

May 1, 2018

Ms. Alicia Brown  
Indiana Department of Environmental Mgmt  
OLQ, Solid Waste Permits Branch  
100 N Senate Avenue  
MC 65-45 IGCN 1101  
Indianapolis, IN 46204-2251

**RE: Follow up to Request for Additional Information, March 5, 2018  
Permit FP 37-01  
NIPSCO – R.M. Schahfer Generating Station  
Wheatfield, Indiana, Jasper County**

Dear Ms. Brown:

On behalf of Mr. Kelly Carmichael, Vice President, Environmental, the Northern Indiana Public Service Company LLC (NIPSCO) is submitting this packet in response to the Department's request identified above.

As identified as an action item in our previous submittal, today's submittal includes the addendum to the Construction Quality Assurance (CQA) plan. The following are being provided through this submittal.

- Two (2) hard copies of the plan
- One (1) CD containing an electronic copy of this package in PDF format

Consistent with the certification submitted with the initial application package, I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information.

Thank you for your attention to this matter. If you have any questions or require additional information, please do not hesitate to contact me at [jloewe@nisource.com](mailto:jloewe@nisource.com) or 219-647-5249.

Sincerely,

A handwritten signature in blue ink, appearing to read "Jeffrey M. Loewe". The signature is fluid and cursive.

Jeffrey M. Loewe  
Principal  
NiSource Environmental



May 1, 2018  
Project No. 0137-300-11-03

Ms. Alicia Brown, Permit Manager  
Indiana Department of Environmental Management  
Solid Waste Permits  
IGCN 1101  
100 North Senate Avenue  
Indianapolis, Indiana 46204-2251

Re: Addendum to CQA Plan  
R.M. Schahfer Generating Station RWS I  
Jasper County  
SW Program ID 37-01

Dear Ms. Brown:

Weaver Consultants Group respectfully submits this letter and attachments as a follow up to the RAI response submitted on April 6, 2018. This submittal includes an amendment to the facility's Construction Quality Assurance (CQA) Plan that provides additional CQA requirements for various components of the facility's liner and final cover systems as requested by IDEM. This submittal also includes a certification statement.

We trust this information is a sufficient response to your comments. We appreciate your expedited review of this information. If you have any questions or require additional information, please contact the undersigned at (574) 271-3447.

Sincerely,

Weaver Consultants Group, LLC

A handwritten signature in black ink, appearing to read 'Bryan de Varona', written over a light blue horizontal line.

Bryan de Varona, P.E.  
Senior Project Manager

A handwritten signature in black ink, appearing to read 'Tony Maxson', written over a light blue horizontal line.

Tony Maxson, P.E.  
Senior Project Director


cc: Bin Wu - NIPSCO  
Jeff Loewe - NiSource  
Michelle Lu - IDEM


Attachments: **Certification Statement**  
**Appendix A - CQA Plan Addendum**

**Solid Waste Land Disposal Facilities  
Signatures and Certification Statements for Permit Modification**

329 IAC 10-11-3(d) requires that the signatory of a solid waste land disposal facility permit application and of other information requested by or on behalf of the Commissioner (including the supplemental information requested by our office for your solid waste land disposal facility permit application) sign to the following certification statement:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further certify that I am authorized to submit this information."

  
\_\_\_\_\_  
APPLICANT'S SIGNATURE



\_\_\_\_\_  
DATE

5/1/18

Anthony E. Maxson, P.E.  
Indiana Registration No. PE10403493

APPLICANT'S NAME TYPED

Note: It is not necessary to submit this form if an equivalent signed certification statement is incorporated into your submittal.

**APPENDIX A**

**ADDENDUM TO CQA PLAN**

May 2018

0137-300-11-03

# **ADDENDUM TO CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN**

## **PHASES VII AND VIII FLY ASH LANDFILL**

### **R.M. SCHAHFER GENERATING STATION**

**WHEATFIELD, INDIANA**

PREPARED BY



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**Attachment**

Existing CQA Plan – Constructino Quality Assurance Plan for Remaining Phases VI and VII Site Preparation and Liner Installation, and Phases V, VI, and VII Closure Cover Installation, dated August 19, 2014, prepared by Sargent & Lundy LLC

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# 1 INTRODUCTION

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This addendum to the Phase VI and VII Construction Quality Assurance Plan has been prepared for NIPSCO to meet the requirements of the Indiana Administrative Code 329 IAC 10, and 40 CFR Parts 257 and 261 (CCR Rules) to ensure high quality installation and construction of various components of the landfill liner and final cover systems at the R. M. Schahfer Generating Station (RMSGGS) Fly Ash Landfill. This CQA plan addendum is intended to supplement the existing permitted CQA Plan (prepared by Sargent and Lundy LLC dated August 19, 2014 which is attached to this addendum) and address design modifications necessary to comply with the currently effective CCR rules for the remaining Phases VII and VIII.

This CQA Plan Addendum addresses the following additional or revised components proposed for Phases VII and VIII of the Fly Ash Landfill at RMSGGS and described in the 2017 Minor Modification submittal:

- › Base Liner System, including Hydraulic Barrier Layer
- › Overliner System
- › Leachate Collection and Removal Systems (drainage layer and protective cover soil layers)
- › Leachate Storage Pond Liner System, and
- › Final Cover Systems.

The detailed CQA requirements for each subcomponent of these systems is provided in the following sections of this addendum.

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## 2 CQA OF LANDFILL COMPONENTS

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This section contains a general description of the subcomponents of the fly ash landfill liner and final cover systems which require a CQA oversight program and where the CQA procedures are addressed in the existing CQA Plan (Attachment 1) or this CQA Plan addendum. Any discrepancies between the requirements of the existing CQA Plan and this Addendum shall be governed by the requirements of this Addendum.

### 2.1 Base Liner System, including Hydraulic Barrier Layer

The base liner system will be constructed of the following subcomponents (from bottom to top):

- › Excavated and compacted subgrade (prepared subbase) (see section 4.2 of the existing CQA plan and section 3 of this addendum for CQA requirements)
- › A 60 Mil HDPE hydraulic barrier geomembrane (see section 4.5 of the existing CQA plan and section 6 of this addendum for CQA requirements)
- › A geocomposite pressure relief drainage layer (see section 7 of this addendum for additional CQA requirements)
- › A 6-inch foundation layer which is placed in conjunction with the Compacted Clay Liner (CCL) (see section 4.3 of this addendum for additional CQA requirements)
- › A 2-foot thick Compacted Clay Liner (CCL) (see section 4.3 of the existing CQA plan and section 4 of this addendum for additional CQA requirements)
- › A Geosynthetic Clay Liner (GCL) if selected for use as a replacement of one foot of compacted clay liner (see section 4.4 of the existing CQA plan and section 5 of this addendum for additional CQA requirements.
- › A 60 Mil textured HDPE upper or primary geomembrane (see section 4.5 of the existing CQA plan and section 6 of this addendum for CQA requirements)

The leachate storage pond liner system components will be the same as the base liner system components listed above and the CQA requirements will be identical.

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## 2.2 Overliner System

The overliner system will be constructed on existing Phase II, IV, and VI waste slopes (where applicable) using the following subcomponents (from bottom to top):

- › Graded and compacted subgrade (existing fly ash) (see section 4.2 of the existing CQA plan and section 3 of this addendum for CQA requirements)
- › A 2-foot thick Compacted Clay Liner (CCL) (see section 4.3 of the existing CQA plan and section 4 of this addendum for additional CQA requirements)
- › A Geosynthetic Clay Liner (GCL) if selected for use as a replacement of one foot of compacted clay liner (see section 4.4 of the existing CQA plan and section 5 of this addendum for additional CQA requirements.
- › A 60 Mil textured HDPE upper or primary geomembrane (see section 4.5 of the existing CQA plan and section 6 of this addendum for CQA requirements)

## 2.3 Leachate Collection and Removal Systems

The leachate collection and removal system will be constructed immediately above the base liner or overliner systems in Phases VII and VIII using the following subcomponents (from bottom to top):

- › Leachate collection piping and sumps (including collection gravel and geotextile) (see sections 7, 8, and 11 of this addendum for CQA requirements)
- › A 12 -inch thick screened bottom ash granular drainage layer will be placed over the entire base liner and overliner above the upper or primary geomembrane (see section 4.7 of the existing CQA plan and section 9 of this addendum for additional CQA requirements)
- › An 18-inch thick bottom ash protective cover layer will be placed over the entire base liner and overliner above the granular drainage layer (section 4.8 of the existing CQA plan will be replaced in its entirety by section 10 of this addendum)

## 2.4 Final Cover System

The final cover system will be constructed on the completed Phase VI, VII and Phase VIII waste slopes (where applicable) using the following subcomponents (from bottom to top):

- 
- › Graded and compacted subgrade (existing fly ash) (see section 4.2 of the existing CQA plan and section 3 of this addendum for CQA requirements)
  - › A 1-foot thick Compacted Clay Liner (CCL) (see section 4.3 of the existing CQA plan and section 4 of this addendum for additional CQA requirements)
  - › A Geosynthetic Clay Liner (GCL) if selected for use as a replacement of the 1-foot thick compacted clay liner (see section 4.4 of the existing CQA plan and section 5 of this addendum for additional CQA requirements).
  - › A 40 Mil textured LLDPE geomembrane (see section 4.6 of the existing CQA plan and section 6 of this addendum for CQA requirements)
  - › Drainage layer collection piping and outlet pipes (including collection gravel and geotextile) (see sections 7, 8, and 11 of this addendum for CQA requirements)
  - › A 12 -inch thick sand granular drainage layer will be placed over the entire final cover geomembrane (see section 9 of this addendum for additional CQA requirements)
  - › An 18-inch thick soil protective cover layer will be placed over the entire final cover surface above the granular drainage layer (Section 4.8 of the existing original CQA plan will be replaced in its entirety with section 10 of this addendum)
  - › A 6 -inch thick vegetative soil layer will be placed over the entire final cover surface to establish vegetation (see section 12 of this addendum for additional CQA requirements)

## **2.5 Modifications to the Existing CQA Plan**

The following items are modifications and/or deletions to the existing CQA plan in addition to the other requirements of this Addendum.

- › Section 4.8 of the existing CQA Plan will be replaced in its entirety by Section 10 of this Addendum.
- › The protective soil layer testing methods and frequencies listed in Attachment A of the existing CQA Plan will be replaced by the testing methods and frequencies listed in Section 10 of this Addendum.

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- › The testing frequency for grain size, Atterberg Limits and water content of off-site clay borrow source listed in Attachment A of the existing CQA Plan shall be changed from one for every 1,000 cubic yards to one per 5,000 cubic yards as outlined in Section 4 of this Addendum.
  - › The crushed rock requirements listed in Attachment A in the existing CQA Plan is for access road construction only and shall not be utilized in the liner or final cover system construction or placed directly on a geomembrane.

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## 3 GENERAL EARTHFILL (SUBGRADE PREPARATION)

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### 3.1 Construction Materials

General earthfill (also known as structural fill) consists of granular and/or cohesive materials which are used for the purpose of earthfill construction (construction of subgrades). The soil used in the construction of general earthfill shall be relatively free of organics, debris or other deleterious material. **The compaction requirements (without soil classification testing) also apply to fly ash or bottom ash subbase surfaces for the overliner and final cover.**

### 3.2 Construction Placement and Testing

The CQA Consultant shall perform the following:

1. For every general earthfill material type, or when visual observations indicate that a change has occurred in the borrow soils, obtain a soil sample and perform the following tests:
  - › moisture-density relationship test using Modified Proctor (ASTM D 1557);
  - › Atterberg Limits, ASTM D 4318;
  - › Grain Size Analysis by sieve and hydrometer, ASTM D 422;
  - › Unified Soil Classification, ASTM D 2487;
2. Monitor and document the placement and compaction of the soils used for general earthfilling.
3. Determine the in-place moisture content and dry density of the general earthfill by nuclear methods following ASTM D 2922, latest edition. In place tests shall be performed at a minimum frequency of one test per acre per lift to verify compliance with the requirements of item (4) below.
4. Verify that general earthfill is compacted to at least 90% of the maximum dry density determined by the Standard Proctor (ASTM D 698).
5. Perform photographic documentation of construction to confirm conformance to project requirements.
6. Prepare a certification report that documents the observations and testing of the construction of the general earthfill materials.

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The Earthwork Contractor shall perform all of the following during construction of general earthfill:

1. Place and compact each lift with a general thickness of 9 inches after compaction.
2. Compact each soil lift thoroughly and uniformly to the required density.
3. Protect the general earthfill from detrimental climatic effects during construction by doing all of the following:
  - › remove all ice, snow, and frozen soil during winter construction prior to placing a lift and not using any frozen soil in any part of the compacted soil liner system;
  - › recompact any soil lift of which its integrity is so adversely affected by weather that it no longer meets the requirements of the project specifications and CQA/CQC plan, at the discretion of the Owner, Certifying Engineer, and/or IDEM;
  - › cover to prevent frost penetration during and following placement during winter construction;
  - › remove observed roots, rocks, rubbish or off-specification soils.



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## 4 COMPACTED CLAY LINERS

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Any discrepancies between the requirements of the original CQA Plan and this Addendum shall be governed by the requirements of this Addendum.

### 4.1 Construction Materials

The soil used in the construction of the compacted clay liner (CCL) shall meet the following requirements:

1. The compacted soil liner shall exhibit a laboratory hydraulic conductivity that is equal to or less than  $1 \times 10^{-7}$  cm/sec for the cell liner, leachate pond liner, and final cover systems within the density and moisture content range specified for the construction as determined by the laboratory study of the moisture, density and hydraulic conductivity relationship as described in 4.2 (1) below.

### 4.2 Preconstruction Testing

The CQA Consultant shall perform the following:

1. Establish a relationship between moisture content, dry density and hydraulic conductivity by laboratory testing of potential soil borrow prior to placement of the soil. A moisture density relation of the soil by ASTM D 698 (Standard Proctor) shall be performed on a representative sample of the borrow source. The sample shall be tested to determine its classification according to ASTM D 2487. Specimens of this sample shall be tested for hydraulic conductivity using the procedures as described in item (4) below. The test specimens shall be prepared at appropriate moisture contents and dry densities to establish a range of values which yield hydraulic conductivities by ASTM D 5084 no greater than  $1 \times 10^{-7}$  cm/sec.
2. Verify that a test pad has been constructed and tested prior to construction of the full scale compacted soil liner. The test pad must be used to verify that the specifications outlined in the approved construction plan, including density, moisture content and hydraulic conductivity can be achieved in the field. Once a test pad has been constructed and shown to meet the requirements of 329 IAC 10-17-5, a new test pad is not required for each cell or closure construction project unless:
  - › A new borrow source is proposed for the project;

- 
- › The dry unit weight of the soil changes by at least five pounds per cubic foot based on a moisture density curve established by a standard or modified Proctor test;
  - › Construction equipment is changed, or;
  - › Construction practices are changed.

The test pad requirements may be waived by the commissioner if the compacted soil liner material meets the following requirements:

- › is of a unified soil classification of ML, CL, MH, CH, or OH;
  - › contains a minimum of fifty percent (50%), by weight, of material that can pass through the number 200 sieve;
  - › consists of a minimum of twenty-five percent (25%), by weight, of clay content, which is defined to mean soil particles that are less than or equal to five-thousandths (0.005) millimeter in diameter;
  - › has a liquid limit (LL) of at least twenty-five (25); and
  - › has a plasticity index (PI) of at least ten (10).
3. Before construction, prior to soil compaction, at a frequency of every 5,000 cubic yards or change in soil material, the soil liner material must be sampled and tested as follows:
- › Moisture-density relationship test using Standard Proctor (ASTM D 698) method;
  - › Atterberg Limits, ASTM D 4318;
  - › Grain Size Analysis by, ASTM D 422;
  - › Unified Soil Classification, ASTM D 2487;
4. Before construction, prior to soil compaction, at a frequency of every 10,000 cubic yards or change in soil material, obtain a sample of soil liner material and perform remolded hydraulic conductivity testing using ASTM D 5084.

### **4.3 Construction Placement and Testing**

The CQA Consultant shall perform the following:

- 
1. Monitor and document the placement and compaction of the soils used in the compacted clay liner systems. All of the following information shall be documented with respect to soil compaction:
    - › the type and weight of compaction equipment;
    - › the method of surface preparation;
    - › the method of adjusting soil moisture, if any;
    - › the method of controlling desiccation;
    - › the thickness of each lift after compaction;
    - › general observations of the number of passes and uniformity of compaction coverage;
    - › observation of the reduction in clod size;
    - › documentation of liner repairs, including removal and replacement of frozen or desiccated soils.
  2. During construction, after the soil liner has been compacted, at a frequency of five tests per acre per lift, determine the in-place moisture content and dry density of the compacted clay liner by nuclear methods following ASTM D 2922, latest edition, to verify compliance with the requirements of item (1) above.
  3. During construction, after the compacted clay liner has been compacted, at a frequency of one test per 5,000 cubic yards, obtain a sample of compacted soil and perform a moisture-density relationship test using Standard Proctor (ASTM D 698) method.
  4. During construction, after the compacted clay liner has been compacted, at a frequency of one test per acre per lift, obtain an undisturbed sample of compacted soil and perform the following tests:
    - › Hydraulic Conductivity, ASTM D 5084;
    - › Atterberg Limits, ASTM D 4318;
    - › Grain Size Analysis, ASTM D 422;
    - › Unified Soil Classification, ASTM D 2487;

The Earthwork Contractor shall perform all of the following during construction of the compacted clay soil liner system:

- 
1. Place and compact each lift with a general thickness of 6 to 9 inches after compaction.
  2. **The initial loose lift thickness for soil placed above the hydraulic barrier geomembrane must be 14 to 18 inches compacted to a final thickness of no less than 12 inches. The first 6 inch layer of soil above the geomembrane shall not be directly compacted so to avoid damage to the geomembrane from compaction equipment.**
  3. Compact each soil lift thoroughly and uniformly to the density, and at the moisture content determined necessary to achieve the required hydraulic conductivity as described in item 4.2 (1).
  4. Integrate each lift into the previous lift by techniques such as scarifying each lift and by using compaction equipment that is capable of penetrating the thickness of each compacted lift, except such a compactor shall not be used in any lift immediately above a synthetic material or other sensitive liner system component.
  5. Protect the compacted soil liner from detrimental climatic effects during construction by doing all of the following:
    - › remove all ice, snow, and frozen soil during winter construction prior to placing a lift and not using any frozen soil in any part of the compacted soil liner system;
    - › recompact any soil lift of which its integrity is so adversely affected by weather that it no longer meets the requirements of the CQA plan, at the discretion of the Owner and Certifying Engineer;
    - › cover to prevent frost penetration during and following placement of the soil layer during winter construction;
    - › provide measures to ensure that the compacted soil liner is protected from desiccation by covering the soil liner or by sprinkling the soil liner with water. Any compacted soil liner that has experienced significant desiccation cracking is to be repaired;
    - › remove observed debris, roots and any angular or sharp rocks larger than two inches in diameter.

The Surveyor will perform the following:

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1. Survey the compacted soil liner system as directed by the Owner to verify that the system meets the approved construction plans and specifications. The Surveyor will establish a 100-foot survey grid system on the landfill cell base and survey locations along the cell perimeter to verify proper line and grade in accordance with the approved construction plans.

#### **4.4 Compacted Clay (Soil) Preparation for Geomembrane Installation**

The CQA Consultant shall perform the following:

1. Inspect the subgrade surface for compliance with the requirements of this CQA plan noted below.
2. Identify areas that do not meet the requirements of the CQA plan and need repair; the CQA Consultant will monitor and document the repairs made to the subgrade.

The Contractor shall perform the following:

1. Prepare the subgrade to a smooth surface, using a smooth drum roller, with grades which meet the approved construction plans with a tolerance of 0.0 to +0.2 feet.
2. Remove debris, organic materials, roots, any angular or sharp rocks larger than two inches in diameter or other material which may damage the geomembrane liner material.
3. Repair any compacted soil liner which exhibits significant desiccation cracking as directed by the Project Engineer. All backfill soils used to repair any areas of the low permeability soil liner system shall meet the applicable requirements of the CQA plan.
4. Protect the prepared subgrade from damage due to desiccation, flooding and freezing.

The Geomembrane Contractor/Installer shall perform the following:

1. Inspect the subgrade surface.
2. Accept in writing that the subgrade surface is acceptable for geomembrane installation prior to deployment of the geomembrane material.

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## 4.5 Test Pads

Prior to placement of the soil liner, a soil liner test pad shall be constructed each time the all the conditions of Section 4.2.2 are met. The purpose of the test pad is to demonstrate that the characteristics of the specified liner materials will meet or exceed the hydraulic conductivity, moisture content, and density requirements under proposed construction conditions. During construction of the test pad, the CQA technician will observe the following to ensure that the methods used during test pad construction are consistent with construction of the actual soil liner:

1. Use of same compaction equipment as used in test pad.
2. Use of same procedures, such as number of passes and speed.
3. Lift thickness does not exceed 9 inches after compaction and total thickness of the test pad is 3 feet.

### 4.5.1 Material Properties

1. The test pad shall be constructed of the same soil to be used for the proposed full scale liner construction.
2. The soil used for the test pad shall be either an SC or CL as defined by the Unified Soil Classification System. The CQA technician will obtain sufficient soil samples from the borrow area to perform pre-construction soil testing.
3. The soil used for the test pad shall possess the same hydraulic conductivity requirements as the full-scale compacted earth liner (minimum of  $1.0 \times 10^{-7}$  cm/sec). The CQA technician will obtain sufficient soil samples from the borrow area to perform pre-construction soil testing.
4. The soil used for the test pad shall possess the following properties:
  - › Minimum of 60% of the particles passing the #40 sieve as tested according to ASTM D422;
  - › Minimum of 30% of the particles passing the #200 sieve as tested according to ASTM D422;
  - › Minimum liquid limit (LL) of 15 and a minimum plasticity index (PI) of 2 as tested according to ASTM D4318.

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5. The soil used for the test pad shall be free of debris, ice, snow, roots or other organic material which may yield unsatisfactory results.
  6. The test liner shall be tested in the field to determine hydraulic conductivity using five (5) Boutwell Permeameters in addition to a Temperature Effect Gauge consistent with procedures set forth in ASTM D6391.
  7. Three Shelby Tube samples shall also be collected and transported to the laboratory to determine hydraulic conductivity. Shelby tubes will be tested to determine moisture content (ASTM D2216), dry density (ASTM D2937), Atterberg Limits (ASTM D4318), grain size (ASTM D422), and undisturbed hydraulic conductivity (ASTM D5084). The laboratory results shall be evaluated to determine if there is a statistical correlation to the field testing results.
  8. If a new borrow source is designated for the liner or a change in equipment or procedure occurs, additional test pads must be constructed and tested to verify compliance with the CQA Plan.

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## 5 GEOSYNTHETIC CLAY LINER

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The proposed design for Phase VII and VIII includes the optional installation of a geosynthetic clay liner (GCL) as indicated in the proposed permit plans to replace 12 inches of compacted clay soil. If a GCL is used as a component of the base liner, overliner, or final cover system, the following CQA requirements will apply.

Any discrepancies between the requirements of the original CQA Plan and this Addendum shall be governed by the requirements of this Addendum.

### 5.1 Materials

The GCL shall be manufactured using high quality bentonite clay which contains at least 80 percent (80%) of high swelling montmorillonite.

The GCL Manufacturer shall submit copies of the GCL roll Quality Control Certificates. These certificates shall be supplied at a minimum frequency of one (1) per every one hundred thousand (100,000) square feet of GCL material produced and supplied to the project. These certificates shall, at a minimum, include: bentonite clay loading (mass per unit area), and peel strength. Additionally, these certificates shall include the results of hydraulic conductivity testing performed at a minimum frequency of one (1) per lot. The results reported on the GCL roll Quality Control Certificates shall, at a minimum, meet the property values detailed in Table 5.1. The GCL Manufacturer shall submit a signed statement that the material supplied, at a minimum, meets these specifications.



**Table 5.1**  
**Geosynthetic Clay Liner(GCL)**  
**Roll Material Properties**

Property	Test Method	Requirements
Fluid Loss	ASTM D 5891	18 mL maximum
Moisture Content <sup>(1)(2)</sup>	ASTM D 4643	12% maximum
Grab Strength (geotextile)	ASTM D 4632	88 lb. minimum
Peel Strength	ASTM D 4632	15 lb. minimum
Mass per Unit Area <sup>(3)</sup>	ASTM D 5993	0.75 lb./ft <sup>2</sup> minimum
Hydraulic Conductivity <sup>(4)</sup>	ASTM D 5054	5.0 x 10 <sup>-9</sup> cm/sec maximum
NOTE:		
1	The moisture content shall be that of the bentonite clay in the GCL product	
2	The moisture content is to be reported as the weight of water divided by the wet weight of bentonite clay sample.	
3	The bentonite clay loading (mass/unit area) shall be determined at a moisture content of 0%.	
4	The hydraulic conductivity shall be specified by the Design Engineer, and measured at an effective confining stress of 5 psi.	

The CQA Consultant shall review the submittals provided by the GCL Manufacturer to verify compliance with the requirements of the CQA/CQC plan.

## 5.2 Geosynthetic Contractor Submittals

The Geosynthetic Contractor shall submit a schedule of GCL installation to the Owner with the following information prior to the start of the GCL installation:

The CQA Consultant shall verify that all submittals required of the Geosynthetic Contractor have been received and meet the requirements of the CQA/CQC plan. The schedule and drawings submitted by the Geosynthetic Contractor, once approved by the CQA Consultant, shall be the basis of the GCL deployment.

## 5.3 GCL Delivery and Storage

The Geosynthetic Contractor shall perform the following:

1. Prepare the GCL roll storage area to protect the GCL from dirt, mud, dust, moisture, and damage at all times prior to deployment. The GCL rolls shall be protected against vandalism, adverse weather and other hazards. The rolls should be stored to allow access for roll identification. The integrity and

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legibility of roll labels must be maintained during storage. The rolls must be protected from the elements by the application and maintenance of a proper cover.

2. Instruct all personnel of the proper handling techniques so as not to damage any of the GCL rolls.
3. Be responsible for off-loading the GCL rolls when delivered to the job-site.
4. Assure that the GCL rolls are packaged, shipped, and stored on-site in such a manner that the GCL rolls are not subjected to damage or moisture.
5. Identify and separate all damaged rolls from undamaged rolls and store these rolls at a location designated by the Owner until disposition of the damaged rolls is determined.
6. Store the GCL rolls per the GCL Manufacturer's recommendations.

The CQA Consultant shall perform the following:

1. Inspect the GCL roll storage area to verify compliance with the CQA/CQC plan.
2. Visually inspect the surface of all GCL rolls for visible defects and/or damage. Compare the roll number against the GCL Manufacturer's QC Certifications for compliance with the project's approved construction plans and specifications and the CQA/CQC plan. Any damage detected shall be documented and the Geosynthetic Contractor will be notified.

## **5.4 GCL Installation**

The GCL can be deployed on the soil subgrade which has been inspected and accepted by the CQA Consultant and the Geosynthetic Contractor.

### *5.4.1 Weather Conditions*

The Geosynthetic Contractor shall not deploy the GCL material during precipitation events or on areas with frost or precipitation accumulation. The GCL material shall not be deployed on softened or unstable subgrade.

### *5.4.2 Placement*

GCL panels shall be placed in a controlled manner to prevent damage to the GCL materials or other in-place material. Any such damage shall be repaired by the Geosynthetic Contractor.

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Personnel working on the GCL shall not smoke, wear damaging shoes, or engage in other activities which could damage the material. Traffic on the GCL panels shall be minimized. No general vehicular traffic is allowed on the GCL material. Low ground pressure 4x4 ATV or similar vehicles may be allowed on the GCL upon the approval of the CQA Consultant. The Geosynthetic Contractor shall provide protection of the GCL from equipment or concentrated personnel traffic associated with the project.

GCL panels shall be deployed in such a manner as to be in contact with the material directly beneath it and preclude folds, wrinkles which may become folds, and bridging. Any wrinkle, fold or bridging that is observed shall be removed through realignment of the GCL panel or cutting and repairing the panel in accordance with the CQA/CQC plan.

Each adjoining GCL panel shall be overlapped a minimum of six (6) inches on each side and a minimum end-to-end overlap of twelve (12) inches, or greater if required by the Geosynthetic Contractor's Installation Quality Control Procedures. The minimum overlap shall be indicated by a line, or series of lines spaced no more than fifty (50) feet on the exposed surface of the GCL panel. The overlap area shall be free of dirt, gravel, and debris. The overlap shall be maintained to prevent seam openings during the installation and covering process. The Geosynthetic Contractor is responsible for assuring that the GCL panels remain overlapped throughout the installation process and until the overlying material is placed. Bentonite clay powder or other approved supplement shall be applied between the GCL layers in the overlap area as required by the GCL Manufacturer's specifications and the Geosynthetic Contractor's Installation Quality Control Procedures.

Orient GCL seams on sideslopes greater than 5% parallel to the fall of the slope, unless approved by the Design Engineer.

Placement of the GCL shall be in such a manner as to reduce the risk of water infiltration into the bentonite clay portion of the GCL. The GCL shall be covered with geomembrane and/or soil materials as required by the project design, as soon as practical, to provide maximum protection against the elements. The Geosynthetic Contractor shall direct stormwater drainage away from the GCL by construction of temporary stormwater diversion berms, or other similar structures.

The GCL shall not come into contact with water or any other fluids which may cause hydration of the bentonite clay of the GCL. Premature hydration of the bentonite clay component of the GCL shall be cause for removal of the hydrated material at no

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expense to the Owner. Prematurely hydrated material includes material hydrated beneath a geomembrane prior to seaming.

The Geosynthetic Contractor shall not install more GCL panels than can reasonably be covered with geomembrane that same day. The Geosynthetic Contractor shall also limit the installation of GCL panels during periods of impending bad weather such that the amount of uncovered GCL panels is minimized.

The Geosynthetic Contractor shall clean the work area daily by removing scrap material and other debris associated with the Geosynthetic activities and disposing of it properly.

The CQA Consultant shall observe and document the GCL deployment to verify that all provisions of the CQA/CQC plan have been followed.

#### *5.4.3 Temporary Anchoring*

The Geosynthetic Contractor is responsible for the temporary anchoring of the GCL during construction. The Geosynthetic Contractor shall use sand bags or other means necessary to restrain the GCL without damage and to prevent the material from being pulled from proper alignment. Areas of damage caused by improper or insufficient temporary anchoring shall, as determined by the CQA Consultant and required by the Owner, be repaired or removed, disposed and replaced at the expense of the Geosynthetic Contractor. Scrap tires are not considered an acceptable method for temporary anchoring of GCL.

#### *5.4.4 Permanent Anchoring*

The Geosynthetic Contractor is responsible for the permanent anchoring of the GCL material. Permanent anchorage shall comply with the approved construction plans and specifications, and shall be installed as soon as practicable following repairs and testing of the GCL material and the installation of the overlying materials.

#### *5.4.5 Repairs*

Holes, tears or damage to the GCL material shall be repaired by placing a patch extending a minimum of one (1) foot in all directions beyond the edges of the defect. Bentonite clay powder or other supplement shall be applied between the GCL panel and the patch if required by the GCL Manufacturer's specifications and the Geosynthetic Contractor's Installation Quality Control Procedures. Patches and repairs shall not be

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allowed on slopes greater than 10%. Damaged GCL panels on slopes greater than 10% shall be replaced.

GCL panels with holes or tears extending more than 25% across the panel width shall be removed and replaced or covered by a single patch. GCL panels, or portions of panels, which contain excessive patching, as determined by the Owner, shall be removed and replaced, or repaired with a single patch.

The CQA Consultant shall verify and document that GCL repairs are performed as required by the CQA/CQC plan.

## **5.5 Geomembrane Placement**

The placement of geomembrane on the GCL shall be discussed and agreed upon by the appropriate parties in attendance at a Construction Meeting. The cover material shall be placed the same day that the GCL is installed. Therefore, only the amount of GCL which can be covered the same day shall be deployed. Equipment shall not be operated directly on the GCL. The placement of cover material shall be performed so as not to induce excessive stresses or slippage of the GCL.

## **5.6 GCL Acceptance**

The Geosynthetic Contractor shall retain ownership and responsibility of the GCL until acceptance by the Owner. The Owner will accept the Geosynthetic when:

1. All required documentation from the GCL Manufacturer and the Installation Contractor has been received and accepted.
2. The geosynthetic installation is complete; and the GCL material is intact and is not in a hydrated condition.
3. Verification that all repairs are complete.
4. The geosynthetic installation has been accepted in a final approval notice signed by the CQA Consultant and the Owner.

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## 6 LLDPE AND HDPE GEOMEMBRANE

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The proposed design includes the installation of a linear low density polyethylene (LLDPE) and/or a high density polyethylene (HDPE) geomembrane liner as indicated in the approved construction plans and specifications for the landfill cover and base liner. This section of the CQA plan addendum addresses only polyethylene geomembrane materials for use for the landfill liner and/or the final cover. These requirements are intended to supplement Section 4.5 and 4.6 of the original CQA plan (Attachment 1). In the event there is a conflict between the two plans, the requirements of this addendum will be followed.

### 6.1 Materials

#### 6.1.1 Resin

The geomembrane manufacturer shall provide the following information prior to delivery of the geomembrane to the jobsite:

1. The resin supplier's name, resin production facility, resin identification, and production date of the resin.
2. A copy of the quality control certificates issued by the resin supplier.
3. Results of tests conducted by the supplier to verify the raw material quality including specific gravity, carbon black content and melt flow index.
4. A certification from the supplier that the polymer used in the geomembrane meets the following criteria of Table 6.1:

**Table 6.1**  
**Geomembrane Resin Requirements**

Property	Test Method	Requirement	
Specific Gravity <sup>(1)</sup> (g/mL)	ASTM D 792 or D 1505	HDPE (min.)	LLDPE
		0.932	0.915-0.926
Carbon Black	ASTM D 1603 or D 4218	between 2.0% and 3.0%	

NOTE:

1 Values are to be determined prior to the addition of carbon black.

5. Reports of tests that are conducted by the manufacturer to verify the quality of the raw materials including specific gravity and melt flow index. These tests shall be performed at a frequency of at least one per resin batch but not less than once per 180,000 pounds of resin used in the manufacturing of the geomembrane.
6. A certification that reclaimed polymer is not added to the resin and that polymer recycled during the manufacturing process does not exceed 2% of the resin.

The CQA Consultant shall review the submittals provided by the manufacturer to verify compliance with the requirements of the approved construction plan including this CQA/CQC plan.

#### 6.1.2 Geomembrane

The geomembrane manufacturer shall perform the following:

1. Provide a certification that the geomembrane manufactured for this project meets the following criteria:
  - a) The geomembrane contains no more than 1% by weight of additives, fillers, or extenders, excluding carbon black;
  - b) The geomembrane was continuously inspected during the manufacturing process for striations, roughness other than produced due to texturing, pinholes, blisters, surface bubbles, thin spots, cracks, damage, undispersed raw materials, or any other indication of contamination;
  - c) The delivered HDPE geomembrane sheets for construction of landfill base liner, leachate pond liner, and overliner must conform to the following minimum properties (Table 6.2) **or the appropriate latest revisions to Geosynthetic Research Institute Test Method GRI-GM13.**

**Table 6.2**  
**Textured High Density Polyethylene (HDPE) Minimum Properties**

Property	Test Method	Value	Units
1. Thickness (min. avg.) lowest ind for 8 of 10 values lowest ind for any 10 values	ASTM D 5994	60 (-5%) -10% -15% <sup>1)</sup>	mils
2. Asperity Height (min. avg.) <sup>(1)</sup>	ASTM D 7466	16	mils
3. Density (min. avg.)	ASTM D 1505/D792	0.940	g/cm <sup>3</sup>
4. Tensile Properties (min. avg.) <sup>(2)</sup> a. Yield Strength b. Break Strength c. Elongation at Yield d. Elongation at Break	ASTM D 6693 Type IV	126 90 12 100	lb./in Width lb./in Width % %
5. Tear Resistance (min.)	ASTM D 1004 Die C	42	lb.
6. Environmental Stress Crack	ASTM D 5397	500	hours
7. Puncture Resistance	ASTM D 4833	90	lb.
8. Carbon Black Content Allowable Range	ASTM D 4218	2-3	%
9. Carbon Black Dispersion Acceptable Levels	ASTM D 5596	See Note 3	
10. Oxidative Induction Time (OIT) (min. avg.) Standard High Pressure	ASTM D3895 ASTM D5885	100 400	min. min.
11. Oven Aging at 85°C Standard OIT (min. avg.), or High Pressure OIT (min. avg.)	ASTM D 5721 ASTM D 3895 ASTM D 5885	55 80	% %
12. Ultraviolet Resistance at High Pressure OIT	ASTM D5885	50	%
<p><b>NOTE:</b></p> <p>1 Of 10 readings, 8 out of 10 must be greater than/equal to 7 mils, and the lowest individual reading must be greater than/equal to 5 mils.</p> <p>2 Machine Direction (MD) and cross-machine direction (XD) average values should be on the basis of 5 test specimens each direction. Yield elongation calculated using a gage length of 33 mm. Break elongation calculated using a gauge length of 50 mm.</p> <p>3 Carbon black dispersion of 10 views: minimum 8 of 10 in Category 1 or 2, all 10 in Categories 1, 2, or 3.</p>			



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d) The delivered LLDPE geomembrane sheets for construction of landfill final cover must conform to the following minimum properties (Table 6.3) or the latest revisions to Geosynthetic Research Institute Test Method GRI-GM17:

**Table 6.3**  
**Linear Low Density Polyethylene (LLDPE) Minimum Properties (Final Cover Applications)**

Property	Test Method	Value	Units
1. Thickness (min. avg.) lowest ind for 8 of 10 values lowest ind for any of the 10	ASTM D 5994	40 (-5%) -10% -15%	mils
2. Asperity Height (min. avg.) <sup>(1)</sup>	ASTM D 7466	16	mils
3. Density (max. avg.)	ASTM D 1505/D 792	0.939	g/cm <sup>3</sup>
4. Tensile Properties (min. avg.) <sup>(2)</sup> a. Break Strength b. Elongation at Break	ASTM D 6693	60 250	lb./in Width %
5. Tear Resistance (min.)	ASTM D 1004 Die C	22	lb.
6. Puncture Resistance	ASTM D 4833	44	lb.
7. Axi-Symmetric Break Resistance Strain (min.)	ASTM D 5617	30	%
8. Carbon Black Content Allowable Range	ASTM D 4218	2-3	%
9. Carbon Black Dispersion Acceptable Levels	ASTM D 5596	See Note 3	
10. Oxidative Induction Time (OIT) (min. avg.) Standard High Pressure	ASTM D 3895 ASTM D 5885	100 400	min. min.
11. Oven Aging at 85°C Standard OIT (min. avg.), or High Pressure OIT (min. Avg.)	ASTM D 5721 ASTM D 3895 ASTM D 5885	35 60	% %
12. Ultraviolet Resistance at High Pressure OIT	ASTM D 5885	35	%
NOTE: 1 Of 10 readings, 8 out of 10 must be greater than/equal to 7 mils, and the lowest individual reading must be greater than/equal to 5 mils. 2 Machine Direction (MD) and cross-machine direction (XD) average values should be on the basis of 5 test specimens each direction. Yield elongation calculated using a gage length of 33 mm. Break elongation calculated using a gauge length of 50 mm. 3 Carbon black dispersion for 10 views: minimum 9 of 10 in Category 1 or 2, all 10 in Categories 1, 2, or 3.			

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2. Provide a copy of the manufacturer's geomembrane properties and quality control requirements, and instructions for geomembrane delivery, storage and handling.
  3. Provide Quality Control certificates for the rolls of geomembrane to be delivered to the job site. Each QC certificate shall include:
    - a) Roll number, geomembrane type, thickness, manufacturer, date of production, and roll dimensions. Each finished roll shall be identified by a number corresponding to the particular batch of resin used.
    - b) The manufacturer's test results on samples from rolls of geomembrane from the same production lot, which verifies that the rolls meet the requirements of this CQA/CQC plan. These samples shall be tested to confirm that the requirements of the CQA/CQC plan are met. The test data shall be identified by roll number.
  4. The manufacturer is responsible for the production of extrusion beads and/or welding rod from polyethylene resin which shall meet the requirements of the approved construction plans and this CQA/CQC plan.

The CQA Consultant shall verify that the manufacturer's submittals meet the requirements of the CQA/CQC plan.

## **6.2 Geosynthetics Contractor Submittals**

The Geosynthetics Contractor shall submit to the Owner the following information prior to the start of geomembrane installation:

1. Schedule of geomembrane installation.
2. Panel layout drawings.
3. Drawings of construction details for anchor trenches, sumps and other features as required by the CQA Contractor.
4. A resume for the Master Seamer to be assigned to the project. A Master Seamer must be present on-site during all geomembrane seaming operations and shall have completed seaming on at least 1,000,000 square feet of polyethylene geomembrane, using both extrusion and fusion welding methods.
5. A resume for each Seamer to be assigned to the project. Each Seamer shall have seamed a minimum of 100,000 square feet of polyethylene geomembrane.

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6. Resumes of any Seamers subsequently assigned to the project shall also be submitted. Seamer apprentices or assistants do not need the requisite experience as long as they are working under the direct supervision of a qualified Seamer.

The CQA Consultant shall verify that all submittals required of the Geosynthetics Contractor have been received and meet the requirements of the approved construction plans and this CQA/CQC plan. The schedule and drawings submitted by the Geosynthetics Contractor, once approved by the CQA Consultant, shall be the basis of geomembrane deployment.

### **6.3 Quality Assurance Testing**

Prior to geomembrane deployment, the CQA Consultant shall verify that geomembrane samples are obtained and tested at the rate of either once per lot or once per fifty thousand (50,000) square feet for the following:

1. Tensile characteristics test for strength and elongation at yield and at break;
2. Carbon black content test; and
3. Carbon black dispersion test.

The CQA Consultant shall verify that the quality assurance test results meet the requirements of Tables 6.2, and 6.3.

### **6.4 Geomembrane Delivery and Storage**

The Geosynthetics Contractor shall perform the following:

1. Assure that the geomembrane rolls or panels are packaged, shipped, off-loaded, and stored on-site in such a manner that the rolls are not subjected to damage.
2. Prepare the roll storage area to protect the geomembrane from dirt, mud, dust, and damage at all times prior to deployment. The geomembrane shall be protected against vandalism, adverse weather and other hazards.
3. Instruct all personnel of the proper handling techniques so as not to damage any of the geomembrane rolls.
4. Assure that the geomembrane material is not folded; folded geomembrane material shall be rejected.
5. Stack the geomembrane rolls per the manufacturer's recommendations, but no more than five rolls high.

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6. Identify and separate all damaged rolls from undamaged rolls and store these rolls at a location designated by the Owner until the disposition of the damaged rolls is determined.

The CQA Consultant shall perform the following:

1. Inspect the geomembrane roll storage area to verify compliance with the CQA/CQC plan.
2. Observe the material off-loading and storage of geomembrane rolls to verify compliance with the requirements of the CQA/CQC plan.
3. Visually inspect the surface of all geomembrane rolls for visible defects and/or damage. Any damage detected shall be documented.

## **6.5 Geomembrane Installation**

### *6.5.1 Anchor Trench*

The CQA Consultant shall verify that the anchor trench has been constructed according to the requirements of the approved construction plans and this CQA/CQC plan. The CQA Consultant shall observe and document the placement of the geomembrane in the anchor trench and the placement of the anchor trench backfill material as required by the approved construction plans and specifications and this CQA/CQC plan. The anchor trench shall not be backfilled until the destructive and non-destructive testing of the seams to be buried has met specifications.

The Geosynthetics Contractor shall perform the following:

1. Anchor trenches shall be constructed and maintained to the nominal dimensions shown on the approved construction plans and specifications, and with rounded edges.
2. Provide for adequate drainage of the anchor trench.
3. Backfill the anchor trench according to the approved construction plans and specifications and this CQA/CQC plan.

### *6.5.2 Weather Conditions*

The CQA Consultant shall verify and document that geomembrane seaming is performed only during weather conditions which are considered acceptable, as described by this CQA/CQC plan in the following sections.

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The Geosynthetics Contractor shall perform the following:

1. Unless otherwise approved by the Engineer, IDEM, or allowed by the Manufacturer's recommendations, not weld during precipitation events, in the presence of excess moisture (i.e. heavy fog or dew, in an area of ponded water), during conditions of winds which affect the control of the welding temperatures (unless engineering controls are installed), or during periods when ambient temperatures are below 32° F. or above 120° F. or sheet temperatures are below 32° Fahrenheit or above 158° F.
2. Ensure that field seaming is not performed in adverse weather conditions that could impair the quality of the geomembrane installation, unless protective structures or other methods are used to maintain seam integrity during construction.

#### *6.5.3 Deployment Methods*

If requested by the Owner, the Geosynthetics Contractor shall install the geomembrane according to the panel layout drawings previously submitted to the Owner. The geomembrane shall be deployed in a manner so as to be in a loose and relaxed condition at the time of geomembrane seaming.

#### *6.5.4 Prevention of Damage*

The Geosynthetics Contractor shall be responsible to assure that:

1. Installation personnel do not use equipment or tools that may damage the geomembrane.
2. No installation personnel shall smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane.
3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.
4. The method used to deploy the geomembrane shall minimize wrinkles.
5. Bridging of grade changes by the geomembrane shall be removed as directed by, and at the discretion of the CQA Consultant.
6. Adequate loading (i.e. sandbags or similar items that will not damage the geomembrane) shall be placed on the geomembrane to prevent uplift and relocation of panels by wind.

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The CQA Consultant shall verify that all provisions for prevention of geomembrane damage have been followed during geomembrane deployment.

#### *6.5.5 Field Panel Identification and Deployment*

The Geosynthetics Contractor shall assign each field panel a unique identification number consistent with the panel layout drawings submitted to the Owner. The Geosynthetics Contractor shall deploy field panels according to the panel layout drawing. Each panel deployed shall be recorded by the Geosynthetics Contractor. Identification number, location and date shall be recorded.

The CQA Consultant shall verify that each panel is clearly identified. The CQA Consultant shall verify and document that the panel deployment proceeds according to the panel layout drawing, and that pertinent information is recorded.

#### *6.5.6 Geomembrane Panel Thickness Measurements*

Manufactured Geomembrane roll thickness measurements will be provided by the geomembrane manufacturer.

## **6.6 Seaming Specifications**

### *6.6.1 General Procedures*

The Geosynthetics Contractor shall perform the following:

1. Overlap (shingle) the geomembrane panels such that any fluid flowing across the seams would flow from the top panel to the underlying panel.
2. Orient all seams located on slopes steeper than 5% parallel to the fall of the slope, unless approved by the Design Engineer. Horizontal seams should be minimized. If horizontal seams are required due to the length of slope they shall be staggered by a slope distance of approximately 50 feet unless otherwise approved by the Design Engineer.
3. Clean the seam area such that the seam area is free of moisture, dust, dirt, debris and foreign matter of any kind prior to seaming.
4. Align seams with the least possible number of wrinkles and "fishmouths". "Fishmouths" are to be cut, removed and patched.

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5. Field seam only in weather conditions which will not impair the quality of the geomembrane liner, unless approved by the CQA Consultant.

The CQA Consultant will observe and document the geomembrane seaming activities to verify that the requirements of the CQA/CQC plan are met.

#### *6.6.2 Trial Welds*

The Geosynthetic Contractor shall perform the following:

1. Begin geomembrane seaming only after geomembrane equipment and Seamers have successfully completed trial welds.
2. Perform trial welds at: (1) at the beginning of each seaming period for each seaming crew; (2) at least once each four-hours of continuous seaming; 3) every time seaming equipment and/or personnel are changed, and 4) when significant changes in geomembrane temperature, as determined by the CQA Consultant, are observed
3. Perform trial welds in the same surroundings and environmental conditions as the productions welds.
4. The trial weld shall be a minimum of 10 feet long for self-propelled seaming devices, and a minimum of 3 feet for hand-held devices.
5. One inch (1") wide cutouts of the trial weld will be subject to shear and peel adhesion testing at the site. A minimum of three cutouts will be tested for shear, and an additional three cutouts will be tested for peel using a digital readout tensiometer and the testing procedures of ASTM D 4437.

A trial weld sample shall be considered passing, according to the following table (Table 6.5), for all specimens tested in peel and shear:



**Table 6.4  
Seam Sample Requirements**

Property		
	40 mill LLDPE	60 mil HDPE
	Textured	Textured
1. Shear Strength	60 lb/in	120 lb/in
2. Peel Adhesion - Fusion	50 lb/in	91 lb/in
3. Peel Adhesion - Extrusion	44 lb/in	78 lb/in

For trial welds, all specimens must meet the seam strength criteria with 0% incursion into the welded area.

A failed trial weld shall not be retested. The seaming equipment and the Seamer that produced the failed trial weld shall not be allowed to weld the project geomembrane until deficiencies or conditions are corrected and successful trial welds are achieved.

The CQA Consultant shall observe the trial weld preparation and testing, and verify that requirements of the CQA/CQC plan are met. The CQA Consultant will document trial welds, test results, and appropriate responses.

*6.6.3 Seaming and Testing Equipment*

The Geosynthetics Contractor shall perform the following:

1. Use extrusion welders and dual track fusion welders for field seaming. Extrusion welders shall be equipped with gauges to indicate the temperature in the welder and the pre-heat nozzle temperature.
2. Provide a field tensiometer for on-site shear and peel tests. This device shall meet the requirements for testing bonded seam strength (shear) and peel adhesion according to ASTM D 4437.
3. Provide air pressure/vacuum pump, air pressure measuring devices, and vacuum boxes with the capabilities for air pressure and vacuum box testing as required in the CQA/CQC plan.
4. Provide coupon die and press to produce weld coupons in the field for shear and peel testing.

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5. If portable gasoline-powered electric generators need to be used on the geomembrane liner, use a protective lining and splash pad large enough to collect spilled fuel under the generator.

#### 6.6.4 *Seam Preparation*

##### 6.6.4.1 Extrusion Welding

The Geosynthetics Contractor shall perform the following:

1. Overlap the geomembrane panels to be welded a minimum of three inches. Unless approved by the Engineer, extrusion welding will not be used for production seams.
2. Clean the geomembrane panel prior to seaming to assure that the area is clean and free of moisture, dirt, dust and debris.
3. Purge the extruder prior to beginning the seam to remove all heat degraded extrudate from the barrel.
4. Keep the welding rod clean and dry.

The CQA Consultant shall verify and document that geomembrane seam overlapping and preparation for extrusion welding is performed as required by the CQA/CQC plan.

##### 6.6.4.2 Fusion Welding

The Geosynthetic Contractor shall perform the following:

1. Overlap the geomembrane panels a minimum of four inches.
2. Clean the geomembrane seam area prior to seaming to assure that the area is clean and free from moisture, dirt, dust, and debris. No grinding is required for fusion geomembrane welding.
3. Use a protective, moveable layer ('rub sheet') directly below the overlap of geomembrane that is to be seamed, if required to prevent build-up of moisture between the panels.

The CQA Consultant shall verify and document that geomembrane overlapping and preparation for fusion seaming is performed as required by the CQA/CQC plan. All production seaming shall be performed by fusion welding processes.

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## 6.7 Non-Destructive Seam Testing

The Geosynthetic Contractor shall perform non-destructive tests on all field seams over their full length. Test equipment required for non-destructive testing shall be furnished and operated by the Geosynthetics Contractor. Where the seam cannot be non-destructively tested, as determined by the CQA Contractor, the Geosynthetics Contractor shall submit to the CQA Contractor an alternate testing method for approval.

The CQA Consultant shall observe and document the results of all non-destructive seam testing. The CQA Consultant shall verify that the test methods meet the requirements of the CQA/CQC plan, and document that all seams which fail non-destructive tests are repaired according to the CQA/CQC plan.

### 6.7.1 Air Pressure Testing

The Geosynthetics Contractor shall perform the following:

1. Conduct air pressure testing wherever determined feasible by the CQA Consultant on dual track fusion seams.
2. Use the following equipment for air pressure testing of dual track fusion seams:
  - a) an air pump or pressure tank equipped with a pressure gauge capable of generating and sustaining a minimum pressure of 27 psi and mounted on a cushion to protect the geomembrane. The air pump may be manual or motor driven.
  - b) a manometer or other pressure measuring device equipped with a sharp needle.
3. Use the following procedures when performing air pressure testing:
  - a) Seal both ends of the seam area to be tested.
  - b) Insert a manometer or other approved pressure gauge into both ends of the channel created by the dual track fusion welding. Means of pressurizing must be provided.
  - c) Energize the air pump to a minimum pressure of 27 psi, the valve shall be closed, and the pressure shall be sustained for five minutes. Long seams may require a stabilization period prior to the start of the testing period to account for pressure equalization and temperature fluctuations.

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- d) If there is a loss of pressure exceeding 3 psi for 60 mil HDPE material or 4 psi for 40 mil LLDPE material, or the pressure does not stabilize, the faulty area shall be located, repaired and retested.
  - e) Ensure that the air channel is not obstructed by releasing air from the end of the seam opposite the manometer and observe pressure drop.
  - f) Remove the manometer and seal the holes in accordance with Section 8.8 of this CQA/CQC plan.

### 6.7.2 Vacuum Box Testing

The Geosynthetics Contractor shall perform the following:

1. Perform vacuum box testing for all seams which cannot be air tested.
2. Use the following equipment for vacuum pressure testing:
  - a) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft gasket attached to the bottom, a valve assembly and a vacuum gauge.
  - b) A vacuum pump assembly equipped with a pressure controller and pipe connections.
  - c) Additional fittings and connections as needed to perform the tests.
3. Use the following procedure when performing the vacuum pressure testing:
  - a) Trim excess geomembrane sheet overlap, if any.
  - b) Apply a soapy solution to a length of the geomembrane approximately the length of the vacuum box.
  - c) Place the vacuum box over the wetted area and apply pressure to seal the box over the seam. Apply a minimum vacuum pressure of five psig to the interior of the box.
  - d) For a period of approximately 10 seconds, examine the geomembrane seam through the viewing window for the indication of soap bubbles.
  - e) If no bubbles appear, release the vacuum and move the vacuum box to the next area of the seam, with a minimum three inch overlap. Repeat the process.
  - f) Mark all areas where soap bubbles formed and repair the seam as required in the CQA/CQC plan. Retest the repaired seam.

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## 6.8 Destructive Seam Testing

### 6.8.1 Sampling

The Geosynthetic Contractor shall perform the following:

1. Obtain at least one destructive test sample per day per seaming crew or machine or every 500 feet of seam of fusion weld or every 400 feet of seam of extrusion weld, whichever is greater, from locations specified by the CQA Consultant. Additional destructive test samples shall be taken as directed by the CQA Consultant.
2. Cut the destructive test samples as seaming progresses in the locations designated by the CQA Consultant. The destructive test samples shall be nominally 12 inches wide by 45 inches long, with the seam centered lengthwise. One cutout from each end of the sample will be field tested prior to destructive testing. The remaining sample is to be cut into thirds (2-15" samples, 1-12" sample), with two pieces given to the CQA Consultant (1-15" laboratory test sample and 1-12" archive sample) and the other sample retained by the Geosynthetics Contractor.
3. Label all samples with the location and seam number and record the date, location, time, roll number, seam number, welding machine, welding technician, and ambient temperature.
4. Repair all holes in the geomembrane resulting from obtaining the destructive test samples. All patches shall be vacuum tested.
5. Locate and document the destructive test sample locations on the panel layout drawing.

The CQA Consultant shall verify that the following destructive test procedures are followed:

1. Determine and identify the locations for destructive test sampling.
2. Verify and document that the Geosynthetics Contractor's destructive sampling and testing procedures meet the requirements of the CQA/CQC plan.
3. Send the destructive test samples to an off-site laboratory for testing. On-site destructive testing performed in a controlled environment by qualified individuals of the CQA Consultant may be utilized in place of an off-site laboratory, if approved by the Project Manager.

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4. Verify and document that all destructive test results meet the requirements of the CQA/CQC plan. Observe and document all subsequent activities relating to the repair and patching of the destructive test sample location.

#### 6.8.2 Testing

The CQA Consultant shall perform the following:

1. Test destructive samples for bonded seam strength (shear) and for peel adhesion. Samples from dual track welds shall be tested for peel adhesion on both tracks of the seam.
2. Cut out ten, one-inch wide replicate specimens from the destructive test sample. Test five specimens for shear and five specimens for peel strength in accordance with ASTM D 4437. The passing criteria is as follows:
  - a) For peel testing, four out of five replicate test specimens must each pass the criteria listed in Table 6.4. The fifth specimen must achieve 80% of the passing strength requirement listed in Table 6.4. All specimens shall achieve 25% or less seam separation as a percentage of the total weld area
  - b) For shear testing, four out of five replicate test specimens must each pass the criteria listed in Table 6.4. The fifth specimen must achieve 80% of the passing strength requirement listed in Table 6.4. All specimens shall achieve 25% or less seam separation as a percentage of the total weld area
  - c) For both shear and peel testing, all specimens must fail by Film Tear Bond (FTB).
3. The Geosynthetic Contractor shall ensure that the following procedures are followed if a sample fails a field destructive test:
  - a) Retrace the welding path to an intermediate location (at a distance of approximately 10 feet from each side of the failed test), at the CQA Consultant's discretion, and take additional destructive test samples. If this test passes the CQA/CQC plan criteria, then the seam shall be repaired between that location and the original failed test location. If the test fails, the process is repeated. All failed test samples must be bounded by passing test samples or the point at which the particular seaming device was taken out of service.
  - b) A laboratory destructive test of a previously performed trial weld sample may be used as a bounding sample for a failed destructive test.

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- c) Over the length of seam failure, either cut out the old seam, reposition the panel and reseat, or install a cap-strip, as required by the CQA Consultant.
  - d) Vacuum test all extrusion weld repairs. Additional destructive samples may be taken at the discretion of the CQA Consultant.

The CQA Consultant shall perform the following:

1. Verify and document that the testing and sampling procedures meet the requirements of the CQA/CQC plan.
2. Verify and document that the results of the testing performed meets the requirements of the CQA/CQC plan.
3. Observe and document all subsequent activities associated with the geomembrane repairs required by the failing destructive sample tests.

## **6.9 Defects and Repairs**

The CQA Consultant shall perform the following:

1. As each geomembrane panel is deployed, or as soon as possible after deployment, observe the geomembrane surface for damage and imperfections including holes, cracks, thin spots, tears, punctures, blisters and foreign material. The surface of the geomembrane shall be clean at the time of the CQA Consultant's observations.
2. Identify, mark and observe non-destructive testing of suspect locations.
3. Verify and document that all defects found as a result of: (1) the inspection and testing of suspected areas; (2) non-destructive tests; (3) destructive tests; (4) any other inspection or observation, are identified for repair.
4. Verify and document that all identified defects are appropriately repaired in accordance with the CQA/CQC plan. Repair equipment, materials and procedures are subject to the approval of the CQA Consultant.
5. Verify and document that all repairs are non-destructively tested and either pass the test, or are again repaired and tested until passing test results are achieved.
6. Record the locations and types of defects and record the repairs and non-destructive testing at these locations.

The Geosynthetic Contractor shall perform the following:

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1. Clean the geomembrane surface prior to inspection of the geomembrane by the CQA Consultant. The geomembrane surface shall be brushed, blown, or washed if the amount of dust or mud inhibits observations.
  2. Perform non-destructive tests of each suspect location, in the presence of the CQA Consultant. Each location that fails the non-destructive tests shall be marked by the CQA Consultant, and repaired according to the procedures in the CQA/CQC plan.
  3. Repair any portion of the geomembrane which exhibits a flaw or fails a destructive or non-destructive test as follows:
    - a) Small holes shall be repaired by extrusion welding. If the hole is larger than 1/4 inch, the hole is to be patched.
    - b) Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp edge, the tear is to be rounded by cutting prior to patching.
    - c) Blisters, large holes, undispersed raw materials and contamination by foreign matter shall be repaired by large patches.
    - d) Surfaces of the geomembrane which are to be patched shall be abraded and cleaned no more than 15 minutes prior to the repair. No more than 5% of the thickness shall be removed by abrading.
    - e) Folded geomembrane that has been creased or otherwise damaged, shall be replaced. Patching may be permitted with the approval of the CQA Consultant.
    - f) Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of three inches beyond the edge of the defect. All patches shall be of the same compound and thickness as the geomembrane being repaired. All patches shall have their top edge beveled with a grinder prior to placement on the geomembrane.
    - g) All surfaces must be clean and dry at the time of repairs. All seaming equipment used in the repairs must be approved by the CQA Consultant. All repair procedures, materials, and techniques must be approved by the CQA Consultant.
  4. Perform non-destructive tests on each repair location. Repairs that pass the non-destructive test shall be noted as an acceptable repair. Failed tests indicate that the repair shall be repeated and retested until a passing test is achieved. The CQA Consultant may also require a destructive seam test sample to be taken from a



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repaired seam. Acceptance of the repaired seam shall then also be subject to the sampling, testing and acceptance criteria of the CQA/CQC plan.

## **6.10 Geomembrane Acceptance**

The Geosynthetic Contractor shall retain ownership and responsibility of the geomembrane until acceptance by the Owner. The Owner will accept the geomembrane installation when:

1. All required documentation from the geomembrane manufacturer and the Geosynthetics Contractor has been received and accepted.
2. The geomembrane installation is complete.
3. Verification that all field seams and repairs, including associated testing, is complete.
4. The geosynthetic installation has been accepted in a final approval notice signed by the CQA Consultant and the Owner.

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## 7 GEONET, GEOTEXTILE, AND GEOCOMPOSITE MATERIALS

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The proposed design include geonet, geotextile and/or geocomposite materials as indicated in the approved permit plans for drainage and stability purposes in the landfill cover and hydraulic barrier. This section of the CQA plan addendum addresses geonet, geotextile, and geocomposite materials for use in the landfill liner system and/or the final cover.

### 7.1 Submittals

The manufacturer of the geonet, geotextile and bonded geocomposite shall submit the following:

1. Manufacturer's specifications and certification stating that the materials meet or exceed the applicable requirements of Tables 7.1 and 7.2.
2. Manufacturer's instructions for handling and storage of the geonet, geotextile and/or the bonded geocomposite.
3. Manufacturer's quality control test results for geonet, geotextile and/or bonded geocomposite. These test results shall identify each roll of bonded geocomposite with the corresponding roll identifications of the geonet and geotextiles incorporated therein such that the results of the following tests can be positively correlated with the geocomposite roll identification. The testing shall be performed by the manufacturer as follows:
4. The geonet shall be sampled at a frequency of one sample for each 100,000 square feet delivered to the jobsite and shall be tested by the manufacturer to verify that the requirements in Table 7.1 are met.
5. The geotextile shall be sampled at a frequency of one sample for each 100,000 square feet delivered to the jobsite and shall be tested by the manufacturer to verify that the requirements in Table 7.2 are met. Testing for UV Resistance is not required; certification by the manufacturer that this requirement is achieved shall be provided.
6. The bonded geocomposite shall be sampled at a frequency of one sample for each 100,000 square feet delivered to the jobsite. The geonet and the geotextile from the geocomposite samples shall be certified that the requirements of Section 9.2.3 are met.

The CQA Consultant shall verify and document that the information submitted by the manufacturer meets the requirements of the approved construction plans and this CQA/CQC plan.

## 7.2 Materials

### 7.2.1 Geonet

The geonet shall be comprised of HDPE and shall meet the following minimum average roll values (Table 7.1):

**Table 7.1  
Geonet Minimum Requirements**

Property	Test Method	Criteria
1. Specific Gravity	ASTM D 792 or D 1505	0.935
2. Carbon Black Content	ASTM D 1603 or D 4218	2 to 3%
3. Thickness	ASTM D 1777 or D 5199	0.200 inches
4. Transmissivity	ASTM D 4716	0.0010 m <sup>2</sup> /sec
5. Tensile Strength (MD)	ASTM D 1682 or D 5035	40 lb/in

### 7.2.2 Geotextile

The geotextile shall consist of continuous filament, needle punched, non-woven material and shall meet the following minimum average roll values:

**Table 7.2  
Geotextile Minimum Requirements**

Property	Test Method	Geotextile Nominal Unit Weight		
		6 oz/yd <sup>2</sup>	8 oz/yd <sup>2</sup>	16 oz/yd <sup>2</sup>
1. Grab Strength	ASTM D 4632	160 lb.	205 lb.	380 lb.
2. CBR Puncture Strength	ASTM D 6241	410 lb.	535 lb.	1080 lb.
4. Trapezoidal Tear	ASTM D 4533	60 lb.	80 lb.	145 lb.
5. Apparent Opening Size	ASTM D 4751	≤ #70 sieve	≤ #80 sieve	≤ #100 sieve
6. UV Resistance <sup>(1)</sup>	ASTM D 4355, 500 hr.	≥ 70%	≥ 70%	≥ 70%
7. Permittivity	ASTM D 4491	1.3 sec <sup>-1</sup>	1.0 sec <sup>-1</sup>	0.5 sec <sup>-1</sup>
NOTE:				
1 Strength retained.				

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The geotextile shall meet the opening size criteria based upon the following formulas:

$$\frac{O_{95} \text{ Geotextile}}{d_{85} \text{ Upper Soil}} < 2$$

### 7.2.3 Geocomposite

The bonded geocomposite shall be comprised of a geonet heat bonded to, and sandwiched between two geotextiles. The geonet shall meet the requirements of Table 7.1. The geotextile shall be not less than 6 oz/yd<sup>2</sup> (nominal specified unit weight) and shall meet the requirements of Section 7.2.2. The geocomposite shall meet the following additional requirements:

1. The geotextile/geonet bond shall exhibit a peel strength of at least one pound per inch, when tested in accordance with ASTM D 7005.
2. The bonded geocomposite shall exhibit a transmissivity equal to, or greater than  $1 \times 10^{-4}$  m<sup>2</sup>/sec.
3. Testing shall be performed in accordance with ASTM D 4716 to demonstrate compliance with this requirement. The adequacy of the transmissivity test results shall be determined by the CQA Consultant.
4. The bonded geocomposite to be used in the final cover system shall exhibit a transmissivity equal to, or greater than that specified in the design report.. Testing shall be performed in accordance with ASTM D 4716 to demonstrate compliance with this requirement. The adequacy of the transmissivity test results shall be determined by the CQA Consultant.

### 7.2.4 Quality Assurance Testing

Quality assurance testing of the geonet, geotextile, and/or geocomposite may be done at the frequencies determined by the Certifying Engineer. The geonet, geotextile and geocomposite shall meet the requirements of Table 7.1, Table 7.2 and Section 7.2.3 respectively.

## 7.3 Material Delivery, Handling, and Storage

The Geosynthetics Contractor shall perform the following:

1. Assure that the geonet, geotextile, and bonded geocomposite rolls are packed, shipped, off-loaded and stored by appropriate methods to prevent damage. The

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Geosynthetics Contractor shall be responsible for replacing any damaged or unacceptable material at no cost to the Owner.

2. Protect the materials from mud, dust, dirt, and other damaging conditions. The manufacturer's procedures for shipping, handling and storage shall be followed.
3. Ship the geotextiles and bonded geocomposites in a closed container.
4. Assure that the geonet, geotextile and the bonded geocomposite rolls are clearly labeled with the manufacturer's name, roll number, lot number, and batch number. Information shall be provided by the manufacturer which clearly identifies the corresponding roll information for the geonet and geotextiles incorporated into the geocomposite.

The CQA Consultant visually inspect the surface of all rolls for defects and/or damage, and document any observed damage to any of the rolls.

#### **7.4 Material Deployment**

The Geosynthetics Contractor shall perform the following:

1. Assure that all geonet, geotextile, and bonded geocomposite materials are handled in a manner to prevent damage.
2. Assure that no materials are placed over the geomembrane until all required documentation regarding the geomembrane installation is complete.
3. Assure that the surface on which the materials are to be placed does not contain stones or excessive dust that could cause damage to any geosynthetic component.
4. In periods of high winds, weight all geosynthetic components with sandbags or similar material. The Geosynthetics Contractor shall be responsible for damage to the geosynthetic components resulting from wind damage.
5. Cut the geonet, geotextile and bonded geocomposite materials using an approved cutter. Care must be taken to protect the underlying geomembrane when the materials are being cut in-place.
6. Use equipment to deploy the geosynthetic components that will not cause damage to any material.
7. Assure that no personnel working on the geosynthetic materials shall smoke, wear damaging shoes or engage in other activities that could damage the materials.

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The CQA Consultant shall observe and document the deployment of geonet, geotextile and bonded geocomposite to verify that all provisions of the approved construction plans and this CQA/CQC plan are met.

## 7.5 Field Seams

The Geosynthetic Contractor shall perform the following:

1. Field seams for geonet:
  - a) The overlap for seams shall be six inches.
  - b) Adjacent panels of the geonet shall be joined using self-locking nylon straps placed at five feet intervals along the seam length on the sides and at one foot intervals along the seam length at the ends. Only ties which do not damage the underlying geomembrane shall be used. Metal ties shall not be allowed.
  - c) Ties shall be white or bright-colored for easy identification.
  - d) Where more than one layer of geonet is installed, overlaps must be staggered and layers tied together.
  - e) Orient all seams located on slopes steeper than 5% parallel to the fall of the slope, unless approved by the Design Engineer.
2. Field seams for geotextile:
  - a) The overlap for seams shall be at least four inches.
  - b) The geotextile shall be continuously sewn between panels, unless other seaming methods are approved by the CQA Consultant.
  - c) The thread used to sew the geotextile panels together shall meet the manufacturer's requirements.
  - d) Orient all seams located on slopes steeper than 5% parallel to the fall of the slope, unless approved by the Design Engineer.
3. Field seams for bonded geocomposite:
  - a) The overlap for seams shall be six inches.
  - b) Adjacent panels of the geonet shall be joined using self-locking nylon straps placed at five feet intervals along the seam length on the sides and at one foot intervals along the seam length on the ends. Butt seams between roll ends shall be covered by a piece of geotextile overlapped 6 inches on each side of the

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- geocomposite seam, and heat bonded in place. Only ties which do not damage the underlying geomembrane shall be used. Metal ties shall not be allowed.
- c) Ties shall be white or bright-colored for easy identification.
  - d) The geotextile shall be continuously sewn between panels unless other seaming methods are approved by the CQA Consultant.
  - e) The thread used to sew the geotextile panels together shall meet the manufacturer's requirements.
  - f) Orient all seams located on slopes steeper than 5% parallel to the fall of the slope, unless approved by the Design Engineer.

The CQA Consultant shall observe and document the seaming of geonet, geotextile, and bonded geocomposite to verify that the requirements of the approved construction plans and this CQA/CQC plan are met.

## **7.6 Defects and Repairs**

The Geosynthetic Contractor shall repair any holes or tears in the geosynthetic materials as follows, using patches made from the same material:

1. Damaged areas of geotextile shall be repaired by sewing a patch in place with a 12-inch overlap in all directions.
2. Damaged areas of geonet shall be repaired by placing a patch overlapping two feet beyond the edges of the hole or tear in all directions.
3. A geonet patch shall be secured to the original geonet every six inches using nylon ties. If the damaged area comprises over 50% or more of the geonet roll width, the damaged area shall be cut out and the two portions of the geonet shall be joined.
4. Damage to a bonded geocomposite shall be repaired as noted for geonets, and the upper geotextile of the patch shall be sewn or heat bonded to the upper geotextile of the geocomposite.

The CQA Consultant shall observe and document the repairs made to the geonet, geotextile and bonded geocomposite to verify that repairs are made according to the requirements of the approved construction plans and this CQA/CQC plan.

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## 7.7 Material Acceptance

The Geosynthetics Contractor retains ownership and responsibility for the geonet, geotextile and bonded geocomposite materials until accepted by the Owner.

The Owner will accept the geosynthetic components installation when:

1. All required documentation from the manufacturer and the Geosynthetics Contractor has been received and accepted.
2. The installation is complete.
3. The completion of field seams and repairs, including associated testing, is verified.
4. Written certification documents, including drawings, sealed by the CQA Consultant have been received by the Owner.



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## 8 GRANULAR PIPE BEDDING

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All granular materials (select aggregate) used in the landfill construction project for pipe bedding shall meet the requirements of this section and the approved construction plans and specifications.

### 8.1 Materials

The granular soils and select aggregates used in the leachate collection and removal system shall meet the following requirements:

1. The select aggregate shall be free of organic material, debris, trash, clay clods or other deleterious material. No sharp-edged rocks or hard objects shall be allowed.
2. The select aggregate shall have 100% of the particle size less than 1.5-inch when tested in accordance with ASTM D 422.
3. Select aggregate shall have no more than 5% by weight pass the #200 US Standard Sieve by washing.
4. The select aggregate shall be placed on an 8 ounce non-woven geotextile to protect the FML. In no instance shall the select aggregate be placed directly on the FML.
5. The geotextile may be wrapped around the select aggregate to serve as a filter to prevent fines from entering the select aggregate.
6. If a geotextile is used as a filter wrap around the select aggregate, the relationship between the granular drainage material and the geotextile filter shall meet the following criteria:

$$O_{95} \text{ of geotextile} < 2 \times D_{85} \text{ of granular drainage material}$$

7. The relationship between the select aggregate and the granular drainage layer shall meet the following criteria:

$$D_{15} \text{ of select aggregate} \leq 5 \times D_{85} \text{ of granular drainage layer}$$

8. Samples of select aggregate shall be obtained on a frequency of at least one per every 1,500 cubic yards placed and tested for grain size distribution using a sieve analysis in accordance with ASTM D 422.
9. Select aggregate samples shall be obtained on a frequency of at least one per every 3,000 cubic yards placed and tested for hydraulic conductivity in accordance with

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ASTM D 2434. The samples shall be collected and tested by the CQA Consultant. The CQA Consultant will verify that the test results meet the requirements of the approved construction plans and this CQA/CQC plan.

10. Select aggregate samples shall be obtained on a frequency of at least one per every 3,000 cubic yards placed and tested for carbonate content in accordance with a modified ASTM D 3042. The modification will be testing the aggregate at a pH of 4. The samples shall be collected and tested by the CQA Consultant. The CQA carbonate content will not be greater than 5 percent.
11. Select aggregate shall meet the minimum permeability as required by the project design. The minimum permeability for the select aggregate is  $1 \times 10^{-2}$  cm/sec.

## **8.2 Construction Methods/Placement**

The Contractor shall install the select aggregate in accordance with the following:

1. Low ground-pressure tire or track equipment shall be utilized for work on the select aggregate whenever the thickness of the granular soil material is less than 24 inches. The granular soil beneath roadways for transporting material over the cell floor and sideslopes shall be at least three feet thick at all times. Excessive rutting shall be prevented. No portion of any earthmoving equipment shall be allowed to contact the underlying geomembrane material at any time.
2. Select aggregate material shall be placed to minimize stresses on the underlying geomembrane. The CQA Consultant will perform the following:
  - a) Observe the placement of the select aggregate and document soil material uniformity and the presence or absence of foreign materials.
  - b) Observe for potential and actual damage to the geomembrane during select aggregate. When damage is suspected, the geomembrane surface shall be exposed to verify its condition. Actual damage to the geomembrane shall be documented and corrective action shall be taken in accordance with procedures outlined in the CQA/CQC plan.
  - c) Certify that the select aggregate material has been placed in accordance with the approved construction plans and specifications at the locations tested.

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### **8.3 Survey**

Direct depth checks or survey methods may be used to determine the pipe bedding layer thickness. Locations where the pipe bedding layer thickness is less than that required on the approved construction plans shall be increased to meet the project specifications.

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## 9 GRANULAR DRAINAGE LAYER

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All granular materials used in the landfill construction project for the base liner, leachate pond, and final cover drainage layers, shall meet the requirements of this section and the approved construction plans and specifications.

### 9.1 Materials

The granular drainage materials used in the leachate collection and removal system and drainage layer components of the final cover shall meet the following requirements:

1. The granular drainage layer in the base liner and leachate pond **may be composed of screened bottom ash** if the material meets the requirements of this section.
2. The granular drainage layer in the final cover system **may not be composed of** screened bottom ash and shall be composed of clean natural soil.
3. The granular drainage layer shall be free of organic material, debris, trash, clay clods or other deleterious material. No sharp-edged rocks or hard objects shall be allowed.
4. Granular drainage layer shall have 98% of the particle size less than 3/8-inch, if placed in direct contact with the geomembrane. The granular drainage layer shall be comprised of clean subangular particles and shall be free of any materials capable of damaging the liner material.
5. The relationship between the granular drainage layer and the protective cover soil shall meet the following criteria:  
$$D_{15} \text{ of drainage layer} / D_{85} \text{ of protective cover} < 5$$
6. Samples of granular drainage materials shall be obtained on a frequency of at least one per every 1,500 cubic yards placed and tested for grain size distribution using a sieve analysis in accordance with ASTM D 422.
7. Granular drainage materials samples shall be obtained on a frequency of at least one per every 3,000 cubic yards placed and tested for hydraulic conductivity in accordance with ASTM D 2434. The granular material samples shall be collected and tested by the CQA Consultant. The CQA Consultant will verify that the test results have a hydraulic conductivity of at least  $1.0 \times 10^{-3}$  cm/sec for the base liner system and  $1.0 \times 10^{-2}$  cm/sec for the final cover system.

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## 9.2 Construction Methods/Placement

The Contractor shall install the granular drainage layer in accordance with the following:

1. Low ground-pressure tire or track equipment shall be utilized for work on the granular drainage material whenever the thickness of the granular soil material is less than 24 inches. The granular material beneath roadways for transporting material over the cell floor and sideslopes shall be at least three feet thick at all times. Excessive rutting shall be prevented. No portion of any earthmoving equipment shall be allowed to contact the underlying geomembrane material at any time.
2. Granular material shall be placed to minimize stresses on the underlying geomembrane. Placement of granular material shall proceed by pushing the granular material up the sideslope. No granular material shall be allowed to fall or slide into place down the sideslope.

The CQA Consultant will perform the following:

1. Observe the placement of the granular material and document material uniformity and the presence or absence of foreign materials.
2. Observe for potential and actual damage to the geomembrane during granular material placement. When damage is suspected, the geomembrane surface shall be exposed to verify its condition. Actual damage to the geomembrane shall be documented and corrective action shall be taken in accordance with procedures outlined in the CQA/CQC plan.
3. Certify that the granular material has been placed in accordance with the approved construction plans and specifications at the locations tested.

## 9.3 Survey

The Surveyor shall survey the granular drainage layer on a 100-foot grid system to verify the granular soil layer thickness. Alternately, direct depth checks may be used to determine the granular soil layer thickness. Locations where the granular soil layer thickness is less than that required on the approved construction plans shall be increased to meet the project specifications. The CQA Consultant will document the placement of additional granular drainage material to meet the requirements of the CQA plan.

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## 10 PROTECTIVE COVER LAYER

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The 18-inch protective cover layer in the base liner and final cover systems must meet the requirements of this section and the approved construction plans and specifications.

### 10.1 Materials

The protective cover layer used in the leachate collection and removal system shall meet the following requirements:

1. The protective cover layer in the base liner system **may be composed of bottom ash** if the material meets the requirements of this section.
2. The protective cover layer in the final cover system **may not be composed of** bottom ash and shall be composed of clean natural soil.
3. The protective cover layer shall be free of organic material, debris, trash, clay clods or other deleterious material. No sharp-edged rocks or hard objects shall be allowed.
4. Protective cover layer shall have no more than 50% by weight pass the #200 US Standard Sieve by washing.
5. The relationship between the granular drainage layer and the protective cover layer shall meet the following criteria:
6.  $D_{15}$  of drainage layer/ $D_{85}$  of protective cover < 5
7. Samples of protective cover layer shall be obtained on a frequency of at least one per every 1,500 cubic yards placed and tested for grain size distribution using a sieve analysis in accordance with ASTM D 422.

### 10.2 Construction Methods/Placement

The Contractor shall install the protective cover layer in accordance with the following:

1. Low ground-pressure tire or track equipment shall be utilized for work on the protective cover soil whenever the thickness of the protective cover material is less than 24 inches. The granular soil beneath roadways for transporting material over the cell floor and sideslopes shall be at least three feet thick at all times. Excessive rutting shall be prevented. No portion of any earthmoving equipment shall be allowed to contact the underlying geomembrane material at any time.

- 
2. Protective cover layer material shall be placed to minimize stresses on the underlying geomembrane. Placement of protective cover layer shall proceed by pushing the protective cover layer up the sideslope. No protective cover layer materials shall be allowed to fall or slide into place down the sideslope.

The CQA Consultant will perform the following:

1. Observe the placement of the protective cover layer and document soil material uniformity and the presence or absence of foreign materials.
2. Observe for potential and actual damage to the geomembrane during granular soil placement. When damage is suspected, the geomembrane surface shall be exposed to verify its condition. Actual damage to the geomembrane shall be documented and corrective action shall be taken in accordance with procedures outlined in the CQA/CQC plan.
3. Certify that the protective cover layer material has been placed in accordance with the approved construction plans and specifications at the locations tested.

### **10.3 Survey**

The Surveyor shall survey the protective cover layer on a 100-foot grid system to verify the protective cover layer thickness. Alternately, direct depth checks may be used to determine the protective cover layer thickness. Locations where the protective cover layer thickness is less than that required on the approved construction plans shall be increased to meet the project specifications. The CQA Consultant will document the placement of additional protective cover layer to meet the requirements of the CQA/CQC plan.

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## 11 PIPING

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All piping used in the landfill construction project shall meet the requirements of the approved construction plans and specifications and this CQA/CQC plan.

### 11.1 Pipe Materials

The pipe manufacturer will provide the CQA Consultant with the following information:

1. Documentation that the pipe provided to this construction project meets the project's engineering specifications.

The CQA Consultant shall review the manufacturer's information to verify that the CQA/CQC plan requirements are met.

### 11.2 Delivery and Storage

The CQA Consultant will document the following information when the pipe is delivered to the jobsite:

1. Name of manufacturer.
2. Product type and identification number.
3. Pipe diameter (I.D.).
4. Pipe Standard Dimension Ratio (SDR).

The pipe will be protected during shipment from excessive heat or cold, puncture or other damage. The pipe will be stored on-site in a manner to protect it from damage.

The CQA Consultant will inspect the pipe delivery paperwork to ensure that the information is correct. The CQA Consultant will also document in the daily summary report of the pipe material delivery.

### 11.3 Pipe Installation

The pipe will be joined by methods as defined by the pipe manufacturer.

The CQA Consultant shall perform the following:

1. Inspect the pipe material for compliance with the approved construction plans and specifications.



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2. Observe and document the placement and backfill of the pipe for compliance with the approved construction plans and specifications.
  3. Observe and document the placement and joining of the pipe for compliance with the approved construction plans and specifications.

The Contractor shall perform the following:

1. Pipe placement shall not be performed in the presence of excessive moisture.
2. Prepare the pipe subgrade condition and slope according to the approved construction plans and specifications.
3. Join the pipe sections according to the pipe manufacturer's specifications.
4. Backfill the pipe according to the approved construction plans and specifications.

The Surveyor shall survey the installed leachate collection pipe at a minimum of every 100 feet and at appurtenances to verify that the pipe location and grade is in conformance with the approved construction plans and specifications.

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## 12 TOPSOIL LAYER FOR FINAL COVER SYSTEM

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### 12.1 Material

The final cover system includes a vegetative growth soil layer. This soil layer shall meet the following requirements:

1. The vegetative growth soil, capable of supporting shallow rooted vegetation.
2. The contractor shall place a seed mixture at a mix of 300 pounds per acre consisting of the following:
  - a) Laramie Tall Fescue
  - b) Fawn Tall Fescue
  - c) Shademark Red Fescue
  - d) Kentucky Bluegrass
  - e) Perennial Ryegrass
  - f) Annual Ryegrass

An alternate seed mix may be used provided it is approved by the Engineer and Owner.

3. Fertilizer recommended for grass shall be applied as necessary in accordance with manufacturer's instructions.

### 12.2 Construction/Placement

The CQA Consultant shall perform the following:

1. Observe and document the placement of the soil layers; visually inspect for material uniformity and the presence or absence of foreign materials.
2. Monitor the placement of the soil layers for potential or actual damage to the underlying protective cover layer, drainage layer or geosynthetic components of the final cover system. Where damage is suspected, the geosynthetic material surface will be exposed to verify its condition. Actual damage shall be documented and corrective actions and repairs shall be made according to the CQA/CQC plan.
3. Certify that the soil layers have been placed in accordance with the approved construction plans and specifications at the locations tested.

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4. Certify that the seed has been placed in accordance with the approved construction plans and specifications.

The Contractor will perform the following:

5. Install the soil layers above the geosynthetic components of the final cover system with at least 12 inches of soil maintained between the underlying geosynthetic materials and the construction equipment tires or tracks.
6. Soil placement shall be accomplished to minimize stresses on the underlying geosynthetic components of the final cover system.
7. Seed shall be installed as specified by the approved construction plans and specifications

The Surveyor shall survey the thickness of final cover soil components on a 100 foot grid system. Alternately, direct depth checks may be used to determine soil thickness. Locations where soil thickness is less than specified in the approved construction plans shall be corrected. The CQA Consultant will document these situations as described in the CQA/CQC plan.

## 13 PUMPS AND ELECTRICAL

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Construction records shall include an inspection and testing of the sump, leachate removal and detection equipment, and any other associated equipment or structures to ensure that the design specifications including material and equipment specifications, coating specifications, and mechanical and electrical equipment installation specifications, are met.

**ATTACHMENT**  
**EXISTING CQA PLAN**

**Client: NORTHERN INDIANA PUBLIC SERVICE COMPANY  
R. M. SCHAHFER GENERATING STATION  
FLY ASH LANDFILL**

**CONSTRUCTION QUALITY ASSURANCE PLAN FOR  
REMAINING PHASES VI AND VII SITE PREPARATION AND  
LINER INSTALLATION, AND PHASES V, VI, AND VII  
CLOSURE COVER INSTALLATION**

**Project No.: 12749-222**

**Issue Purpose: Minor Permit Modification Request**

**Issue Date: August 19, 2014**

**Revision 1, Client Comment**

**Purpose: Agency Request for Additional Information**

**Prepared By: Sargent & Lundy LLC**





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**ATTACHMENTS**

- ATTACHMENT A - CONSTRUCTION QUALITY ASSURANCE MONITORING/TEST METHODS/TEST FREQUENCY
- ATTACHMENT B - EXAMPLES OF DATA AND MONITORING SHEETS



## 1.0 INTRODUCTION

This Construction Quality Assurance Plan applies to Site Preparation and Liner Installation of Phases VI and VII Fly Ash Landfill and the Closure Cover Installation of Phases V, VI, and VII at Northern Indiana Public Service Company's (NIPSCO, the Owner) R. M. Schahfer Generating Station located northeast of Wheatfield, Jasper County, Indiana.

Quality control monitoring, documentation, and testing will be the responsibility of the Independent Quality Assurance Contractor/Testing Firm. Soil testing will be primarily the responsibility of the same independent testing firm retained by the Owner to serve as the Construction Quality Assurance Monitor (CQA Contractor) Testing of the high density polyethylene (HDPE) liner and linear low density polyethylene (LLDPE) geomembrane cover will be primarily the responsibility of the Installation Contractor and his selected Geosynthetics Installer, with the CQA Contractor observing and documenting the geomembrane placement and testing.

The scope of work for each Phase shall be separated into two work contracts as follows:

- a. Installation – All construction and installation activities shall be performed by the Installation Contractor in accordance with design drawings and specification requirements.
- b. Construction Quality Assurance (CQA) – Quality control monitoring and testing including soil testing, Compacted Clay Liner (CCL) testing, Documentation of the Geosynthetic Clay Liner (GCL) testing and the HDPE/LLDPE geomembrane liner/cover testing shall be primarily the responsibility of an independent third party testing firm retained by the Owner to serve as the Construction Quality Assurance Monitor (CQA Contractor).

Prior to commencement of construction activities, the Installation Contractor shall submit a Construction Quality Control (CQC) Plan to the Owner for the CQA Contractor's review. The Installation Contractor's CQC Plan shall be consistent with the applicable elements contained herein and when combined with this CQA Plan, shall become the Construction Quality Assurance/Construction Quality Control Plan. This CQA/CQC Plan, in conjunction with the project drawings and specifications, shall direct the construction of the Phase VI and Phase VII Site Preparation and Liner Installation and Closure Cover Installation of Phase V, Phase VI, and Phase VII of the Fly Ash Landfill.

This CQA Plan outlines the program to be implemented during construction of Phase VI and Phase VII Fly Ash Landfills and closure of Phase V, Phase VI, and Phase VII Fly Ash Landfills:

- a. Subgrade preparation
- b. Compacted Clay Liner (CCL) installation (if selected by the Owner)
- c. Geosynthetic Clay Liner (GCL) installation (if selected by the Owner)
- d. LLDPE geomembrane cover installation
- e. HDPE geomembrane liner installation
- f. Granular drainage layer installation.





- g. Protective soil layer installation.

This CQA Plan is based primarily on the applicable requirements of 329 Indiana Administrative Code (IAC) Article 10 – Solid Waste Land Disposal Facilities. Additional resources included the Technical Guidance Document entitled “Construction Quality Control and Construction Quality Assurance (CQC/CQA) of Geomembrane Liner” (OLQ General ID#0000-02-SW) dated January 24, 2000.

## **2.0 RESPONSIBILITY AND AUTHORITY**

The responsibilities of the parties involved in Construction Quality Assurance for all Phases of the Fly Ash Landfill are described in this section.

### **2.1 Owner**

NIPSCO, as Owner of the facility, is responsible for complying with the requirements of the Indiana Department of Environmental Management (IDEM). The Owner has the authority to select and dismiss parties charged with the design, CQA monitoring, and construction activities. The Owner also has the authority to accept or reject drawings and specifications, CQA/CQC Plans, reports and recommendations of the CQA Contractor and Engineer, and the materials and workmanship of the Installation Contractor. The CQA Contractor, Installation Contractor along with the Owner’s Construction Manager shall be responsible for implementing the CQA/CQC Plan. Upon completion of landfill construction, the Owner will be responsible for operation and closure of the facility.

The Owner shall also employ an independent surveying company to verify/confirm horizontal and vertical alignment of required installation features with the plans and specifications.

### **2.2 Engineer**

The selected Engineer for the Phase VI Fly Ash Landfill Project, will be responsible to design the Phase VI landfill to meet the design requirements of the IDEM issued landfill permit. The Engineer may revise components design to meet unexpected site conditions or as changes in construction methodology occur that could adversely affect facility performance. The selected Engineer will be responsible for specifying corrective measures where deviation from the drawings and specifications is detected by the CQA Contractor.

The Engineer is been tasked with the preparation of this specific CQA Plan for the following elements of the landfill construction:

- a. Subgrade preparation
- b. CCL installation
- c. GCL installation
- d. HDPE geomembrane liner installation
- e. LLDPE geomembrane cover installation
- f. Granular drainage layer installation



- g. Protective Soil layer installation

### **2.3 Installation Contractor**

The Installation Contractor shall be responsible for performing all the procurement, construction and installation work in accordance with the design drawings and specification requirements. The specific responsibilities of the Installation Contractor include:

- a. Initial site grading and site preparation
- b. Procurement of all materials
- c. Construction of Phase VI Fly Ash Landfill
- d. Construction of Phase VII Fly Ash Landfill
- e. Closure of Phase V Fly Ash Landfill
- f. Closure of Phase VI Fly Ash Landfill
- g. Closure of Phase VII Fly Ash Landfill
- h. Construction of site roads
- i. Construction of storm water and leachate drainage components
- j. Coordinating and interfacing with the CQA Contractor as required in accordance with the CQA/CQC Plan

### **2.4 CQA Contractor**

The CQA Contractor shall conduct independent field testing for confirmation of CQC testing and shall coordinate with the Installation Contractor to insure the implementation of the CQA Plan.

The Owner will be responsible for designating a CQA Monitor who will direct the other CQA personnel as well as implementation of the CQA Plan and will provide coordination with the Installation Contractor and his subcontractors through the Installation Contractor's CQC Manager.

The specific responsibilities and authority of the CQA Monitor is defined below and in the project's drawings and specifications:

- a. Training CQA personnel on CQA Plan requirements and procedures
- b. Review of drawings and specifications for clarity and completeness
- c. Review and implement CQA Plan requirements and procedures
- d. Schedule and coordinate CQA monitoring activities
- e. Review and approval of the Contractor's CQC Plan
- f. Review of field tests, measurements, and laboratory analysis
- g. Direct and support its personnel in performing observations and confirming field and/or laboratory analysis by:



- Submitting testing samples taken for evaluation and analysis as specified in this plan
- Confirming that regular calibration of testing equipment used is properly conducted and recorded
- Confirming that the testing equipment and procedures used are consistent
- Confirming that the CQA test data is accurately recorded and maintained

The CQA Contractor shall implement the CQC Plan provided by the Installation Contractor through field observation of construction activities; performing construction quality control tests; evaluating the construction quality control of the HDPE geomembrane liner and LLDPE geomembrane cover installer and other subcontractors and independent testing laboratories retained by the Installation Contractor; preparing and documenting reports and recommending corrective actions when necessary. The Installation Contractor shall provide a CQC Manager who shall direct the implementation of the CQC Plan and provide coordination with the CQA Contractor.

The specific responsibilities and authority of the CQC Manager and any independent testing services/laboratories retained by the Installation Contractor shall be defined in the Contractor's CQC plan to be submitted to the Owner after contractor selection and prior to the commencement of construction activities.

### **3.0 PERSONNEL QUALIFICATIONS**

This section identifies the required qualifications of the CQA Contractor and describes expected duties. The qualifications and responsibilities of the CQC Manager and any independent testing services/laboratories retained by the Installation Contractor shall be described in the Installation Contractor's CQC Plan to be submitted to the Owner upon selection of the Installation Contractor.

#### **3.1 CQA Contractor**

The CQA Contractor is responsible for the CQA Plan implementation. The CQA Contractor shall be a designated third party testing service/laboratory retained by the Owner to perform CQA activities during construction activities. The CQA Contractor shall possess adequate training in civil and geotechnical compliance testing and services. The CQA Contractor shall work so that CQA/CQC related matters are conveyed to and acted upon by the affected organizations.

The CQA Contractor shall possess sufficient practical, technical and administrative experience to execute and record quality assurance activities. This shall include knowledge of specific field practices relating to construction techniques used for landfills, observation and testing procedures, equipment and documentation procedures.

CQA personnel includes employees of the third party testing laboratory retained by the Owner, as well as other personnel designated by the Owner, as needed. The CQA personnel will possess sufficient practical, technical, and administrative experience to execute and record quality assurance activities. This includes knowledge of specific field practices relating to construction techniques used for landfills, observation and testing



procedures, equipment, and documentation procedures. The CQA personnel will be under the supervision of the CQA Contractor.

### **3.2 Consultants**

Authorities in engineering geology, geotechnical engineering, civil engineering and other technical disciplines may be called in from external organizations by the CQA and installation Contractors in the event of unusual site conditions or testing results. Documentation of consultant qualifications shall be provided when outside testing or technical judgments are used as a basis for decision in some aspect of construction quality assurance.

## **4.0 MONITORING ACTIVITIES**

This section of the CQA Plan describes activities (observations, testing, and documentation) that shall be performed by the CQA Contractor during construction. The scope of this discussion addresses the construction and installation of new facility components along with manufacture/fabrication of various components and sub-components when applicable. This section also addresses the monitoring activities that shall be done during construction for comparison to the construction drawings and specifications. The first subsection addresses pre-construction activities generally applicable to all facility components. The subsequent subsections address each facility component separately and are further subdivided into sections or pre-construction, construction and post-construction monitoring activities unique to each component. Specific test methods and test frequencies used to test the major components of the landfill construction are listed and referenced in Attachment A. Examples of data and monitoring sheets have been included as Attachment B.

### **4.1 General Pre-Construction Activities**

The Installation Contractor and CQA Contractor shall jointly review the design drawings and specifications and discuss the design concepts to provide an understanding of expected conditions, methods of construction and the scope of drawings and specifications.

### **4.2 Subgrades**

Monitoring activities during construction and preparation of the liner subgrade and landfill final cover shall develop sufficient information for the CQA Contractor to confirm that the facility is constructed in accordance with design drawings and specifications by testing for the following:

- a. Soil density and moisture content
- b. Side slope failure from soft silts and clays, loose sands, weak foundation soil or side slopes that are steeper than specified
- c. Surface sloughing fine sands
- d. Improper undercut of the toe of the slopes
- e. Development of tension cracks at the top of the slopes

The following subsections describe the CQA activities that shall be performed to monitor the construction of the subgrades, including for fills and embankments, in regard to the project



specifications. Specific tests mentioned in this section are listed and referenced in Attachment A.

#### **4.2.1 Pre-Construction**

Pre-construction monitoring activities for liner and cover subgrade preparation, including for fills and embankments, shall include observation of the fill procedure and review of incoming materials.

Materials to be used for fills and embankments shall be observed to insure that no soft, structurally weak materials, large rocks or other deleterious materials are included. Initial monitoring of the soil shall be largely visual. The CQA Contractor shall be familiar with visual-manual soil classification techniques (ASTM D2488). The soil shall also be observed for organics, changes in moisture content, color, or texture. In addition to observations, the CQA Contractor shall compare the CQA test results of the material properties to that of the requirements of the Installation design drawings and specification in order to verify compliance.

#### **4.2.2 Construction**

CQA Contractor activities during construction of the subgrades shall include the following:

- a. Observations of surfaces for adequate filling of depressions and slough areas on the slope
- b. Lab testing of materials in accordance with project specifications
- c. Observation of surface water runoff control and erosion protection
- d. Measurements of the depth and slope of the excavation to evaluate its construction in regard to the design drawings
- e. Observations of stripping and excavation to determine that undesirable materials are removed
- f. Confirmation of lift thickness
- g. Observations of the compaction operation to provide the proper preparation of the subgrade, prior to placement of the CCL, GCL, HDPE, or LLDPE liner
- h. Testing the density and moisture content of the compacted subgrade soil according to ASTM D1557. Failed test shall be repeated and/or remedial actions shall be taken according to specifications
- i. Observation of type of compaction equipment, number of passes and uniformity of compaction coverage
- j. Confirmation that the Installation Contractor performed the necessary surveying during construction to insure that the facility dimensions, side slopes and bottom slopes are as specified in the drawings and specifications. Owner is responsible for final survey documentation via an independent surveying company.

The CQA Contractor shall utilize visual-manual soil identification techniques and index property tests as specified in Attachment A to monitor subgrade soil composition.



### **4.2.3 Post-Construction**

Subgrade completion monitoring activities may include observation of proofrolling, additional testing of subgrade soil, observing subgrade surfaces, and additional surveys to measure elevations, slopes and subgrade boundaries where discrepancies with the design drawings are suspected.

### **4.3 Compacted Clay Liner (CCL)**

This section describes the monitoring activities necessary as part of the CCL construction, if selected by the Owner as an alternative to a GCL, in accordance with design drawings and specifications. Specific tests mentioned in this section are listed and referenced in Attachment A. Additional tests may be performed at the Owner's discretion.

#### **4.3.1 Pre-Construction**

Pre-construction CQA activities include sampling and testing of the soil materials to evaluate its suitability in regard to the design drawings and specifications through laboratory testing. Procedures and methods for observing and testing of clay material before construction include the following:

- a. Grain size
- b. Atterberg limits
- c. Moisture-density curve (Standard Proctor).
- d. Hydraulic conductivity (remolded samples)
- e. Water Content

These tests shall be performed on samples obtained by the Installation Contractor as the soil is excavated from the borrow sources. Owner will perform confirmation testing on the soil as delivered to the site. Test methods and test frequencies are listed in Attachment A. At the initial start of installation of the CCL, a test pad comprised of proposed CCL materials shall be constructed by the Installation Contractor, as specified, within the landfill area and tested to verify that the specific density, moisture content and hydraulic conductivity can be achieved prior to constructing the CCL. The test pad shall be a minimum of 20 feet long, 40 feet wide and 1 to 3 feet thick and shall be constructed and tested using the same equipment procedures as those to be used on the CCL construction. Upon completion of the test pad, a minimum of one of the following four testing procedures shall be performed, as specified, to confirm the in-situ hydraulic conductivity:

- a. Sealed double-ring infiltrometer (SDRI)
- b. Boutwell borehole test, with a minimum of five tests required
- c. Large diameter test using a carve block, hand-trimmed into a 12-inch diameter sample, with a minimum of three tests required
- d. Undisturbed Shelby Tube samples

Testing and documentation for the test pad shall be as required per specifications. The documentation shall be submitted as part of the final CQC/CQA report submitted to IDEM.



#### 4.3.2 Construction

CQA activities include the following procedures to monitor the construction of the CCL:

- a. Procedures and methods for observing and testing of the soil before placement shall help to allow the following:
  - Removal of roots, rocks, rubbish, and unsuitable soil from the soil material (visual)
  - Identification of changes in soil characteristics requiring a change in construction specification requirements or additional testing (visual)
  - Adequate clod size reduction of material (visual and direct measurement of clod size)
  - Adequate spreading and incorporation of water to obtain full penetration through clods and uniform distribution of the specified water content (visual)
  - Procedures to be followed to adjust the soil moisture content in the event of a significant prolonged rain or drought during construction (ASTM D2216)
  - Prevention of significant water loss and desiccation cracking before and after compaction (visual). All soil material shall be kept moist by periodic spraying with water.
  
- b. Procedures and methods for observing and confirming the testing of the soil compaction process shall be employed to include the following:
  - Uniformity of coverage by compaction equipment, especially at compacted fill edges, in equipment turnaround areas, and at the tops and bottoms of slopes (visual)
  - Uniformity of material measured by performing Atterberg limit tests (ASTM D4318) and moisture-density tests (ASTM D698)
  - Sufficient hydraulic conductivity (ASTM D5084) of lab samples
  - Consistent achievement of the specified soil density (ASTM D6938) and water content throughout each completed lift
  - Achievement of sufficient strength to supply a stable base for supporting overlying materials
  - Timely placement of protective covers to limit desiccation of soil material between the installation of lifts or after completion of the liner
  - Sealing of top of CCL surface to provide smooth base for HDPE geomembrane liner placement by the use of a smooth drum roller
  - Prevention of accidental damage of installed portions of the CCL by equipment traffic

Test areas represented by failed test results shall be remedied and tested again until appropriate test results are obtained. The compaction process will be affected by climate. Wet weather can alter the soil water content so that close control of the



compaction process is not possible. Movement of the construction equipment may be severely affected. In very dry weather, the water content of the surface of each compacted fill layer can also be altered in a very short time by drying, making continuous watering and blending necessary. Atmospheric conditions shall be observed and recorded by the CQA Contractor and appropriate actions shall be taken by the Installation Contractor when unsuitable weather conditions exist.

#### **4.3.3 Post- CCL Construction**

Immediately before placement of HDPE geomembrane liner, the CCL surface shall be inspected for cracks, holes, ruts greater than 1-inch depth, rock or gravel larger than 2 inches in any dimensions, sharp objects, or any other defects and rolled with a smooth steel-wheeled roller to seal the soil and provide a smooth base. All defective areas shall be repaired prior to HDPE geomembrane liner placement. If the soil is defective (soft, wet, or desiccated), this material shall also be removed and the resultant volume replaced. Excavated areas of the soil shall be repaired and subsequent monitoring shall be done to insure that there is continuity between the repaired and undisturbed areas. Special attention shall be paid to the final observations of the sidewall and bottom slopes, soil coverage, moisture content, and liner thickness. The completed compacted soil liner shall be protected from desiccation and erosion following completion of the uppermost lift.

#### **4.4 GEOSYNTHETIC CLAY LINER (GCL)**

This section describes the activities necessary to monitor the construction of the GCL as an Owner-selected alternative to a CCL. Specific tests listed in this section are also listed and referenced in Attachment A. Additional tests may be performed at the Owner's discretion. The GCL liner may be utilized in lieu of the CCL, if accepted by IDEM. If GCL is to be used, the same subgrade preparation previously described will be completed.

##### **4.4.1 Pre-construction**

Pre-construction activities for the GCL include the following:

- a. Review and documentation of the Manufacturer's GCL material submittals as required by specifications including:
  - Copies of the GCL Manufacturer's catalog data describing the GCL material proposed for use on the project
  - Copies of the GCL Manufacturer's QA certificates on tests performed on the material and a summary of results after the tests
  - Certification of compliance from the Manufacturer of the GCL, signed by its authorized representative, stating that the liner material meets the specification requirements and that those requirements are guaranteed by the Manufacturer
  - Manufacturer's Quality Control and Quality Assurance Policies and Procedures
  - Compatibility testing and documentation





b. Observations related to transportation, handling, and storage of the GCL material

- Confirm that the GCL material has been protected with appropriate covering material. The roll of finished liner material provided by the Manufacturer must be marked to show the following minimum information:
  1. Name of Manufacturer
  2. Product type
  3. Product thickness
  4. Manufacturing batch code
  5. Date of manufacture
  6. Roll number
  7. Physical dimensions (length and width)
  8. Manufacturing testing CQA program documentation
- The GCL material shall be inspected by the CQA Contractor to confirm that it has not been damaged by:
  1. Punctures from handling, nails, splinters, etc
  2. Tears from operation of equipment or inadequate packaging
  3. Exposure to temperature extremes resulting in unusable material
  4. Blocking resulting from the bounding together of adjacent membrane layers due to excessive heat and pressure
  5. Crumpling or tearing from inadequate packaging support
  6. Premature wetting

When damage to a roll cover has occurred, examination of the underlying material shall be conducted. If damage is found, the CQA Contractor shall examine the entire shipment for damage. The CQA Contractor shall review delivery tickets and Manufacturer quality control documentation to confirm that the GCL material rolls received on-site meet the project specifications. The CQA Contractor shall confirm that the GCL is stored in a secure area with provisions for protection from adverse weather to avoid damage caused by heavy winds, precipitation, temperature extremes in accordance with project specifications.

c. Monitoring of the subgrade preparation/installation

- Test subgrade to insure compaction requirements are met
- Inspect subgrade to insure that it is smooth and free of vegetation, sharp edged rocks, stones, sticks, construction debris and other foreign matter that could contact the GCL
- Identify and record locations where compaction requirements are not met or a smooth surface is not achieved for Installation Contractor remediation



- d. Evaluation of the personnel and equipment to be used to install the GCL to insure compliance with project specifications

#### 4.4.2 Construction

The observations and tests necessary to detect defects during construction are discussed in the following subsections.

a. GCL Placement

Identifying labels from each roll shall be taken and saved for future reference testing, if necessary. Furthermore, the position of each roll of material shall be noted on a final panel installation drawing. This document can be used as future reference. Monitoring activities that are necessary and shall be documented during liner placement include the following:

- Written acceptance by the Installation Contractor that subgrade is in a condition suitable for GCL deployment
- Observations regarding the GCL placement plan
- Observations of the weather conditions (i.e., temperature, humidity, precipitation, and wind) and that they are appropriate for GCL geomembrane liner placement and seaming
- Observations and tests to confirm that all designed GCL connections are appropriately installed
- Measurements to confirm that the required overlaps of adjacent GCL sheets were achieved; that proper temporary anchorage was used; that specified temporary and final seaming materials/techniques were used; and that the GCL was placed in a relaxed (non-stressed) state.
- Inspection of anchor trench construction. Verify that anchor trench and GCL is installed in accordance to design drawings and specifications.
- Inspection of temporary protection of GCL to be in accordance with design drawings and specifications

As each GCL piece is placed, it shall be observed for tears, punctures, and thin spots. To accomplish this, the pieces shall be traversed by the CQA Contractor in such a way that the entire surface is observed. If the weather becomes unacceptable for installation of the GCL, the CQA Contractor shall stop the GCL installation until conditions again become favorable, thus minimizing the potential for unacceptable installation.

b. GCL Seaming:

Monitoring activities that shall be documented during field seaming operations include the following:

- Confirmation that the seaming areas are free from dirt, dust, and moisture
- Confirmation that the seaming materials (bentonite) and equipment are as specified



- Confirmation that the seaming placement plan was followed
- Confirmation that a firm subgrade, free from sharp rocks, debris, or other deleterious material supports the GCL
- Recording of weather conditions
- Confirmation that the proper material lapping is provided during installation
- Inspection of the GCL to detect damage caused by equipment or personnel during the seaming process
- Observation of field seam installation to insure proper procedure is followed in accordance with Manufacturer's requirements
- Observation in accordance with specifications. Seams not meeting specification overlap and bentonite application shall be recorded as to location, seaming crew, and equipment. The data shall be reviewed for possible patterns. Repairs shall be made in accordance with approved techniques and re-examined to confirm their integrity.
- Confirm that repairs are performed as soon as possible and in accordance with the specifications. Each repair shall be nondestructively examined for continuity. Documentation of all repairs including location, type, and method used shall be made.

#### **4.4.3 Post-Construction**

Immediately before placement HDPE geomembrane liner, the GCL surface shall be observed for defects and all defective areas shall be repaired prior HDPE geomembrane liner, with the same requirements listed in the CCL placement section. All GCL placement and test result records shall be reviewed to insure all panels, seams, and repairs have been tested and documented as conforming to the CQC/CQA Plan.

#### **4.5 HDPE Geomembrane Liner**

This section describes the monitoring activities necessary as part of HDPE geomembrane liner in accordance with design drawings and specifications. Specific tests mentioned in this section are listed and referenced in Attachment A. Additional tests may be performed at the Owner's discretion.

##### **4.5.1 Pre-Construction**

Pre-construction activities for the HDPE geomembrane liner include the following:

- a. Review and collection of the Manufacturer's HDPE geomembrane liner material submittals and certifications in accordance with specifications:



- Representative samples of the geosynthetic material
  - Manufacturer's Quality Control and Quality Assurance Policies and Procedures
  - Written warranties from the Manufacturer and Installation Contractor covering the quality of the material and workmanship as applicable and as required by the specifications
  - Testing laboratory information
  - Geomembrane resin submittals
  - Geomembrane sheeting submittals
  - Seaming procedures submittals
  - Installation data
  - Panel layout
- b. Observations related to transportation, handling, and storage of the HDPE geomembrane liner material:
- Confirm that the HDPE geomembrane liner material has been protected with appropriate covering material. The roll of finished liner material provided by the Manufacturer must be marked to show the following minimum information:
    1. Name of Manufacturer
    2. Product type
    3. Product thickness
    4. Manufacturing batch code
    5. Date of manufacture
    6. Roll number
    7. Physical dimensions (length and width)
    8. Manufacturing testing CQA program documentation
  - The HDPE geomembrane liner material shall be inspected by CQA Contractor to confirm that it has not been damaged by:
    1. Punctures from handling, nails, splinters, etc.
    2. Tears from operation of equipment or inadequate packaging
    3. Exposure to temperature extremes resulting in unusable material
    4. Blocking resulting from the bounding together of adjacent geomembrane layers due to excessive heat and pressure
    5. Crumpling or tearing from inadequate packaging support

When damage to a roll cover has occurred, examination of the underlying material shall be conducted. If damage is found, the CQA Contractor shall examine the entire shipment for damage. The CQA Contractor shall review delivery tickets and Manufacturer quality control documentation to confirm that the HDPE geomembrane liner material rolls received on-site meet the project specifications. The CQA Contractor shall confirm that the HDPE geomembrane



liner material is stored in a secure area with provisions for protection from adverse weather to avoid damage caused by heavy winds, precipitation, temperature extremes in accordance with project specifications.

- c. Monitoring of the CCL or GCL (i.e., HDPE geomembrane liner component subgrade) installation in accordance with this CQA Plan and specifications
- d. Evaluation of the personnel and equipment to be used to install the HDPE geomembrane liner

#### 4.5.2 Construction

The observations and tests necessary to detect defects during construction are discussed in the following subsections.

- a. Placement - Identifying labels from each roll shall be taken and saved for future reference. The position of each roll of material shall be noted on a final panel installation drawing. This document can be used as future reference. Monitoring activities that are necessary and shall be documented during liner placement include the following:
  - Written acceptance by the liner contractor that subgrade is in a condition suitable for liner deployment
  - Observations regarding the liner placement plan
  - Observations of the weather conditions (i.e., temperature, humidity, precipitation, and wind) and that they are appropriate for HDPE geomembrane liner placement and seaming
  - Inspection and measurements of the anchor trench so that it is as specified in the construction drawings; that trench corners are rounded to limit stressing of the HDPE geomembrane liner; and that backfilling of the trench is performed as soon as possible and compacted with care so as not to damage the liner
  - Inspections and tests to confirm that all designed HDPE geomembrane liner connections are appropriately installed
  - Measurements to confirm that the required overlaps of adjacent HDPE geomembrane liner sheets were achieved; that proper temporary anchorage was used; that specified temporary and final seaming materials/techniques were used; and that the HDPE geomembrane liner was placed in a relaxed (non-stressed) state.
  - As each HDPE geomembrane panel is placed, it shall be inspected for tears, punctures, and thin spots. To accomplish this, the panels shall be traversed by the CQA Contractor in such a way that the entire surface is observed. If the weather becomes unacceptable for installation of the HDPE geomembrane liner, the CQA Contractor shall stop the HDPE geomembrane liner installation until conditions again become favorable, thus minimizing the potential for unacceptable installation.
- b. HDPE LINER SEAMING - Monitoring activities that shall be documented during field seaming operations include the following:



- Confirm that the membrane seaming areas are free from dirt, dust, and moisture
- Confirm that the seaming materials and equipment are as specified
- Confirm that the seaming placement plan was followed
- Confirm that a firm subgrade, free from sharp rocks, debris, or other deleterious material supports the HDPE geomembrane liner
- Record weather conditions
- Confirm that the proper material lapping is provided during installation
- Record temperatures, pressures, and speed of seaming, when applicable, and that they are as specified (e.g., gauges and dials shall be read and readings recorded)
- Record curing time between seaming and seam testing
- Inspection of the HDPE geomembrane liner to detect damage caused by equipment or personnel during the seaming process
- Inspection of startup testing of welding equipment, including peel and shear testing of sample welds
- Inspection of field seam installation so that a homogeneous bond was formed
- Perform nondestructive tests on 100 percent of the field seams. Failed seams shall be recorded as to location, seaming crew, and equipment. The data shall be reviewed for possible patterns. Repairs shall be made in accordance with approved techniques and re-tested to confirm their integrity.
- Perform destructive seam testing on every 500 feet of fusion weld seam and on every 400 feet of extrusion weld seam. Additional test locations and shorter testing frequency may be necessary at the CQA Monitor's discretion. Test locations and testing frequency shall be based on failed nondestructive tests, and other causes that could result in unacceptable seams.
- Confirm that destructive seam samples are large enough for the installer to test in the laboratory, for an independent laboratory evaluation, and for site Owner archiving. Seam samples shall be a minimum of 12 inches wide by 42 inches long.
- Confirm that laboratory testing is performed in accordance with design specifications with predetermined pass/fail values. Both peel and shear testing should be performed in accordance with GRI Test Method GM19. The test results for HDPE geomembrane liner seam samples shall exhibit 90 percent of the minimum yield strength in shear and 70 percent (fusion weld) and 60 percent (extrusion weld) in peel to be acceptable.
- Confirm that for field seams that fail, the installer did go on either side of the failed seam location (10 foot minimum), take another sample, test it, and if it passes, cap strip the seam between the two locations. Acceptable seams must be bounded by two passed-test locations, unless the capped seam extends to the edge of the lining.
- Confirm that repairs are performed as soon as possible and in accordance with the specifications. Each repair shall be nondestructively tested for continuity.



Documentation of all repairs including location, type, and method used shall be made.

#### **4.5.3 Post-Construction**

Immediately before placement of the granular drainage layer, the HDPE geomembrane liner surface shall be inspected for defects, and all defective areas shall be repaired prior to granular drainage material placement. All HDPE geomembrane placement and test result records shall be checked to insure all panels, seams, and repairs have been tested and documented as conforming to the CQC/CQA Plan.

#### **4.6 LLDPE Geomembrane Cover**

This section describes the monitoring activities necessary as part of LLDPE geomembrane cover in accordance with design drawings and specifications. Specific tests mentioned in this section are listed and referenced in Attachment A. Additional tests may be performed at the Owner's discretion.

##### **4.6.1 Pre-Construction**

Pre-construction activities for the LLDPE geomembrane liner include the following:

a. Review and collection of the Manufacturer's LLDPE geomembrane liner material submittals and certifications in accordance with specifications:

- Representative samples of the geosynthetic material
- Manufacturer's Quality Control and Quality Assurance Policies and Procedures
- Written warranties from the Manufacturer and Installation Contractor covering the quality of the material and workmanship as applicable and as required by the specifications
- Testing laboratory information
- Geomembrane resin submittals
- Geomembrane sheeting submittals
- Seaming procedures submittals
- Installation data
- Panel layout

b. Observations related to transportation, handling, and storage of the LLDPE geomembrane liner material:

- Confirm that the LLDPE geomembrane liner material has been protected with appropriate covering material. The roll of finished liner material provided by the Manufacturer must be marked to show the following minimum information:

1. Name of Manufacturer
2. Product type



3. Product thickness
4. Manufacturing batch code
5. Date of manufacture
6. Roll number
7. Physical dimensions (length and width)
8. Manufacturing testing CQA program documentation

c. The LLDPE geomembrane liner material shall be inspected by CQA Contractor to confirm that it has not been damaged by:

- Punctures from handling, nails, splinters, etc
- Tears from operation of equipment or inadequate packaging
- Exposure to temperature extremes resulting in unusable material
- Blocking resulting from the bounding together of adjacent geomembrane layers due to excessive heat and pressure
- Crumpling or tearing from inadequate packaging support

When damage to a roll cover has occurred, examination of the underlying material shall be conducted. If damage is found, the CQA Contractor shall examine the entire shipment for damage.

The CQA Contractor shall review delivery tickets and Manufacturer quality control documentation to confirm that the LLDPE geomembrane liner material rolls received on-site meet the project specifications. The CQA Contractor shall confirm that the LLDPE geomembrane liner material is stored in a secure area with provisions for protection from adverse weather to avoid damage caused by heavy winds, precipitation, temperature extremes in accordance with project specifications.

- d. Monitoring of the CCL or GCL (i.e., LLDPE geomembrane liner component subgrade) installation in accordance with this CQA Plan and specifications
- e. Evaluation of the personnel and equipment to be used to install the LLDPE geomembrane liner

#### **4.6.2 Construction**

The observations and tests necessary to detect defects during construction are discussed in the following subsections.

- a. Placement - Identifying labels from each roll shall be taken and saved for future reference. The position of each roll of material shall be noted on a final panel installation drawing. This document can be used as future reference. Monitoring activities that are necessary and shall be documented during liner placement include the following:
  - Written acceptance by the liner contractor that subgrade is in a condition suitable for liner deployment





- Observations regarding the liner placement plan
  - Observations of the weather conditions (i.e., temperature, humidity, precipitation, and wind) and that they are appropriate for HDPE geomembrane liner placement and seaming
  - Inspection and measurements of the anchor trench so that it is as specified in the construction drawings; that trench corners are rounded to limit stressing of the LLDPE geomembrane liner; and that backfilling of the trench is performed as soon as possible and compacted with care so as not to damage the liner
  - Inspections and tests to confirm that all designed LLDPE geomembrane liner connections are appropriately installed
  - Measurements to confirm that the required overlaps of adjacent LLDPE geomembrane liner sheets were achieved; that proper temporary anchorage was used; that specified temporary and final seaming materials/techniques were used; and that the LLDPE geomembrane liner was placed in a relaxed (non-stressed) state
- b. As each LLDPE geomembrane panel is placed, it shall be inspected for tears, punctures, and thin spots. To accomplish this, the panels shall be traversed by the CQA Contractor in such a way that the entire surface is observed.
- c. If the weather becomes unacceptable for installation of the LLDPE geomembrane liner, the CQA Contractor shall stop the LLDPE geomembrane liner installation until conditions again become favorable, thus minimizing the potential for unacceptable installation.
- d. LLDPE LINER SEAMING - Monitoring activities that shall be documented during field seaming operations include the following:
- Confirm that the membrane seaming areas are free from dirt, dust, and moisture
  - Confirm that the seaming materials and equipment are as specified
  - Confirm that the seaming placement plan was followed
  - Confirm that a firm subgrade, free from sharp rocks, debris, or other deleterious material supports the LLDPE geomembrane liner
  - Record weather conditions
  - Confirm that the proper material lapping is provided during installation
  - Record temperatures, pressures, and speed of seaming, when applicable, and that they are as specified (e.g., gauges and dials shall be read and readings recorded)
  - Record curing time between seaming and seam testing
  - Inspection of the LLDPE geomembrane liner to detect damage caused by equipment or personnel during the seaming process
  - Inspection of startup testing of welding equipment, including peel and shear testing of sample welds
  - Inspection of field seam installation to insure that a homogeneous bond was formed
  - Perform nondestructive tests on 100 percent of the field seams. Failed seams shall be recorded as to location, seaming crew, and equipment. The data shall



be reviewed for possible patterns. Repairs shall be made in accordance with approved techniques and re-tested to confirm their integrity.

- Perform destructive seam testing per frequencies listed in Attachment A. Additional test locations and shorter testing frequency may be necessary at the CQA Monitor's discretion. Test locations and testing frequency shall be based on failed nondestructive tests, and other causes that could result in unacceptable seams.
- Confirm that destructive seam samples are large enough for the installer to test in the laboratory, for an independent laboratory evaluation, and for site Owner archiving. Seam samples shall be a minimum of 12 inches wide by 42 inches long.
- Confirm that laboratory testing is performed in accordance with design specifications with predetermined pass/fail values. Both peel and shear testing should be performed in accordance with GRI Test Method GM19.
- Confirm that for field seams that fail, the installer did go on either side of the failed seam location (10 foot minimum), take another sample, test it, and if it passes, cap strip the seam between the two locations. Acceptable seams must be bounded by two passed-test locations, unless the capped seam extends to the edge of the lining.
- Confirm that repairs are performed as soon as possible and in accordance with the specifications. Each repair shall be nondestructively tested for continuity. Documentation of all repairs including location, type, and method used shall be made.

#### **4.6.3 Post-Construction**

Immediately before placement of the granular drainage layer, the LLDPE geomembrane liner surface shall be inspected for defects, and all defective areas shall be repaired prior to granular drainage material placement. All LLDPE geomembrane placement and test result records shall be checked to insure all panels, seams, and repairs have been tested and documented as conforming to the CQC/CQA Plan.

#### **4.7 Granular Drainage Layer**

This section describes the monitoring activities necessary to insure that the granular drainage layer is constructed in accordance design drawings and specifications. Specific tests mentioned in this section are listed and referenced in Attachment A.

##### **4.7.1 Pre-Construction**

Pre-construction CQA activities include sampling and testing of the granular drainage layer materials to evaluate its suitability in regard to the project specifications through laboratory testing. Procedures and methods for observing and testing of compacted soil liner materials before construction shall include the following:



- a. Grain size
- b. Hydraulic conductivity

These tests shall be performed on samples obtained as the source material. Test methods and test frequencies are listed in Attachment A.

#### **4.7.2 Construction**

Construction CQA activities include the following procedures to monitor the construction of the granular drainage layer:

- a. Inspection and testing to insure compaction requirements are met
- b. Inspection and monitoring to insure layer thickness requirements are met
- c. Inspection to insure that drainage layer piping is installed in accordance with design drawings and specifications
- d. Observation of granular drainage layer testing to insure that HDPE geomembrane is not damaged

Test areas, represented by failed test results, shall be remedied and tested again until appropriate test results are obtained.

#### **4.7.3 Post-Construction**

Immediately before placement of the overlying geotextile and protective soil layer, the granular drainage layer surface shall be inspected for defects or any other adverse features. All defective areas shall be repaired. Special attention shall be paid to the final observations of the sidewall and bottom slopes and layer thickness.

#### **4.8 Protective Soil Layer**

This section describes the monitoring activities necessary insure that the protective soil layer is constructed in accordance with design drawings and specifications. Specific tests mentioned in this section are listed and referenced in Attachment A.

##### **4.8.1 Pre-Construction**

Pre-construction CQA activities include sampling and testing of the materials to evaluate its suitability in regard to the project specifications through laboratory testing. Procedures and methods for observing and testing of protective soil layer materials before construction shall include the following:

- a. Grain size
- b. Moisture-density curve (Standard Proctor)
- c. Hydraulic conductivity



These tests shall be performed on samples obtained as the soil is excavated from the borrow sources. Test methods and test frequencies are listed in Attachment A.

#### **4.8.2 Construction**

Construction CQA activities include the following procedures to monitor the construction of the protective soil layer:

- a. Inspection of the geotextile material used to separate the granular layer and the protective layer to insure that it has been installed in accordance to design drawings and specifications. Confirm that overlap requirements are met and that any tears have been repaired prior to placement of protective soil layer.
- b. Inspection and testing of the material prior to placement as follows to insure:
  - Removal of roots, rocks, rubbish, and unsuitable soil from the soil material
  - Identification of changes in material characteristics requiring a change in construction specifications or additional testing
- c. Inspecting and testing of the material compaction to insure:
  - Uniformity of coverage by compaction equipment, especially at compacted fill edges, in equipment turnaround areas, and at the tops and bottoms of slopes. Successive lifts of soil materials shall be placed orthogonal to the previous lift of materials.
  - Uniformity of material measured by performing moisture density tests (ASTM D698)
  - Consistent achievement of the specified hydraulic conductivity (ASTM D698), within the specified moisture range
  - Consistent achievement of the specified soil density (ASTM D6938) and water content throughout each completed lift
  - Achievement of sufficient strength to supply a stable base for supporting overlying fly ash waste materials
  - Prevention of accidental damage of installed portions of the protective soil layer by equipment traffic

Test areas represented by failed test results shall be remedied and tested again until appropriate test results are obtained. Atmospheric conditions shall be observed and recorded by the CQA Contractor and appropriate actions shall be taken when unsuitable weather conditions exist.

#### **4.8.3 Post-Construction**

The protective soil layer surface shall be inspected for cracks, holes, or defects. All defective areas shall be repaired by the Installation Contractor. Soft, wet, or desiccated material shall be removed and the resultant volume replaced. Excavated areas of the material shall be



repaired by the Installation Contractor and subsequent monitoring shall be performed by the CQA Contractor in order to insure continuity between the repaired and undisturbed areas. Special attention shall be paid to the final observations of the sidewall and bottom slopes, soil coverage, moisture content, and layer thickness.

#### **4.8.4 Additional Testing Requirements**

In addition to Construction Quality Assurance for the composite landfill lining system as specified herein, the CQA Contractor shall perform miscellaneous field and laboratory testing as specified in the specifications for non-landfill lining system portions of the Work including, but is not limited to testing of crushed rock surfacing and earthwork which includes general cut and fill and pipe backfill.

#### **4.9 Concrete**

This section describes the monitoring activities necessary for concrete installation.

##### **4.9.1 Construction**

Monitoring activities that will be observed during concrete installation include the following:

- Observations that the concrete placement plans were followed and rebar placement is correct
- Observation of weather conditions
- Observation of proper curing time prior to backfilling, and that the finished concrete product is free from defects and damage caused by equipment or workmanship

#### **5.0 SAMPLING STRATEGY**

It is necessary to estimate the quality of a material or construction process from the observed or measured quality of a representative sample that is a small fraction of the total material or process. Guidance on judgmental sampling and testing is included in this section.

##### **5.1 Sampling Basis**

Sampling methods and testing frequency shall be based on judgmental sampling with minimum sampling frequencies. It is imperative that the judgmental sampling procedure be used in association with minimum sampling frequencies to sample the construction materials or operations being evaluated. Judgmental sampling refers to a sampling strategy where decisions concerning sample size, selection scheme, and/or locations are based on other than probabilistic considerations. The objective is to select typical sample elements that represent a whole process or to identify zones of suspected poor quality. Selection of the sampling location(s) for the construction quality assurance process shall be the responsibility of the CQA Contractor.



## **5.2 Selection of Sample Size**

The judgmental method primarily depends on the judgment of the CQA Contractor, based on engineering and materials evaluation experience. Testing frequency for the judgmental sampling program is set to produce a fixed proportion of the population (such as 10 percent) or to yield a pre-specified sample size per specified unit of time, distance, area, or volume (e.g., taking samples of liner seams on a per linear foot basis). The sample proportions or sizes included in the specifications have been established on the basis of judgment and experience from similar construction projects. Sampling schemes are used to specify minimum sampling frequencies. These frequencies shall be increased to identify potential problem areas where additional tests should be made. Samples ideally shall be located where the CQA Contractor has reason to doubt the quality of materials or workmanship.

## **5.3 Corrective Measures**

When inspections or tests indicate that materials or work do not meet the tolerances set forth in the specifications, corrective measures shall be implemented. For material subject to 100 percent inspection, substandard material shall be rejected. When workmanship subject to 100 percent inspection is rejected (e.g., HDPE or LLDPE geomembrane seams), it shall be redone until it meets specifications. For material or workmanship subject to judgmental methods which is in question because of CQA Contractor observations or test results, additional testing of the component is necessary prior to rejecting the block of work and implementing the corrective measures set forth in the specifications. This additional testing shall confirm that there is either a problem with the construction or an invalid test result has been reported. The Owner shall be made aware of all failed tests, the extent of any rejected material or workmanship, and all proposed corrective measures. CQA Contractor shall monitor the remediation to insure the appropriate test results are obtained.

## **6.0 DOCUMENTATION**

The CQA Plan depends to a large extent on recognizing the construction activities that should be monitored and assigning responsibility to the CQA Contractor for the monitoring of each activity. This shall be accomplished most effectively by documenting CQA activities. The CQA Contractor shall note, through required descriptive remarks, data sheets, and checklists signed by them, that the monitoring activities have been accomplished. Representative examples of data and monitoring sheets are shown in Attachment B.

### **6.1 Daily Recordkeeping**

Standard daily reporting procedures include preparation of a summary report with supporting monitoring data sheets and, when appropriate, problem identification and corrective measures reports.

#### **6.1.1 Daily Monitoring Report**

The CQA Contractor shall prepare a daily summary report. This report shall provide the chronological framework for identifying and recording all other reports. At a minimum, the summary reports shall include the following information:



- a. Unique identifying sheet number for cross-referencing and document control
- b. Date, project name, location, and other identification
- c. Data on weather conditions
- d. Reports on meetings held and their results or direction made
- e. Unit processes and locations of construction underway during the time frame of the daily summary report
- f. Equipment and personnel being used in each unit process, including subcontractors
- g. Descriptions of areas or units of work being monitored and documented
- h. Description of off-site materials received, including any quality verification (vendor certification) documentation
- i. Calibrations or re-calibrations of test equipment, including actions taken as a result of re-calibration
- j. Decisions made regarding material or work, and/or corrective actions to be taken in instances of substandard quality
- k. Unique identifying sheet numbers of monitoring data sheets and/or problem reporting and corrective measure reports used to substantiate the decisions described in the preceding item
- l. Signature of the appropriate CQA Contractor supervisor

Items above shall be summarized into site-specific checklists and data sheets.

### **6.1.2 Monitoring Data Sheets**

The CQA Contractor shall record the field and/or laboratory test on monitoring data sheets. Required data to be addressed for most of the standardized test methods are included in the pertinent ASTM Standards. Recorded observations may take the form of notes, charts, sketches, photographs, or any combination of these. Where possible, a checklist shall be developed and used to insure that pertinent factors of a specific observation are not overlooked. At a minimum, the monitoring data sheets shall include the following information:

- a. Unique identifying sheet number for cross-referencing and document control
- b. Description or title of the monitoring activity and date
- c. Location of the monitoring activity or location from which the sample increment was obtained
- d. Type of monitoring activity procedure used (referenced to standard method when appropriate)
- e. Recorded observation or test data, with all necessary calculations
- f. Results of the monitoring activity; comparison with specification requirements
- g. Personnel involved in the monitoring activity
- h. Signature of the appropriate CQA Contractor supervisor



### **6.1.3 Problem Identification and Corrective Measures Reports**

Problem identification and corrective measures reports, prepared by the CQA Contractor shall be cross-referenced to specific monitoring data sheets where the problem was identified. At a minimum, they shall include the following information:

- a. Unique identifying sheet number for cross-referencing and document control
- b. Description of the problem
- c. Location of the problem
- d. Probable cause of the problem
- e. How and when the problem was located (reference to monitoring data sheets)
- f. Estimation of how long problem has existed
- g. Suggested corrective measure
- h. Documentation of correction (reference to monitoring data sheets)
- i. Final results
- j. Suggested methods to prevent similar problems
- k. Signature of the appropriate CQA supervisor

In some cases, not all of the above information shall be available or obtainable. However, when available, such efforts to document problems could help to avoid similar problems in the future. Upon receiving the CQA Contractor's written concurrence, copies of the report shall be submitted to the Owner for their comments and acceptance.

### **6.2 Photographic Reporting Data Sheets**

Photographic reporting data sheets, prepared by the CQA Contractor shall be cross-referenced or appended to monitoring data sheets and/or problem identification and corrective measure report. At a minimum, photographic reporting data sheets shall include the following information:

- a. A unique identifying number on data sheets and photographs for cross-referencing and document control.
- b. The date, time, and location where the photograph was taken and weather conditions.
- c. The size, scale, and orientation of the subject matter photographed.
- d. Location and description of the work.
- e. Signature of the photographer and the CQA supervisor.

These photographs shall serve as a pictorial record of work progress, problems, and corrective measures.

### **6.3 Construction Quality Control Daily Summary Report and Data Sheets**

The CQA Contractor shall submit a CQC daily summary report and the corresponding CQC data sheets to the Owner and Engineer on a daily basis. The daily summary report and data sheets shall contain the information listed in 6.1.1 and 6.1.2 above.





#### **6.4 Acceptance of Completed Components**

All daily monitoring summary reports, monitoring data sheets, and problem identification and corrective measures reports shall be retained by the CQA Contractor. The documentations shall be evaluated for internal consistency and for consistency with similar work. Timely review of these documents shall permit errors, inconsistencies, and other problems to be detected and corrected as they occur, when corrective measures are easiest to implement. The above information shall be assembled and summarized into bi-weekly acceptance reports. These reports shall indicate the materials used and construction processes. These reports shall be included in project records, which shall be kept on file with the Owner.

#### **6.5 Final Documentation**

At the completion of landfill construction, the CQA Contractor shall develop a final report. This report shall include all of the daily monitoring summary reports, monitoring data sheets, problem identification and corrective measures reports, photographic reporting data sheets, acceptance reports, deviations from design and material specifications (with justifying documentation), and record drawings. The final report shall be sealed and certified by a Professional Engineer registered in the State of Indiana. The report shall, at a minimum, include:

- a. Document index and table of contents
- b. Plan view of entire facility to show construction progression
- c. Soil liner grades; soil lift compaction tests results; laboratory and in-situ hydraulic conductivity test results; statistical verification and certification by a registered engineer showing work was constructed in accordance with the CQA Plan, design drawings and specifications
- d. Granular drainage layer and protective soil layer depth verification information
- e. CHDPE piping installation observation
- f. All monitoring device/equipment specifications and warranties
- g. All testing locations and results and equipment calibrations performed during construction
- h. Minimum of two cross-sections (one north-south and one east-west) through the completed landfill phase and cover
- i. Dated photographs of phases of construction
- j. Comprehensive narrative of construction of CCL, GCL, HDPE geomembrane liner and LLDPE geomembrane liner components, and granular drainage layer, geotextile, cover material including all test reports, inspection reports, daily summaries, and problem identification and corrective actions
- k. Forms/tables showing the following HDPE and LLDPE geomembrane installation information:
  - Geomembrane Manufacturer's certification and certificate analysis, including roll number, resin specifications, and finished HDPE geomembrane specifications



- Geomembrane Manufacturer's certification and certificate analysis, including roll number, resin specifications, and finished LLDPE geomembrane specifications
- Conforming to Construction Record drawing showing panel layout, liner penetration locations, record drawing of sump, seam locations, defect and repair locations, and certificate of acceptance of soil subgrade by Installation Contractor
- Trial weld information including date/time, ambient temperature, weld type, shear and peel test results, welding equipment ID number, welding technician ID number
- Panel placement information including panel dimension and panel number, date/time of placement, and roll number
- Panel seaming information including date/time of seaming, seam ID number, panel number and seam length, and weather conditions
- Nondestructive testing information including starting date/time and pressure, ending date/time, and pressure, seam ID number, and pass/fail results
- Destructive testing information including date, location of test, sample ID number, seam ID number, field/lab peel and shear test results, pass/fail results
- Repairs information including date, panel number, location of repair and patch size, test results, pass/fail results

#### I. Explanation of any deviations from the CQA/CQC Plan

This document shall be signed by the CQA Contractor and included as part of the CQA Plan documentation. This document shall also include the CQC daily summary reports and CQC data sheets as an attachment. Final documentation as part of the CQA Plan documentation does not sanction the CQA Plan as a guarantee of facility construction and performance. Rather, the primary purpose of the final documentation is to improve confidence in the constructed facility through written evidence that the CQA Plan was implemented as proposed and that the construction proceeded in general accordance with the design drawings and specifications.

#### 6.5.1 Responsibility and Authority

The final documentation shall reemphasize that areas of responsibility and lines of authority were clearly defined, understood, and accepted by all parties involved in the project. Signatures of the Owner's field representatives, the CQA Contractor, and the Installation Contractor (including all subcontractors) shall be included as confirmation that each party understood and accepted the areas of responsibility, lines of authority, and performed their function(s) in accordance with the CQA Plan.

#### 7.0 DOCUMENT CONTROL

The CQA Plan and all CQA documentation shall be maintained under a document control procedure. This indexing procedure shall provide for convenient replacement of pages in the CQA Plan thereby not requiring a revision to the entire document. It shall identify the revisions status of the CQA documents, and enable the CQA documents to be organized in terms of their relationship to each other, the CQA Plan, and the time and location of the materials and/or workmanship that they represent. For CQA documentation, a control



scheme shall be used to organize and index all CQA documents. This scheme shall be designed to allow easy access to all CQA documents and shall enable a reviewer to identify and retrieve original data sheets for any completed block of work or facility component. This shall require a unique identifying number for each CQA record and an indexing scheme to relate summary reports to the original monitoring data sheets. For example, each daily summary report shall clearly identify the monitoring data sheets upon which it is based. Problem identification and corrective measures reports also shall identify the pertinent monitoring data sheets that identified the substandard materials or workmanship, and monitoring data sheets that document construction quality after implementation of the corrective measures.

## **7.1 Storage Of Records**

During the construction activities, the CQA Contractor shall be responsible for all CQA documents. This includes the CQA Contractor's copy of the design criteria, drawings, and specifications, the CQA Plan, and the originals of all of the data sheets and reports. Duplicate records shall be maintained at another location to avoid loss of this information if the originals are destroyed. Once construction is complete, the document originals shall be transmitted to the Owner and stored by the Owner in a manner that allows for easy access while still protecting them from any damage. All documentation shall be maintained through landfill operation and post-closure.

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## **ATTACHMENT A**

### **CONSTRUCTION QUALITY ASSURANCE MONITORING/ TEST METHODS/TEST FREQUENCY**



**Attachment A**  
**Construction Quality Assurance Monitoring/  
 Test Methods/Test Frequency**

Units: SF = square feet; SY = square yard; CY = cubic yard

Facility Component	Factor to be Monitored	Monitoring/Testing Method	Test Method Reference	Test Frequency****	Estimated Number of Tests*
Subgrade	Removal of unsuitable materials	Observation	NA		
	Proofrolling of subgrade	Observation	NA		
	Filling of surface sloughs	Observation	NA		
	Surface water runoff control	Observation	NA		
	Surface finishing	Observation	NA		
	Slope	Surveying	NA		
	Depth of excavation	Surveying	NA	One per 100-foot grid spacing	
	Soil compaction	Nuclear gauge	ASTM D6938	One for every 5,000 SY of prepared subgrade	
	Moisture	Nuclear gauge	ASTM D6938	One for every 5,000 SY of prepared subgrade	
	Moisture-density curve	Standard proctor	ASTM D698	One for every 30,000 SY of prepared subgrade and all changes in material	
Off-site Clay Borrow Source	Soil index properties	Grain size	ASTM D422	One for every 1,000 CY	
	Soil index properties	Atterberg limits	ASTM D4318	One for every 1,000 CY	
	Moisture	Water content	ASTM D2216	One for every 1,000 CY	
	Moisture-density curve	Standard proctor	ASTM D698	One for every 5,000 CY and all changes in material	
	Hydraulic conductivity	Lab hydraulic conductivity	ASTM D5084	One for every 10,000 CY	



Facility Component	Factor to be Monitored	Monitoring/Testing Method	Test Method Reference	Test Frequency****	Estimated Number of Tests*
		(remolded samples)			
Compacted Clay Liner	Slope	Surveying	NA		
	Thickness	Surveying	NA	One per 100-foot grid spacing	
	Density	Nuclear gauge Sand cone	ASTM D6938 ASTM D1556	Five per acre per lift, randomly selected and evenly distributed	
	Moisture content	Nuclear gauge	ASTM D6938	Five per acre per lift, randomly selected and evenly distributed	
	Hydraulic conductivity (retaining Density and Moisture information)	Undisturbed hydraulic conductivity	ASTM D5084	One per acre per lift	
	Soil index properties	Atterberg limits	ASTM D4318	One per acre per lift and each type of material	
	Soil index properties	Grain size	ASTM D422	One per acre per lift and each type of material	
Compacted Clay Liner (cont.)	Moisture-density curve	Standard proctor	ASTM D698	One for every 5,000 CY and all changes in material	
HDPE Geomembrane Liner	Handling and storage	Observation	NA		
	Thickness**	Thickness	ASTM D5199	5 measurements per roll evenly distributed	
	Density	Density	ASTM D1505/ D792	One per 50,000 SF or one per lot	
	Melt Flow Index	Melt Flow Index	ASTM D1238	One per 50,000 SF or one per lot	
	Tensile properties**	Tensile properties	ASTM D638	One per 50,000 SF or one per lot	
	Tear resistance**	Tear strength of plastic sheeting	ASTM D1004	One per 50,000 SF or one per lot	
	Carbon black content**	Carbon black content	ASTM D1603	One per 50,000 SF or one per lot	



Facility Component	Factor to be Monitored	Monitoring/Testing Method	Test Method Reference	Test Frequency****	Estimated Number of Tests*
HDPE Geomembrane Liner (cont.)	Carbon black dispersion**	Carbon black dispersion	ASTM D5596	One per 50,000 SF or one per lot	
	Destructive testing of seams**	Bonded seam strength in shear and peel	ASTM D4437	One per every 500 LF of fusion weld seam and one per every 400 LF of extrusion weld seam	
	Nondestructive testing of seams***	Air testing for fusion weld seams; vacuum testing for extrusion weld seams	Project Specification	100% of all seams	
	Welding materials	Manufacturer's certification	NA		
	Welding equipment	Manufacturer's certification	NA		
	Installer test weld***	Bonded seam strength in shear and peel	ASTM D4437	One in morning and afternoon per operating technician per welder. Additional testing when equipment is shut off longer than 30 minutes, when wide temperature fluctuations occur, and after four hours of continuous welder operation.	
	Anchoring	Observation	NA	Shall withstand liner movement/damage due to wind forces. Final anchoring shall conform to IDEM Guidance Document for Geomembrane Liner	
	Overlap	Observation	NA	3 inches minimum for extrusion welding or 5 inches minimum for fusion welding	

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Facility Component	Factor to be Monitored	Monitoring/Testing Method	Test Method Reference	Test Frequency****	Estimated Number of Tests*
LLDPE Geomembrane Liner	Handling and storage	Observation	NA		
	Thickness**	Thickness	ASTM D5199	5 measurements per roll evenly distributed	
	Density	Density	ASTM D1505/ D792	One per 50,000 SF or one per lot	
LLDPE Geomembrane Liner	Melt Flow Index	Melt Flow Index	D1238	One per 50,000 SF or one per lot	
	Tensile properties**	Tensile properties	ASTM D638	One per 50,000 SF or one per lot	
	Tear resistance**	Tear strength of plastic sheeting	ASTM D1004	One per 50,000 SF or one per lot	
	Carbon black content**	Carbon black content	ASTM D1603	One per 50,000 SF or one per lot	
	Carbon black dispersion**	Carbon black dispersion	ASTM D5596	One per 50,000 SF or one per lot	
	Destructive testing of seams**	Bonded seam strength in shear and peel	ASTM D4437	One per every 500 LF of fusion weld seam and one per every 400 LF of extrusion weld seam	
	Nondestructive testing of seams***	Air testing for fusion weld seams; vacuum testing for extrusion weld seams	Project Specification	100% of all seams	
	Welding materials	Manufacturer's certification	NA		
	Welding equipment	Manufacturer's certification	NA		





Facility Component	Factor to be Monitored	Monitoring/Testing Method	Test Method Reference	Test Frequency****	Estimated Number of Tests*
LLDPE Geomembrane Liner (cont.)	Installer test weld***	Bonded seam strength in shear and peel	ASTM D4437	One in morning and afternoon per operating technician per welder. Additional testing when equipment is shut off longer than 30 minutes, when wide temperature fluctuations occur, and after four hours of continuous welder operation.	
	Anchoring	Observation	NA	Shall withstand liner movement/damage due to wind forces. Final anchoring shall conform to IDEM Guidance Document for Geomembrane Liner	
	Overlap	Observation	NA	3 inches minimum for extrusion welding or 5 inches minimum for fusion welding	
HDPE Pipe	Installation and Hydro-testing	Observation	NA	Check for proper weld beads and tests conforming to specifications	
Geotextile	Seaming	Observation	NA	3 inch min overlap on flat surfaces, 6-8 inches around pipe depending on diameter. Check for proper sewed seams.	
Granular Drainage Layer	Grain size (to the No. 200 sieve)	Particle size analysis	ASTM D422	One per 1,500 CY or 2,400 Ton	
	Hydraulic conductivity	Hydraulic conductivity	ASTM D2434	One per 3,000 CY or 4,800 Ton	
	Thickness	Surveying	NA	One per 100-foot grid	



Facility Component	Factor to be Monitored	Monitoring/Testing Method	Test Method Reference	Test Frequency****	Estimated Number of Tests*
				spacing	
Protective Soil Layer	Grain size (to the No. 200 sieve)	Particle size analysis	ASTM D1140	One per 1,500 CY or 2,400 Ton	
	Hydraulic conductivity	Hydraulic conductivity	ASTM D2434	One per 3,000 CY	
	Moisture-density curve	Standard proctor	ASTM D698	One per acre per lift and change in material	
	Density Index Density (cohesionless)	Nuclear gauge Sand cone Vibratory Table	ASTM D6938 ASTM D1556 ASTM D4253/D4254	One per acre per lift evenly distributed	
	Moisture Content	Nuclear gauge	ASTM D6938	One per acre per lift evenly distributed	
	Slope	Surveying	NA		
	Thickness	Surveying	NA	One per 100-foot grid spacing	
HDPE Pipe (Stormwater and Solid/Perforated Leachate Pipe)	Alignment	Observation	NA	Shall be +/- 1-inch per 100 feet of pipe. Check for displaced or broken pipe and visible defects.	
	Leakage	Observation of Construction Contractor performed hydrostatic tests	ASTM F1417	Check testing is performed as specified in the Technical Specification Reference Document	
Earthwork	Soil compaction	Nuclear gauge	ASTM D6938	As specified in the Technical Specification Reference Document	
	Moisture Content	Nuclear gauge	ASTM D6938	As specified in the Technical Specification Reference Document	
	Moisture-density curve	Standard proctor	ASTM D698	One initial test and one for every change in material	

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Facility Component	Factor to be Monitored	Monitoring/Testing Method	Test Method Reference	Test Frequency****	Estimated Number of Tests*
Granular Material	Compaction	Vibratory Table	ASTM D4253 and D4254	Minimum of one test per section of trench, not exceeding 500 lineal feet	
Crushed Rock	Compaction	Nuclear gauge	ASTM D6938	One test every 100 feet along roadway	
	Moisture Content	Nuclear gauge	ASTM D6938	One test every 100 feet along roadway	
	Smoothness	Observation	NA	Shall be no deviation in excess of 3/8-inch in 10 feet	

**NOTES:**

- \* Numbers of tests will be estimated when construction plans are prepared for each liner and cover installation package, based on estimated material quantities. Actual number of tests may vary.
- \*\* Test to be conducted by HDPE or LLDPE Geomembrane Liner Manufacturer. Test results shall be reviewed by CQA Monitor.
- \*\*\* Test to be conducted by CQC personnel and observed by CQA personnel. Destructive test samples shall also be sent to third party testing laboratory as specified.
- \*\*\*\* All Test Frequencies are minimum requirements. Additional testing may be requested by the Owner.

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## **ATTACHMENT B**

### **EXAMPLES OF DATA AND MONITORING SHEETS**

## NIPSCO R.M. Schahfer Fly Ash Landfill Closure

### Weekly Project Weather Report

Project Number:

Report Number:

Phase Number:

Date	Day	Temp °F		Inches		Weather Description	
		High	Low	Rain	Snow		
	Mon.						
	Tue.						
	Wed.						
	Thur.						
	Fri.						
	Sat.						
	Sun.						
Additional Comments						Legend	
						C Clear	
						PC Partly Cloudy	
						OC Overcast	
						LR Light Rain	
						HR Heavy Rain	
						LS Light Snow	
						HS Heavy Snow	
						Reported By	
Notes							
1. Rainfall to tenths - Snow to tenths. Record the time frames of each. 2. Identify the portion or area within the total project represented by this report if different from the total project. 3. Attach a copy of this report to each package of Contractor's Weekly Construction Progress Reports							



**NIPSCO R.M. Schahfer Fly Ash Landfill Closure**

**SUBGRADE ACCEPTANCE REPORT**

**Project Number:**

**Date:**

**Installer  
Representative:**

**Phase:**

**Description of  
Inspected Area:**

**Remedial Action Required:**

\_\_\_\_\_  
Signature - Installer

\_\_\_\_\_  
Signature- CQA Monitor

















**NIPSCO R.M. Schahfer Fly Ash Landfill Closure**

**DAILY FIELD ACTIVITIES REPORT**

Project Number:

Date:

Contractor:

Phase Number:

Geosynthetic Installer:

Activities: \_\_\_\_\_

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Equipment Used: \_\_\_\_\_

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Signature - CQA Monitor