOSYNTHETICS	
✓	✓	Weekly Project Meeting (Not Attached)
✓	✓	Weekly Meeting Sign-In Sheet (Not Attached)
✓	✓	Meeting Report
✓	✓	Submittal Log (Not Attached – Determined for Each Project)
✓	✓	Correspondence Log (Not Attached – Determined for Each Project)
✓	✓	Conversation Summary
✓	✓	Memorandum of Record
✓	✓	Daily Field Report
✓		Master Log for Test Samples
✓		Laboratory Test Request (Not Attached – Determined for Each Project)
✓		Nuclear Gauge Moisture Density Test Log
✓		Drive Cylinder Test Log (to be provided by CQA Officer)
✓		Moisture Content Test Report
✓		Sieve Analysis
✓	✓	Report of Nonconformance
	✓	Acceptance of Subgrade
	✓	Received Log
	✓	Trial Weld Log
	✓	Panel Placement and Seam Log
	✓	Non-Destructive Testing
	✓	Destructive Seam Test Results (Field Results)
✓	✓	Photographic Log

ATTACHMENT F-2 SAMPLE CQA FORMS

The CQA Officer may provide similar forms to be used so long as the appropriate information is collected and documented.

Meeting Report

Date: _____

Location: _____

Attendees: _____

Summary of Meeting

[illegible]

Distribution:

Conversation Summary

Project Number: _____ Date: _____

Project Name: _____ **Attendees:** _____

Summary of Conversation

[illegible]

Prepared By: _____	Reviewed By: _____
--------------------	--------------------

Reviewed By: _____

Distribution:

Memorandum of Record

Project Number: _____

Date: _____

Project Name: _____

Attendees: _____

Memorandum

Prepared By: _____

Reviewed By: _____

Distribution: _____

Daily Field Report

Report No.:

Project Number: _____

Date: _____

Project Name: _____

Equipment: _____

Weather: _____

Summary

Prepared By: _____

Time Arrived: _____

Reviewed By: _____

Time Departed: _____

Master Log for Test Samples

Project Number: _____ **Sheet** _____ **of** _____

Project Number: _____ **Sheet** _____ **of** _____

Project Name: _____

[illegible]

Nuclear Gauge Moisture Density Test Log

Project Number: _____

Tested By _____

Project Name: _____

Reviewed By: _____

Project Location: _____

Date: _____

Soil Characterization Engineering Material Properties

Compaction Curve No.	Compaction			Sketch
	Soil Description	Max. Dry Density (pcf) Y	Opt. Moist. Content (%) w	

Nuclear Gauge Moisture and Density Test Data (ASTM D3017 & D2922)

Test Number					
Northing/Station					
Easting/Offset					
Elevation/Lift					
Probe Depth					
Compaction Curve Number					
a	Wet Density (pcf)				
b	Weight of Water (pcf)				
w	Moisture Content				
$d=a/(1+(w/100))$	Dry Density (pcf)				
$r=(d/Y)*100$	Relative Compaction				

Laboratory Moisture Test Data (ASTM D2216 & 4643)

Test Method	Mic.	Oven	Mic.	Oven	Mic.	Oven	Mic.	Oven	Mic.	Oven
Tare Number										
A	Wet soil + tare (gr.)									
B	Dry Soil + Tare (gr.)									
C=A-B	Water (gr.)									
D	Tare (gr.)									
E=B-D	Dry Soil									
$W=C/E)*100$	Moisture Content (%)									

Combined Nuclear and Laboratory Test Data

$F=a/(1+(W/100))$	Dry Density (pcf)									
$R=(F/Y)*100$	Rel. Compaction (%)									
Required Relative Compaction (%)										
Required Moisture Range (%)										

Note: For test location use estimated Northing and Easting, Station and Offset, or show on a sketch (Attach sheet if necessary)

Moisture Content Test Report

Project Number: _____ **Tested By:** _____
Project Name: _____ **Sampled By:** _____
Project Location: _____ **Reviewed By:** _____

Sample Number							
Date							
Tare No.							
Wet Wt. + Tare							
Dry Wt. + Tare							
Weight of Water							
Weight of Tare							
Weight of Dry Soil							
Percent Moisture							

Sample Number							
Date							
Tare No.							
Wet Wt. + Tare							
Dry Wt. + Tare							
Weight of Water							
Weight of Tare							
Weight of Dry Soil							
Percent Moisture							

Sample Number							
Date							
Tare No.							
Wet Wt. + Tare							
Dry Wt. + Tare							
Weight of Water							
Weight of Tare							
Weight of Dry Soil							
Percent Moisture							

Sample Number							
Date							
Tare No.							
Wet Wt. + Tare							
Dry Wt. + Tare							
Weight of Water							
Weight of Tare							
Weight of Dry Soil							
Percent Moisture							

Sieve Analysis

Project: Number: _____ Tested By: _____

Project Name: _____ **Date Tested:** _____

Project Location: _____ **Reviewed By:** _____

Sample Description

--

Moisture Content		Sample Reduction	
Tare No.		Reduction Sieve Size	

a Wet Wt. + Tare (gm) _____

b	Dry Wt. + Tare (gm)	_____
---	---------------------	-------

c=a-b	Weight Water (gm)
100	100
90	90
80	80
70	70
60	60
50	50
40	40
30	30
20	20
10	10
0	0

d	Weight Tare (gm)	
---	------------------	--

e=b-d	Weight Dry Soil (gm)	_____
-------	----------------------	-------

$w=c/e*100$	Moisture Content (%)
-------------	----------------------

Sample Reduction

Reduction Sieve Size

f	Total Sample Weight	
---	---------------------	--

g Reduced Sample Weight _____

$$h = g/f \cdot 100 \quad \text{Percent of Total Sample}$$
[illegible]

Sieve Analysis							
Standard Sieve Size	Accumulative Weight Retained			Accum. Percent Retained ($r=n/t \times 100$)	Accum. Percent Passing ($p=100-r$)	Percent of Total ($s=p \times h/100$)	Remarks
	Gross (l)	Tare (m)	Net (n)				
Total (t)							

[illegible]

Report of Nonconformance

Report No.:

Project Number: _____

Project Name:

Nonconformance Description:

Prepared By:

Date:

Corrective Action Taken:

Prepared By:

Date:

Corrective Action Verification

Verified By:

Date:

Acceptance of Subgrade

Installer Name: _____ Project Number: _____

Address: _____ Project Name: _____

Owner: _____

Authorized Representative: _____

I the undersigned, duly authorized representative of _____
do hereby agree that the subsurface is suitable for geosynthetic placement.

Installers Signature

Title

Printed Name

Date

Owner's Representative

Title

Printed Name

Date

Geosynthetic Received Log

Geosynthetic Type _____

Project Number: _____

Project Location: _____

Project Name: _____

Monitor: _____

[illegible]

Remarks might included "QA sample taken", "damaged roll", "missing QC documentation", etc.

Trial Weld Log

Sheet of

Project Number: _____

Project Name: _____

Sample No.	Date/ Time	Equip # Type	Operator	Temperature			Test Results							Mon-itor
							Inside Peel (lbs)		Outside Peel (lbs)		Shear (lbs)			
				Amb.	Sheet	Equip.	Break	P/F	Break	P/F	Break	P/F		

Wedge Weld
 Thickness _____ mils
 Peel _____ psi
 Shear _____ psi

Extrusion Weld
 _____ mils
 _____ psi
 _____ psi

For each weld, test a minimum of two specimens in peel and two in shear

 Checked By: _____

Panel Placement and Seam Log

Sheet _____ of _____

Project Number: _____ Project Name: _____	Date: _____
--	--------------------

Project Name: _____

[illegible]

Sketch - label panel number, give approximate dimensions and show repair and destructive test locations

Non-Destructive Testing

Project Number: _____

Project Name: _____

[illegible]

* Air pressure (AP) or Vacuum Box (VP)	Checked By
--	------------

Air pressure (AP) or Vacuum Box (VB) _____ Checked By: _____

Destructive Seam Test Results (Field Results)

Project Number: _____
Project Name: _____

Sheet No.: _____

Sample No.: _____ Seam No.: _____ Date Seamed: _____ Equip. No.: _____
 Operator: _____ Date Tested: _____ Monitor: _____

Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Pass/Fail _____ Pass/Fail _____ Pass/Fail _____

Sample No.: _____ Seam No.: _____ Date Seamed: _____ Equip. No.: _____
 Operator: _____ Date Tested: _____ Monitor: _____

Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Pass/Fail _____ Pass/Fail _____ Pass/Fail _____

Sample No.: _____ Seam No.: _____ Date Seamed: _____ Equip. No.: _____
 Operator: _____ Date Tested: _____ Monitor: _____

Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Pass/Fail _____ Pass/Fail _____ Pass/Fail _____

Sample No.: _____ Seam No.: _____ Date Seamed: _____ Equip. No.: _____
 Operator: _____ Date Tested: _____ Monitor: _____

Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Pass/Fail _____ Pass/Fail _____ Pass/Fail _____

Sample No.: _____ Seam No.: _____ Date Seamed: _____ Equip. No.: _____
 Operator: _____ Date Tested: _____ Monitor: _____

Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Pass/Fail _____ Pass/Fail _____ Pass/Fail _____

Sample No.: _____ Seam No.: _____ Date Seamed: _____ Equip. No.: _____
 Operator: _____ Date Tested: _____ Monitor: _____

Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Pass/Fail _____ Pass/Fail _____ Pass/Fail _____

Sample No.: _____ Seam No.: _____ Date Seamed: _____ Equip. No.: _____
 Operator: _____ Date Tested: _____ Monitor: _____

Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Shear (ppi) _____ Inside Peel (ppi) _____ Outside Peel (ppi) _____
 Pass/Fail _____ Pass/Fail _____ Pass/Fail _____

Photographic Record

Client: Tulare County

Prepared by:

Photograph Date:

Location: Woodville Landfill

Project No:

Photograph No. 1	
Direction:	
Description:	

Photograph No. 2	
Direction:	
Description:	