UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4
Science and Ecosystem Support Division
Enforcement and Investigations Branch
980 College Station Road
Athens, Georgia 30605-2720

October 24, 2008

**4SESD-EIB-ES**

**MEMORANDUM**

**SUBJECT:** SESD-EIB-ES Document Review for the SWMU 4 – Sludge Lagoon Closure & Post-Closure Plan for ArvinMeritor/ Grenada Manufacturing, Grenada, Mississippi
EPA ID No. MSD 007 037 278; SESD Project No.09-0018

**FROM:** Sharon Matthews, P.G. SFM 10/24/08
Enforcement Section

**THRU:** Mike Bowden, Chief MBowden 10/24/08
Enforcement Section

**TO:** Don Webster
Corrective Action Section
Restoration and Underground Storage Tank Branch

Attached is the document review for the subject facility. If you have any questions, please contact me at (706) 355-8608 or at email matthews.sharon@epa.gov.

---

Section 1 – Good summary of the site/regulatory history.

Section 2 - The information given in this section coincides with notes I have taken from what has been discussed in past meetings/email/correspondence with the facility and their consultant. In addition, I would suggest that someone from the Mississippi Department of Environmental Quality (MDEQ) review this document since their Nonhazardous Solid Waste Management Regulations were used to prepare this closure/post-closure plan for the Sludge Lagoon.

Section 3 – The information given in this section appears to satisfy the financial assurance requirements. However, I would suggest that Financial Assurance personnel more familiar with this subject also review this section for adequacy.



DOCKET NO. 633488

Section 4 – No comment.

Appendix A – this section is an elaboration of the information given by ArvinMeritor and Brown and Caldwell personnel during the 10/29/07 meeting in the USEPA Atlanta office. The bench-scale data given here indicates that the in-situ solidification/stabilization for the Sludge lagoon materials is an acceptable choice for the treatability of this unit.

Appendices B and C – I would suggest that engineering personnel review these sections on Bearing Capacity Calculations and using the HELP Model.

Appendix D – The information given here in the Construction Quality Assurance Plan appears to adequately address how the Sludge Lagoon will be closed in accordance with the applicable requirements. I would suggest that personnel more familiar with using Geotextiles for closing units such as the Sludge Lagoon also review this section.

Appendices E and F - I would suggest that engineering personnel review these sections on soil erosion and settlement calculations.

Appendices G, H and I – No comment.

Appendix J - The information given in this section appears to satisfy the financial assurance requirements. However, I would suggest that Financial Assurance personnel more familiar with this subject also review this section for adequacy.

Attachments – No comment.

4700 Lakehurst Court
Suite 100
Columbus, OH 43016

Tel: (614) 410-6144
Fax: (614) 410-3088

2008 SEP 22 P 1:29

RESTORATION & UNDERGROUND
STORAGE TANK BRANCH

BROWN AND CALDWELL

September 19, 2008

131016.002

Mr. Donald Webster
U.S. EPA Region 4
Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, GA 30303

Subject: Solid Waste Management Unit 4 – Sludge Lagoon
Closure and Post-Closure Care Plan
Grenada, Mississippi

Dear Mr. Webster:

On behalf of ArvinMeritor, Inc., Brown and Caldwell (BC) respectfully submits the enclosed Closure and Post-Closure Care Plan (Plan) for Solid Waste Management Unit 4 – Sludge Lagoon at the former ArvinMeritor, Inc. facility in Grenada, Mississippi. Three copies of the Plan are enclosed for your distribution and review.

If you have any questions during your review of the Plan, please do not hesitate to contact us at (614) 410-6144.

Very truly yours,

Brown and Caldwell

Richard A. Isaac, P.E.
Principal Engineer

Ihsan Al-Fayyomi
Vice President

Enclosures

c: David O'Connor, ArvinMeritor, Inc.
Don Williams, Grenada Stamping

# SOLID WASTE MANAGEMENT UNIT 4 – SLUDGE LAGOON CLOSURE AND POST-CLOSURE CARE PLAN

Prepared for

ArvinMeritor

Troy, Michigan

September 19, 2008

BROWN AND CALDWELL

4700 Lakehurst Court, Suite 100

Dublin, Ohio 43016

# TABLE OF CONTENTS

LIST OF FIGURES ..... III

LIST OF TABLES ..... III

LIST OF ACRONYMS ..... IV

1. INTRODUCTION ..... 1-1
   Site/Regulatory History ..... 1-1
   Corrective Action Objectives ..... 1-3
   Purpose ..... 1-4
   Closure and Post-Closure Care Plan Format ..... 1-4

2. CLOSURE AND POST-CLOSURE ..... 2-1
   *2.1 Section IV Part E: Closure and Post-Closure Care* ..... 2-1
      *1. Closure/Post-Closure Plan* ..... 2-1
      *2. Closure Requirements* ..... 2-3
      *3. Post-Closure Requirements* ..... 2-12

3. FINANCIAL REQUIREMENTS ..... 3-1
   *3.1 Section IV Part F Financial Assurance* ..... 3-1
      *1. Financial Assurance for Closure* ..... 3-1
      *2. Financial Assurance for Post-Closure Care* ..... 3-4
      *3. Financial Assurance for Corrective Action* ..... 3-6
      *4. Criteria for Allowable Mechanisms* ..... 3-7

4. LIMITATIONS ..... 4-1
   Document Limitations ..... 4-1

APPENDIX A ..... A
   Lagoon Solidification/Stabilization Study ..... A

APPENDIX B ..... B
   Bearing Capacity Calculations ..... B

APPENDIX C ..... C
   HELP Model Results ..... C

APPENDIX D ..... D
   Construction Quality Assurance Plan ..... D

APPENDIX E ..... E
   Soil Erosion Calculations ..... E

APPENDIX F ..... F
   Settlement Calculations ..... F

APPENDIX G ..... G
Post-Closure Care Inspection Log ..... G
APPENDIX H ..... H
Opinion of Probable Closure Cost ..... H
APPENDIX I ..... I
Opinion of Probable Post-Closure Care Cost ..... I
APPENDIX J ..... J
Financial Assurance Mechanism ..... J
REFERENCES ..... 1

## LIST OF FIGURES

Figure 1-1. Site Location Map ..... 1-2
Figure 1-2. Location of Solid Waste Management Units and Areas of Concern ..... 1-5
Figure 2-1. Final Cover System Configuration ..... 2-8

## LIST OF TABLES

Table 2-1. Textured HDPE Geomembrane Material Properties ..... 2-5
Table 2-2. Double-Sided Geocomposite Material Properties ..... 2-7
Table 2-3. Seeding Specifications ..... 2-10
Table 3-1. Opinion of Probable Closure Cost ..... 3-2
Table 3-2. Opinion of Probable Post-Closure Care Cost ..... 3-5

# LIST OF ACRONYMS

| | | | |
|---|---|---|---|
| AOC | Area of Concern | PC | Portland Cement |
| AS | Alternative Standard | PCE | Tetrachloroethene |
| ASTM | American Society of Testing and Materials | PID | Photoionization Detector |
| bgs | Below Ground Surface | PMP | Project Management Plan |
| CFR | Code of Federal Regulations | ppm | Parts Per Million |
| CKD | Cement Kiln Dust | PR | Preliminary Review |
| CMS | Corrective Measures Study | PRB | Permeable Reactive Barrier |
| COC | Constituent of Concern | psi | Pounds Per Square Inch |
| DCA | Dichloroethane | PTW | Plant Temporary Well |
| DCE | Dichloroethene | QAPP | Quality Assurance Project Plan |
| DOT | Department of Transportation | RCRA | Resource Conservation and Recovery Act |
| DNAPL | Dense Non-Aqueous Phase Liquid | RFA | RCRA Facility Assessment |
| DTW | Depth to Water | RI | Remedial Investigation |
| GAC | Granular Activated Carbon | ROST | Rapid Optical Screening Tool |
| HSWA | Hazardous and Solid Waste Amendment | s.u. | Standard Units |
| HVMPE | High-Vacuum Multi-Phase Extraction | SVE | Soil Vapor Extraction |
| ICU | Intermediate Confining Layer | SVOC | Semi-Volatile Organic Compounds |
| IP | Interface Probe | SWMU | Solid-Waste Management Unit |
| LB | Lagoon Boring | TCA | Trichloroethane |
| LKD | Lime Kiln Dust | TCE | Trichloroethene |
| LLC | Limited Liability Company | TDS | Total Dissolved Solids |
| LNAPL | Light Non-Aqueous Phase Liquid | TSF | Tons Per Square Foot |
| LTW | Lagoon Temporary Well | UCS | Unconfined Compressive Strength |
| MCL | Maximum Contaminant Level | USEPA | United States Environmental Protection Agency |
| MIP | Membrane Interface Probe | VC | Vinyl Chloride |
| MW | Monitoring Well | VOC | Volatile Organic Compound |
| MDEQ | Mississippi Department of Environmental Quality | VSI | Visual Site Inspection |
| NAPL | Non-Aqueous Phase Liquid | ZVI | Zero-Valent Iron |

# 1. INTRODUCTION

## Site/Regulatory History

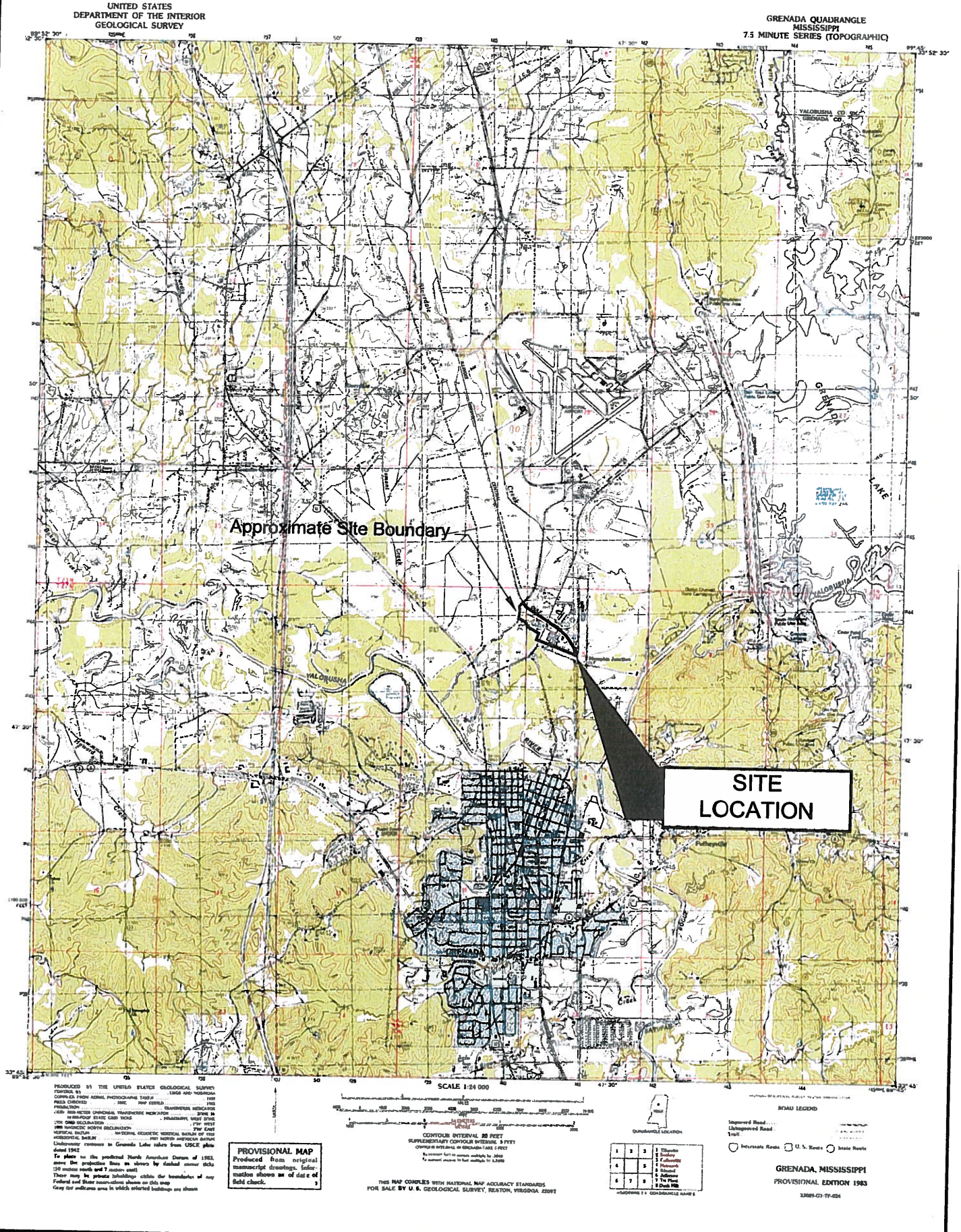
The entities formerly comprising the Automotive Division of Rockwell International Corporation (Rockwell), which are now, through a series of corporate transactions and restructurings, a part of ArvinMeritor, Inc. (ArvinMeritor), owned and operated a wheel-cover manufacturing facility located at 635 Highway 332 in Grenada, Mississippi (see Figure 1-1). The facility was operated by Rockwell from 1966 to 1985, before the operations and property were sold to Textron Automotive Company, formerly Randall Textron. In 1999, Textron Automotive Company sold the operations and property to Grenada Manufacturing, LLC, who continues to operate the wheel cover plant today.

ArvinMeritor and Textron have conducted a number of environmental investigations at the facility (hereafter referred to as the Site). The 1994 Remedial Investigation (RI) Report (RI Report) detailed sampling and analyses of soil, surface water, sediment, and groundwater at the facility. The RI Report contained a description of the Site, including its geology and hydrogeology as well as the sampling and analysis work that was conducted. Results from the investigation were discussed on a site-wide basis because solid waste management units (SWMUs) and areas of concern (AOCs) had not yet been defined. In addition to soil and groundwater impacts, two areas containing free-phase organics, light non-aqueous phase liquid (LNAPL), and dense non-aqueous phase liquid (DNAPL) were identified.

The RI Report identified the presence of trichloroethylene (TCE) and its degradation products as well as toluene and chromium in the soil and groundwater at the Site. A Baseline Risk Assessment (BRA) was performed for soil and groundwater as part of a Supplemental RI (March 1994). The primary concern with respect to impacted groundwater was the migration of chlorinated volatile organic compounds (VOCs) to Riverdale Creek on the western side of the Site. The BRA identified eight VOCs (1,2-dichloroethane [1,2-DCA], 1,1-dichloroethene [1,1-DCE], 1,2-dichloroethene [1,2-DCE] [total], tetrachloroethene [PCE], toluene, 1,1,2-trichloroethane [1,1,2-TCA], TCE, and vinyl chloride [VC]), one semi-volatile organic compound (SVOC) bis (2-ethylhexyl) phthalate, and two metals (chromium VI and arsenic) as constituents of concern (COC).

Subsequent to the submittal of the RI Report, the facility became subject to regulation under the Resource Conservation and Recovery Act (RCRA). A RCRA Facility Assessment (RFA) was performed by the United States Environmental Protection Agency (U.S. EPA) and its contractor (A.T. Kearney, Inc.) as part of the Hazardous and Solid Waste Amendments (HSWA) permit process for the Site in 1996 and 1997. As a result of the Preliminary Review (PR) and Visual Site Inspection (VSI), 26 SWMUs and 3 AOCs were identified.

In 1998, ArvinMeritor collected another set of groundwater samples to measure VOC concentrations and to evaluate the potential for natural attenuation processes for remediation of the groundwater contamination. Analyses included VOCs and bioremediation parameters recommended in U.S. EPA's document, *"Technical Protocol for Evaluating Monitored Natural Attenuation of Chlorinated Solvents in Ground Water"* (U.S. EPA, 1998). The data are presented in a January 1999 report by Brown and Caldwell (BC) titled *"Supplemental Groundwater Sampling and Analysis: Natural Attenuation Evaluation."* The evaluation established that natural attenuation was reducing the quantities of chlorinated solvents in Site groundwater.




Apr 15, 2008 - 4:00pm rwelch

P:\ArvinMeritor\Grenada\Technical Review (131016)\Reports\Sludge Lagoon Closure\Figures\Site Location Map.dwg

BROWN AND CALDWELL

FIGURE 1-1
SITE LOCATION MAP

In January 2001, after submittal and approval of the June 2000 Interim Measures (IM) Work Plan, BC prepared and submitted the RCRA Facility Investigation (RFI) Report. This RFI Report was revised in October 2001 and included results of site-wide sampling for VOCs, SVOCs, and other contaminants. In August 2003, the Corrective Measures Study (CMS) Report, which summarized work completed at the Site, specified the installation of a zero-valent-iron (ZVI) permeable reactive barrier (PRB) as the Site's remediation technology, and outlined potential additional remedial measures, was submitted to the U.S. EPA and approved. Construction of the PRB was completed in the spring of 2005 and a performance monitoring program has been in place since then.

In July 2006, the Corrective Measures Pre-Design Work Plan (Work Plan) was prepared based upon review of the CMS recommendations. The Work Plan outlined additional Site investigations necessary to fully evaluate the need for the corrective measures recommended in the CMS and to design those corrective measures deemed necessary. The Work Plan, submitted to and approved by the U.S. EPA, outlined a suite of pre-design investigation activities that were subsequently performed by BC in 2007, the results of which were presented in the Corrective Measures Pre-Design Investigation Results dated February 2008. Recommendations/conclusions from the 2008 Corrective Measures Pre-Design Investigation include the following:

1. Temporary wells in the Main-Plant Area and around the Sludge Lagoon showed that DNAPL is no longer present in AOC A and that neither LNAPL nor DNAPL is present around the Sludge Lagoon. The temporary wells should be abandoned according to Mississippi standards.
2. Two areas around the Sludge Lagoon exhibit elevated VOC concentrations and the extent of the final cover system designed for the Sludge Lagoon should extend over these two identified areas.
3. Combination of the lagoon sludge, Type I Portland Cement, and lime kiln dust is recommended, as it provides adequate solidification/stabilization of the sludge to prevent migration and to support a final cover system.
4. Installation of a sheet pile barrier is not recommended since no significant gain in contaminant reduction or control would be achieved.
5. The high-vacuum multi-phase pilot test resulted in minimal enhancement to product recovery; the recommendation is to employ more passive strategies e.g., manual extraction with Teflon™ bailers.
6. Additional signage should be posted at the PRB and Sludge Lagoon with the existing property use restrictions to remain in effect for evaluation at five-year intervals without additional deed restrictions.

## Corrective Action Objectives

Several corrective actions were identified in the CMS to control exposure and migration of the contamination at the Site. These actions take into consideration site characteristics, land use, current conditions, and previous and on-going source control measures. The following corrective actions, included in the CMS, were identified for the Sludge Lagoon:

1. Prevent further degradation of soil and groundwater with appropriate source control corrective measures. Utilize the PRB as a site-wide migration control measure.
2. Comply with standards for management of waste during corrective measure implementation.
3. Develop and implement use restrictions/institutional controls for site soil and groundwater to prevent future exposures.

4. Implement the approved Performance Monitoring Plan to track the progress of the corrective action program.

This Closure and Post-Closure Care Plan was chosen to address the corrective action objectives for the Sludge Lagoon.

## Purpose

The purpose of this Closure and Post-Closure Care Plan (Plan) is to address the corrective measures identified for the onsite Sludge Lagoon, designated as SWMU 4, at the Site. The Sludge Lagoon is one of four SWMUs or AOCs at the Site undergoing RCRA corrective action for releases of hazardous constituents (see Figure 1-2). The CMS, conducted and submitted in August 2003, identified four corrective measures to address the Sludge Lagoon including source and migration controls. The Sludge Lagoon corrective measures include the following:

| Source Controls | Migration Controls |
|---|---|
| Solidification/Stabilization | Permeable Reactive Barrier |
| Capping/Cover System | |
| NAPL Recovery | |

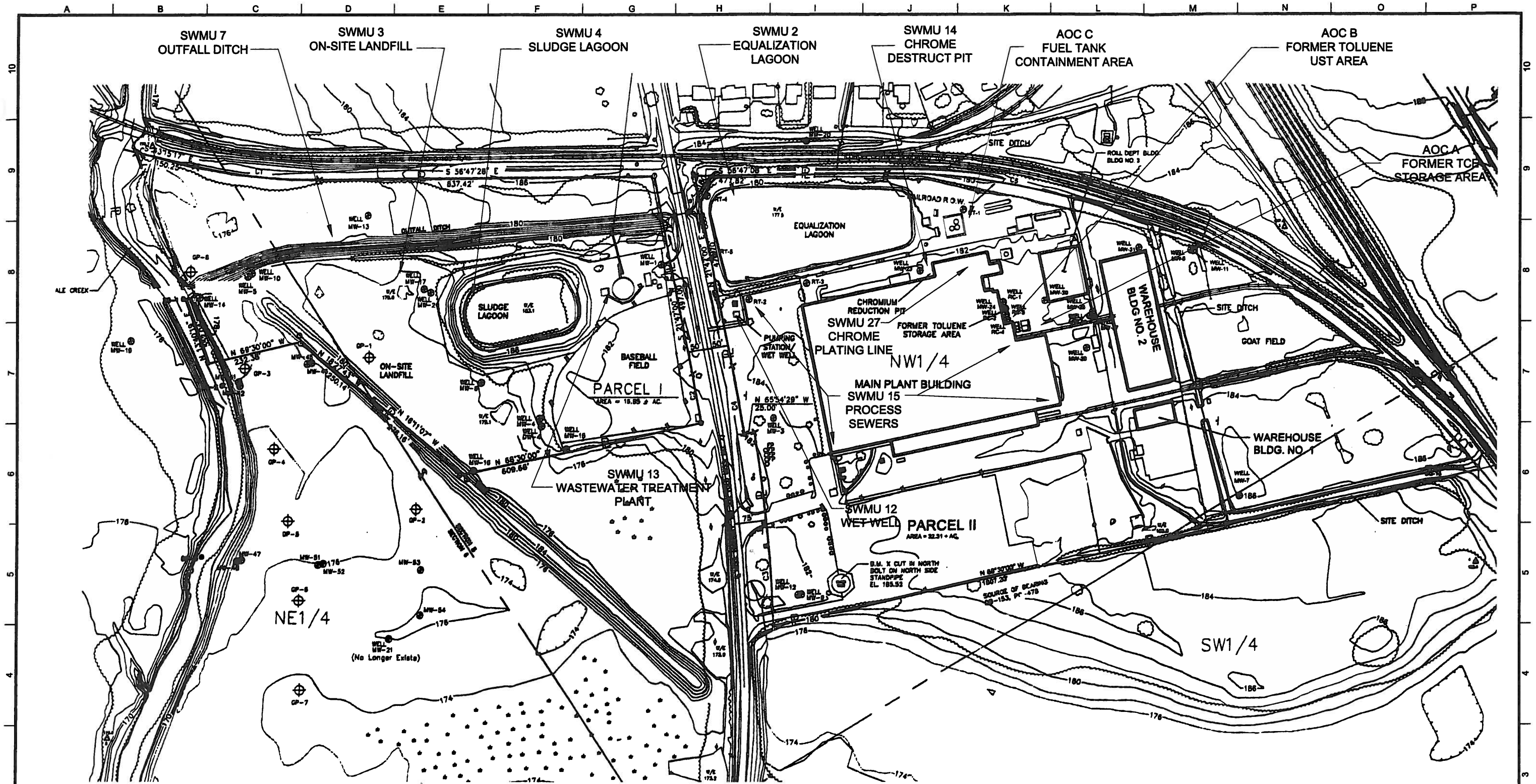
The Non-Aqueous Phase Liquid (NAPL) Recovery source control was addressed as part of the Corrective Measures Pre-Design Investigation conducted by BC throughout the calendar year 2007. No LNAPL or DNAPL was detected in the lagoon temporary well (LTW) couplets; therefore, NAPL will not be addressed in the Plan. The recommendations from the Corrective Measures Pre-Design Investigation Plan included the in-place solidification/stabilization of the sludge and design and construction of a final cover system implemented as source control corrective measures for the Sludge Lagoon. The permeable reactive barrier migration control, implemented at the Site in 2005, will continue to serve as the corrective measure for impacted groundwater beneath the Sludge Lagoon.

## Closure and Post-Closure Care Plan Format

The Plan was prepared to adhere to the regulations presented in the Mississippi Department of Environmental Quality (MDEQ) Nonhazardous Solid Waste Management Regulations. There are no formal regulations that specifically address the closure and post-closure care of surface impoundments within the MDEQ Nonhazardous Solid Waste Management Regulations; therefore, the closure and post-closure care regulations for municipal solid waste landfills (MSWLF) were used to develop the Plan. Where the regulations specifically address "MSWLF", the interpretation and response will be in the context of closure and post-closure care of the Sludge Lagoon. The appropriate sections of the regulations are presented in the following sections of the Plan and include the following:

Section IV Part E – Closure and Post-Closure.
Section IV Part F – Financial Requirements.

For ease of review, the Plan format presents the regulations followed with narrative including tables, figures, and references to appendices and design drawings to address each regulation. Regulations within each section that do not pertain to the closure and post-closure care of the Sludge Lagoon are indicated to be "Not Applicable".




**LEGEND**

⊕ GEOPROBE PIEZOMETER

◕ MONITORING WELL

**SWMUS**

2 - EQUALIZATION LAGOON
3 - ON-SITE LANDFILL
4 - SLUDGE LAGOON
7 - OUTFALL DITCH
12 - WET WELL
13 - WASTEWATER TREATMENT PLANT
14 - CHROME DESTRUCT PIT
15 - PROCESS SEWERS (UNDER THE BUILDING)
27 - CHROME PLATING LINE (APPROXIMATE LOCATION)

**AOCS**

A - FORMER TCE STORAGE AREA
B - FORMER TOLUENE STORAGE AREA
C - FUEL TANK FARM CONTAINMENT AREA

BROWN AND CALDWELL
COLUMBUS, OHIO

SUBMITTED: PROJECT MANAGER DATE:
APPROVED: BROWN AND CALDWELL DATE:

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)
DESIGNED:
DRAWN:
CHECKED:
CHECKED:
APPROVED:

EXTERNAL REFERENCES
IMAGE REFERENCES

REVISIONS

| ZONE | REV. | DESCRIPTION | BY | DATE | APP. |
|---|---|---|---|---|---|

**FIGURE 1-2**
**LOCATION OF SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN**
**GRENADA MANUFACTURING, LLC PLANT**
**GRENADA, MISSISSIPPI**

FILENAME
B/C PROJECT NUMBER
CLIENT PROJECT NUMBER
DRAWING NUMBER
SHEET NUMBER
OF

# 2. CLOSURE AND POST-CLOSURE

## 2.1 Section IV Part E: Closure and Post-Closure Care

### 1. Closure/Post-Closure Plan

***a. Owners of MSWLF units must prepare a written closure/post-closure plan that describes the steps necessary to close all MSWLF units at any point during its active life in accordance with the requirements of paragraph E.2 of this section, to monitor and care for the facility during the post-closure period in accordance with the requirements of paragraph E.3 of this section, and to reclaim any on-site borrow areas used for obtaining daily or final cover. The plan, at a minimum, must include the following information:***

This document, referred to as "the Plan," is the written Closure and Post-Closure Care Plan for the Sludge Lagoon, submitted for approval by the Regional Administrator. This Plan describes the steps necessary for closure of the Sludge Lagoon in accordance with paragraph E.2 and includes monitoring and care of the facility during the post-closure care period in accordance with paragraph E.3 and reclamation of on-site borrow areas used for obtaining final cover materials, if any.

***(1) a description of the final cover, designed in accordance with paragraph E.2.a or E.2.b of this section, and the methods and procedures to be used to install the cover;***

A description of the final cover system design and the methods and procedures used to construct the final cover system is provided with paragraph E.2.b.

***(2) an estimate of the largest area of the MSWLF unit ever requiring a final cover as required in paragraph E.2.a of this section at any time during the active life;***

The largest area of the Sludge Lagoon including the final cover system will be approximately 2.2 acres (see Drawing C-5).

***(3) an estimate of the maximum inventory of wastes ever on-site over the active life of the landfill facility;***

The volume of sludge material in the Sludge Lagoon is estimated to be approximately 6,524 cubic yards based on field survey. The sludge material will be solidified/stabilized using in-situ technologies to add Type I Portland cement and lime kiln dust at a rate of 7.5 percent and 20 percent, respectively, to the sludge material to provide an unconfined compressive strength of 12-15 pounds per square inch (psi) (refer to the Lagoon Solidification/Stabilization Study included in Appendix A). A hydraulic excavator will be used to blend the Type I Portland cement and lime kiln dust into the sludge material. The hydraulic excavator operator will possess knowledge and expertise with mixing and blending reagents using the bucket in order to obtain the required unconfined compressive strength (UCS) of the solidified/stabilized sludge. Controls will be used throughout the solidification/ stabilization process to account for dust suppression and surface water issues related to the water within the sludge material and water from rainfall events. Bearing capacity calculations indicating that the solidified/ stabilized sludge material will support the proposed final cover system are included in Appendix B.

***(4) a schedule for completing all activities necessary to satisfy the closure requirements in paragraph E.2 of this section.***

The Sludge Lagoon final closure implementation is anticipated to be completed within 180 days of receipt of approval of the Plan from the Regional Administrator. The schedule will be revised and provided to the Regional Administrator throughout the closure implementation period as factors such as regulatory reviews, preparation of comment responses (if any), contractor procurement, contract award, implementation delays (mainly due to weather conditions), etc. are encountered and addressed.

***(5) a description of the monitoring and maintenance activities required in paragraph E.3 of this section for each MSWLF unit, and frequency at which these activities will be performed;***

The Plan includes discussion of the monitoring and maintenance activities including the frequency for the post-closure care of the former Sludge Lagoon as required in paragraph E.3.

***(6) name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and***

ArvinMeritor will administer activities throughout the post-closure care period. ArvinMeritor will be responsible for performing routine maintenance and storage and updating of the former Sludge Lagoon records and Plan. A complete listing of the names and addresses of personnel and regulatory agency(ies) who receive a copy of the Plan will be maintained by the Post-closure Care Contact. The Following individual is currently designated to be contacted regarding the post-closure care of the former sludge Lagoon:

David O'Connor
Manager – Corporate Environmental
ArvinMeritor, Inc.
2135 West Maple Road
Troy, Michigan 48084-7186
Telephone: (248) 435-2706
Facsimile: (248) 435-8354
Cellular: (734) 751-5704
E-Mail: David.OConnor@ArvinMeritor.com

***(7) a description of the planned use of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with any other state or federal regulations. The Department may approve any other disturbance if the owner demonstrates that disturbance of the final cover, liner or other component of the containment system, including any removal of waste, will not increase the potential threat to human health or the environment.***

The surface area and subsurface within the limits of the final cover system at the former Sludge Lagoon is currently not part of any future development plans for the Site. Activities related to the post-closure care of the former Sludge Lagoon will be performed in a manner that does not compromise the integrity of the final cover system.

***b. Owners of MSWLF units must notify the Department that a closure/post-closure plan has been prepared and placed in the operating record no later than the effective date of these regulations, or by the initial receipt of waste, whichever is later.***

Submittal of the Plan to the Regional Administrator will serve as notification that a Closure/Post-Closure Care Plan for the Sludge Lagoon has been prepared and that the Plan will be placed in the operating record within one work week of receiving approval of the Plan from the Regional Administrator.

***c. Closure and post-closure activities at an MSWLF unit must be conducted in accordance with the closure/post-closure plan after approval of the plan is granted by the Department. Any proposed change to the plan must be submitted to the Department for approval. No changes to the plan may be made without approval by the Department. A copy of the approved plan must be kept at the landfill or another approved site until the owner has been released from the requirements for closure and post-closure care.***

All closure and post-closure activities at the Sludge Lagoon will be conducted in accordance with the Plan upon its approval by the Regional Administrator. Any proposed changes will be submitted to the Regional Administrator and changes will not be implemented without prior approval of the Regional Administrator. A copy of the approved Plan will be kept onsite by Don Williams, Environmental Manager of Grenada Stamping & Assembly until ArvinMeritor has been released from the closure and post-closure care requirements.

## 2. Closure Requirements

The Sludge Lagoon will be closed in a manner that protects human health and the environment by controlling, minimizing, and eliminating where possible the post-closure escape of waste, waste constituents, leachate, contaminated runoff, or waste decomposition products to the ground, surface waters, or to the atmosphere. The sludge material in the Sludge Lagoon will be solidified/stabilized in-situ with a final cover system constructed that will accomplish the following goals:

- Stabilize the remaining wastes and waste residues.
- Solidify the remaining wastes to a bearing capacity sufficient to support a final cover system.
- Function as designed with a minimum of maintenance.
- Minimize or eliminate the infiltration of precipitation and surface water run-off into the closed lagoon.
- Promote efficient drainage while minimizing the effects of erosion on the final cover system.
- Accommodate settling and subsidence to maintain the integrity of the final cover system.
- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

***a. Owners of MSWLF units and all other landfills must install a final cover system that is designed to minimize infiltration and erosion. The final cover system must be comprised of an erosion layer underlain by an infiltration layer as follows:***

***(1) The infiltration layer must be comprised of a minimum of 18 inches of earthen material that has a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10-5 cm/sec, whichever is less, and***

The Plan proposes the use of an alternative final cover system as presented under paragraph E.2.b.

***(2) The erosion layer must consist of a minimum of 6 inches of earthen material that is capable of sustaining native plant growth.***

The Plan proposes the use of an alternative final cover system as presented under paragraph E.2.b.

***b. The Department may approve an alternative final cover design that includes:***

***(1) an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraph E.2.a.(1) of this section, and***

The bottom liner system consists of clay material present at the bottom and along the interior side slopes of the Sludge Lagoon. Although no information is available pertaining to the quality of the clay material used in the bottom liner, an assumption is made that the permeability of the clay material is at least less than or equal to $1.0 \times 10^{-6}$ centimeters per second (cm/sec). Typically, the permeability of clay material used in the construction of barrier layers for bottom liners and/or final cover systems ranged from $1.0 \times 10^{-6}$ cm/sec to $1.0 \times 10^{-7}$ cm/sec with the higher permeability ($1.0 \times 10^{-6}$ cm/sec) used in the final cover system barrier layer. The barrier layer proposed for the Sludge Lagoon final cover system is a 60-mil textured HDPE geomembrane which possesses a permeability of $2.0 \times 10^{-13}$ cm/sec. Based on the permeability of the 60-mil textured HDPE geomembrane, the proposed final cover system will possess permeability much less than the existing bottom liner system even if the assumption is made that the permeability of the clay material is $1.0 \times 10^{-7}$ cm/sec.

An analysis of the effectiveness of the proposed final cover system incorporating the 60-mil textured geomembrane barrier layer and the geocomposite drainage layer was performed using the Hydrologic Evaluation of Landfill Performance (HELP) Model developed by the U.S. Army Corps of Engineers. The proposed final cover system was modeled with a fair stand a grass and with no vegetation which represents the worst-case scenario. The results provide sufficient data to show that the proposed final cover system will minimize, if not eliminate, surface water infiltration to the underlying solidified/stabilized sludge material. The HELP Model results are provided in Appendix C.

***(2) an erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in paragraph E.2.a.(2) of this section.***

The Sludge Lagoon will be closed by the installation of a barrier layer to minimize precipitation and surface water infiltration overlain by a drainage layer to promote infiltrated surface water run-off away from the barrier layer. The appropriate protective features, such as the vegetative (erosion) layer, are included in the final cover system design. The proposed final cover system meets or exceeds the technical performance criteria established for typical minimum standards pertaining to the final slopes and surface water infiltration.

No portion of the completed final cover system will have a finished grade of less than five percent, nor will the side slopes exceed a maximum of 33 percent or 3 horizontal to 1 vertical (3:1). Enhancements to the typical soil final cover system (minimum requirements) include the installation of a 60-mil textured geomembrane barrier layer overlain by a geocomposite drainage layer. The 60-mil textured geomembrane was selected as the physical barrier due to its availability, performance, constructability, effectiveness, and regulatory acceptance. Using a textured geomembrane will enhance the slope stability of the proposed final cover system. The following narrative provides a detailed description of the final cover system constructed in ascending order.

Subbase layer consisting of a combination of the solidified/stabilized sludge material and common borrow soil upon which the 60-mil geocomposite will be installed. The finished subbase will be smooth and free of all rocks, sticks, sharp objects, or debris of any kind. The function of the subbase is to provide a stable foundation upon which to construct the final cover system.

60-mil textured, high density polyethylene (HDPE) geomembrane similar to Poly-Flex Polyethylene Geomembranes (see Table 2-1 for material properties) used as the barrier layer. The HDPE geomembrane will effectively eliminate the infiltration of precipitation into the underlying solidified/stabilized sludge material. The hydraulic conductivity (k) of a 60-mil textured, HDPE geomembrane is $2.0 \times 10^{-13}$ cm/sec.

**Table 2-1. Textured HDPE Geomembrane Material Properties**

| Property | Test Method | Minimum Average Values – 60 mil |
|---|---|---|
| Thickness, mils | ASTM D 5994 | |
| Minimum average | | 57 |
| Lowest individual of 8 of 10 readings | | 54 |
| Lowest individual of 10 readings | | 51 |
| Asperity Height[1], mils | GRI GM12 | 10 |
| Sheet Density, g/cc | ASTM D 1505/D 792 | 0.940 |
| Tensile Properties[2] | ASTM D 6693 | |
| Yield Strength, lb/in | | 126 |
| Break Strength, lb/in | | 120 |
| Yield Elongation, % | | 12 |
| Break Elongation, % | | 100 |
| Tear Resistance. lb | ASTM D 1004 | 42 |
| Puncture Resistance, lb | ASTM D 4833 | 90 |
| Stress Crack Resistance[3], hrs | ASTM D 5397 (App.) | 300 |
| Carbon Black Content[4], % | ASTM D1603 | 2.0 – 3.0 |
| Carbon Black Dispersion | ASTM D 5596 | See Note 5 |
| Oxidative Induction Time (OIT), Standard OIT, minutes | ASTM D3895 | 100 |
| Oven Aging at 85°C<br>High Pressure OIT – % retained after 90 days | ASTM D 5721<br>ASTM D 5885 | 80 |
| UV Resistance[6]<br>High Pressure OIT[7] – % retained after 1600 hrs | GRI GM11<br>ASTM D 5885 | 50 |
| Seam Properties | ASTM D 6392<br>(@ 2 in/min) | |
| Shear Strength, lb.in | | 120 |
| Peel Strength, lb/in – Hot Wedge | | 91 |
| - Extrusion Fillet | | 78 |
| Roll Dimensions | | |
| Width (feet) | | 23 |
| Length (feet) | | 500 |
| Area (square feet) | | 11,500 |
| Gross weight (pounds, approx.) | | 3,500 |

1. Of 10 readings: 8 must be ≥ 7 mils and lowest individual reading must be ≥ 5 mils.
2. Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Yield elongation is calculated using a gauge length of 1.3 inches; Break elongation is calculated using a gauge length of 2.0 inches.
3. The yield stress used to calculate the applied load for the SP-NCTL test should be the mean value via MQC testing.
4. Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.
5. Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.
6. The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
7. UV resistance is based on percent retained value regardless of the original HP-OIT value.

This data is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. These values are subject to change without notice.

Source: POLY-FLEX, INC., Grand Prairie, Texas.

Geocomposite drainage layer consisting of a HDPE geonet with non-woven geotextile heat bonded to each side of the geonet similar to Poly-Flex Geocomposite GC-08D-2.0 (see Table 2-2 for material properties) which provides a transmissivity of 0.2 gallons per minute-foot (gal.min-ft). The function of the geocomposite is to intercept and divert infiltrating surface water away from the underlying geomembrane.

Vegetative (erosion protective) cover consisting of either 18-inches of common borrow soil and 6-inches of topsoil or 24-inches of common borrow soil if the soil contains sufficient organics and nutrients to sustain vegetative growth. The common borrow soil will consist of soil material classified as SM-SC or ML-CL under the Unified Soil Classification System (USCS).

The proposed final cover system configuration is depicted in Figure 2-1 and Detail A on Drawing C-7 and the Construction Quality Assurance Plan (CQAP) is provided in Appendix D.

The configuration of the final contours of the cover system were generated to promote the run-off of precipitation and the establishment of vegetation while eliminating surface water accumulation and soil erosion. The final contours were designed with a maximum allowable slope of 25 percent (4:1) and a minimum allowable slope of five percent. The overall average slope of the final cover is 7.8 percent (see Drawing C-5) which will minimize the potential for erosion of the final cover system. Potential erosion concerns will be further addressed by planting quick rooting vegetation and routine maintenance activities to address erosion issues as they are discovered. An analysis of soil erosion using the universal soil loss equation based on the final contour configuration estimated an erosion loss of 0.997 tons per acre per year which is considerably less than the 5.0 tons/acre/year generally accepted as the allowable erosion loss for final cover systems. The soil erosion calculations are provided in Appendix E.

The proposed final cover system will be graded to tie into the existing adjacent topography (see Drawing No. C-5). Surface water flows across the Site from east to west trending toward the outfall ditch to the north of where the former Sludge Lagoon is located. Construction of the proposed final cover system will not alter the existing surface water flow patterns within the area of the Site adjacent to the former Sludge Lagoon. The side slopes of the closed Sludge Lagoon will be flatter than the existing berm side slopes which will potentially minimize the erosion at the proposed final cover system/adjacent ground tie-in interface.

Surface settlement as a result of consolidation of the subbase and the solidified/stabilized sludge material subjected to the construction of the approximate two-foot thick proposed final cover system has been assessed. The settlement calculations presented in Appendix F predict a maximum potential differential settlement of 1.25 feet in the subbase and solidified/stabilized sludge material due to the imposed load of the proposed final cover system.

Although potential surface settlement is projected to be 1.25 feet, localized depressions may occur across the surface of the closed Sludge Lagoon where settlement is greater. It is not possible to accurately predict the size and depth of these depressions as their dimensions are heavily dependent on the manner in which the subbase and the solidified/stabilized sludge material were placed. By using strict Construction Quality Assurance (CQA) controls during the performance of the sludge material solidification/stabilization and subsequent placement and compaction and placement and compaction of the subbase, occurrence of depressions in the surface of the closed Sludge Lagoon are not anticipated. If depressions in the closed Sludge Lagoon surface occur, these depressions will be addressed as part of the monitoring and maintenance program associated with the post-closure care of the Sludge Lagoon.

A 60-mil textured HDPE geomembrane possesses an allowable tensile strain of 13 percent before breaking. The strain exhibited on the 60-mil textured HDPE geomembrane as a result of settlement of 1.25 feet was calculated to be 0.0031 percent. Therefore, if differential settlement of up to 1.25 feet occurs following

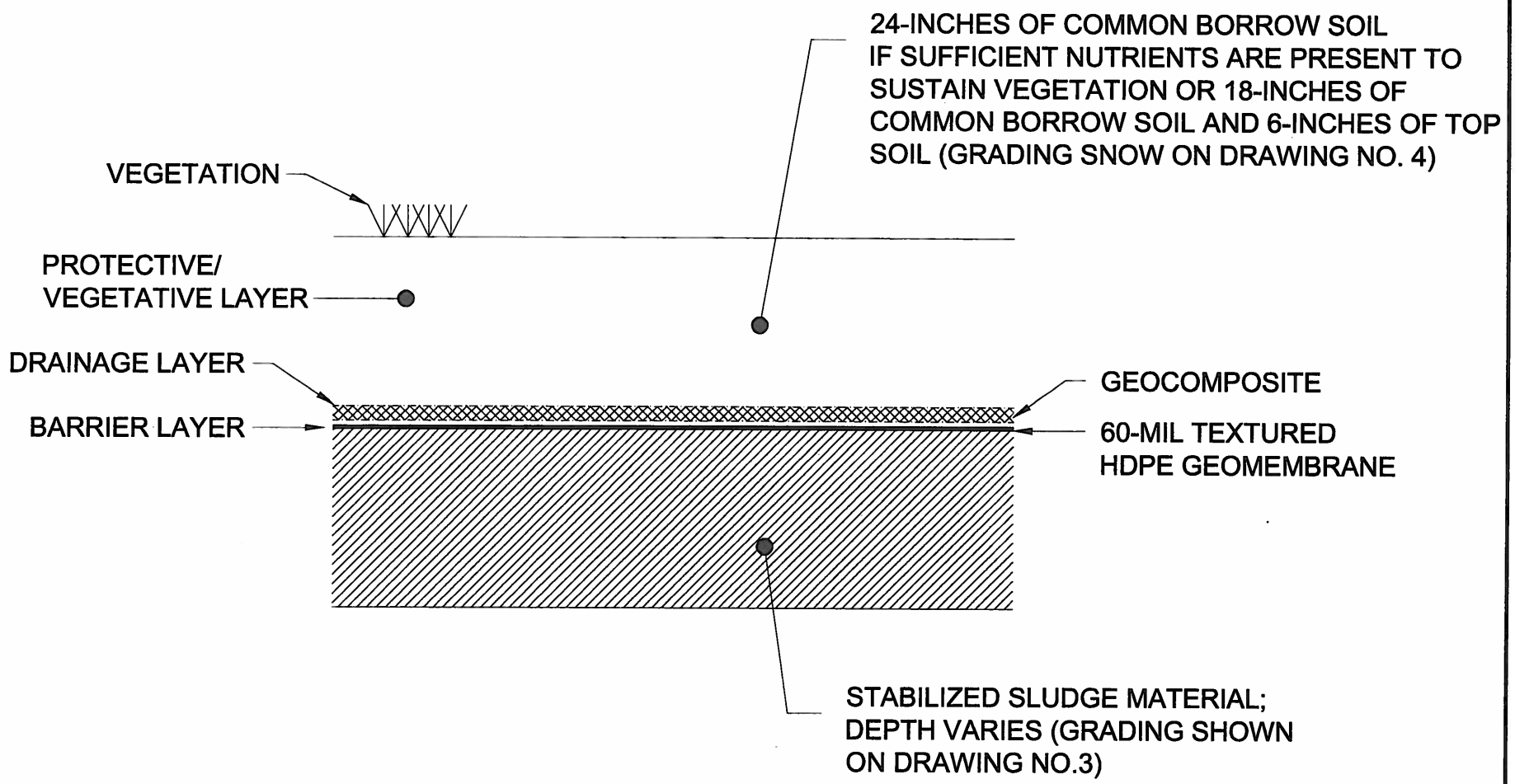
**Table 2-2. Double-Sided Geocomposite Material Properties**

| Property | Test Method | Minimum Average Values – GC-08D-2.0 |
|---|---|---|
| **GEOCOMPOSITE PROPERTIES** | | |
| Transmissivity, (MD), gal/min-ft<br>metal plate/geocomposite/metal plate<br>hydraulic gradient, i = 1<br>normal pressure = 10,000 lb/ft$^2$<br>seat time = 15 minutes | ASTM D 4716 | 0.2<br>(4.0 x $10^{-5}$ m$^2$/sec) |
| Ply Adhesion, lb/in | ASTM D 7005 | 1 |
| Roll Dimensions | | |
| Roll width, feet | | 13.5 |
| Roll length, feet | | 200 |
| **COMPONENT PROPERTIES** | | |
| **Geonet** | | |
| Thickness, mil | ASTM D 5199 | 200 |
| Density, min., g/cc | ASTM D 1505 | 0.940 |
| Carbon Black Content, % | ASTM D 1603 | 1.5 – 3.0 |
| Tensile Strength, (Peak, MD), lb.in | ASTM D 7179 | 45 |
| Transmissivity, (MD), gal/min-ft<br>metal plate/net/metal plate<br>hydraulic gradient, i = 1<br>normal pressure = 10,000 lb/ft$^2$<br>seat time = 15 minutes | ASTM D 4716 | 5.0<br>(1.0 x $10^{-3}$ m$^2$/sec) |
| **Geotextile** | | |
| Unit Weight, oz/yd$^2$ | ASTM D 5261 | 8 |
| Grab Strength, lb | ASTM D 4632 | 220 |
| Grab Elongation, lb | ASTM D 4632 | 50 |
| Tear Strength, lb | ASTM D 4533 | 80 |
| Puncture Strength, lb | ASTM D 4833 | 120 |
| Permittivity, sec$^{-1}$ | ASTM D 4492 | 1.3 |
| AOS, MaxARV | ASTM D 4751 | 80 sieve |
| UV Stability, % ret. (500 hr.) | ASTM D 4355 | 70 |

The above property values, unless otherwise specified, are the minimum acceptable average test results for any roll based on the specified test methods and do not refer to an individual test specimen. Geotextile property values are Minimum Average Roll values, except for AOS, which is Maximum Average Roll value. Geonet and Geotextile properties are tested prior to lamination.

This data is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. These values are subject to change without notice.

Source: POLY-FLEX, INC., Grand Prairie, Texas




BROWN AND CALDWELL

FIGURE 2-1
PROPOSED FINAL COVER SYSTEM

closure of the Sludge Lagoon, unless an atypically large depression develops, the integrity of the geomembrane barrier layer and the geomembrane's ability to minimize infiltration will not be compromised. Routine inspections will identify and mitigate any surface manifestations or irregular solidified/stabilized sludge material consolidations.

***c. The final cover gradient on landfills that receive waste on or after the effective date of these regulations shall be a minimum of four percent (4%) and a maximum of twenty-five percent (25%), unless otherwise approved by the Department.***

The Sludge Lagoon has been inactive since 1999. The final configuration of the former Sludge Lagoon following completion of the final closure implementation activities will be a low, relatively flat, mound (see Drawing C-5). The design slopes of the proposed final cover system are not less than five percent on the top surface and not greater than 25 percent which is equivalent to a 4:1 (horizontal to vertical) grade on the side slopes.

***d. The final cover gradient on MSWLF units that stop receiving waste before the effective date of these regulations shall not exceed twenty-five percent (25%), unless otherwise approved by the Department.***

The final configuration of the former Sludge Lagoon following completion of the final closure implementation activities will be a low, relatively flat, mound (see Drawing C-5). The design slopes of the proposed final cover system are not less than five percent on the top surface and not greater than 25 percent which is equivalent to a 4:1 (horizontal to vertical) grade on the side slopes.

Other than performance of routine maintenance activities associated with the post-closure care of the Sludge Lagoon (i.e. inspections, grass mowing, fence, gate, and sign repair/replacement, etc.), the final cover system has been designed and will be constructed to minimize maintenance requirements. The final contours were designed to account for potential erosion issues.

***e. A native grass seed or other shallow-rooted vegetation suitable to minimize soil erosion, as approved by the Department, must be planted and maintained over each closed unit. Trees may not be used in lieu of or in addition to the grass cover.***

Vegetation will consist of a native grass seed or other shallow-rooted vegetation in order to minimize soil erosion. Trees will not be used. Seeding to establish vegetation in the form of grasses native to the area obtained from the National Resources Conservation Service (NRCS) Grenada Field Office is provided in Table 2-3 and includes requirements for fertilizer and mulch.

***f. Following closure of each MSWLF unit or other landfill, the owner must notify the Department that a certification, signed by an independent registered professional engineer, verifying that the final cover system has been completed in accordance with paragraphs E.2.a through E.2.e of this section, has been placed in the operating record. Such certification must be placed in the operating record within sixty (60) days after planting the grass seed in accordance with paragraph E.2.e of this section.***

ArvinMeritor will, within 60 days of completion of the closure implementation activities, notify the Regional Administrator and place in the operating record certification that closure of the Sludge Lagoon is completed and was performed in accordance with the approved Plan. The Certification of Closure will be signed by ArvinMeritor and by an independent registered professional engineer in the State of Mississippi.

**Table 2-3. Seeding Specifications**

| Plant Species | Seeding Rates (Per Acre) | | Seeding Dates | Planting Depth (Inches) | Fertilizer (Minimum Rates) | Mulch (Tons per Acre |
|---|---|---|---|---|---|---|
| | Alone | Mixture[1] | | | $N-P_2O_5-K_2O$ | |
| Bahiagrass, Pensacola | 30 lbs | 20 lbs | March-May<br>Sept – Oct[3] | 1/4 | 72-72-72[6] | 2 |
| Bermudagrass | | | | | | |
| Common (Hulled) | 8 lbs | 3 lbs | March -May | 1/4 | 72-72-72 | 2[7] |
| Hybrid[2] | 25,000 | 20,000 | March- June | 2-3 | -- | -- |
| Common (unhulled) | 10 lbs | 5 lbs | Sept – Oct[4] | 1/4 | 72-72-72 | 2 |
| Tall Fescuegrass | 30 lbs | 20 lbs | Sept- Oct<br>Feb 15 – March 15[5] | 1/4 – 1/2 | 72-72-72 | 2 |

**Notes:**

1. Planned seed mixtures must include at least one perennial grass specie.
2. May include coastal, Alicia, or Tifton. 20,000 springs = 1 bushel. 1 bushel = 1.25 cubic feet. Clippings not recommended.
3. Fall seeded bahiagrass will be seeded in combination with fescue, wheat, ryegrass, or cereal rye. Use 30 lbs bahia seed per acre.
4. Fall seeding will be in combination with fescue. Use 10 lbs unhulled seed per acre.
5. For cropland practices only.
6. Apply fertilizer when grass begins to green up.
7. Apply mulch only in March. Mulch for April and May is optional.

***g. (1) Within ninety (90) days after all landfill units are closed, the owner must record on the deed to the landfill facility property, or some other instrument that is normally examined during title search, a notation and survey plat, prepared by a registered land surveyor, indicating the location and dimensions of the actual filled area with respect to permanently surveyed benchmarks or Section corners, and notify the Department that the notation and survey plat have been recorded and a copy of each has been placed in the operating record.***

Within 90 days of Certification of Closure of the Sludge Lagoon, ArvinMeritor will record, in accordance with Mississippi State Law, a notation on the deed to the Site property that will in perpetuity notify any potential purchaser of the Site property the following information:

- The land on the Site beneath and within the limits of the final cover system of the former Sludge Lagoon has been used to manage sludge wastes.
- The use of this land is restricted.
- Attach a survey plat, prepared by a registered land surveyor, stating the type, location, and quantity of sludge material disposed of in the former Sludge Lagoon.

The notation will be filed with the local zoning authority or the authority with jurisdiction over local land use with a copy of the deed including the notation and survey plat submitted to the Regional Administrator and entered into the operating record.

***(2) The notation on the deed must in perpetuity notify any potential purchaser of the property of the following information:***

***(i) the land has been used as a landfill facility;***

A notation will be prominently displayed on the survey plat and the deed to the Site property which states the former Sludge Lagoon was used for the disposal of sludge material.

***(ii) the name of the landfill owner(s);***

A notation will be prominently displayed on the survey plat and the deed that specifies ArvinMeritor as the owner of the former Sludge Lagoon.

***(iii) the year the landfill started and ended disposal operations; and***

A notation will be prominently displayed on the survey plat and the deed that disposal of sludge material in the Sludge Lagoon was initiated in 1977 and ceased in 1999.

***(iv) its use is restricted under paragraph E.1.a.(7) of this section.***

A notation will be prominently displayed on the survey plat and the deed to the Site property which states the surface area and subsurface within the limits of the final cover system is restricted and shall not be disturbed and/or used for any purpose. The surface area and subsurface within the limits of the final cover system at the former Sludge Lagoon is currently not part of any future development plans for the Site.

***h. The owner of a landfill may request permission from the Department to remove the notation and survey plat from the deed if all wastes are removed from the facility.***

Not applicable; at this time, ArvinMeritor has no plans to remove the sludge material from the former Sludge Lagoon. ArvinMeritor reserves the right to request permission from the Regional Adminstrator to remove the notation and survey plat from the deed if, in the future, plans change and the sludge material is removed from the former Sludge Lagoon and disposed offsite in an approved disposal facility.

***i. Prior to beginning closure of each MSWLF unit or other landfill as specified in paragraph E.2.j of this section, an owner must notify the Department that a notice of intent to close the unit or landfill has been placed in the operating record.***

With the submittal of this Plan, ArvinMeritor is notifying the Regional Adminstrator of ArvinMeritor's intent to close the Sludge Lagoon. A copy of this Plan will be placed in the operating record.

***j. The owner must begin closure activities of each MSWLF unit or other landfill no later than 30 days after the date on which the unit receives the known final receipt of wastes or, if the unit has remaining capacity and there is a reasonable likelihood that the unit will receive additional wastes, no later than one year after the most recent receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Department if the owner demonstrates that the unit has the capacity to receive additional wastes and the owner has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed unit.***

Not applicable. This Site is undergoing Corrective Action under the HSWA portion of the RCRA Permit dated July 31, 1998 and modified on December 23, 2005. The Sludge Lagoon has been inactive since 1999 and will not receive additional sludge material. Final closure implementation activities will be initiated following approval of this Plan from the U.S. EPA.

***k. The owner must complete closure activities of each MSWLF unit or other landfill within 180 days following the beginning of closure as specified in paragraph E.2.j of this section. Extensions of the closure period may be granted by the Department if the owner demonstrates that closure will, of necessity, take longer than 180 days and he has taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed unit.***

Final closure implementation can be completed within 180 days after approval of the Plan from the U.S. EPA. An extension to the closure period is not anticipated; however, if issues beyond the control of ArvinMeritor occur during performance of the final closure implementation, an extension of the closure period will be submitted to the Regional Administrator following the applicable requirements for requesting a modification to the permit.

## 3. Post-Closure Requirements

***a. Following closure of each MSWLF unit or other landfill, the owner must conduct post-closure care. Post-closure care must be conducted for 30 years, except as provided under paragraph E.3.b of this section.***

Post-closure care for the closed former Sludge Lagoon will begin at the completion of the final closure implementation activities. Post-closure care will adhere to the applicable requirements under Section IV Part E and will continue for 30 years after the date on which the final closure implementation activities were completed.

Following completion of the closure implementation, only routine inspections/maintenance typically associated with final cover systems is anticipated to occur during the post-closure care period. Maintenance of the vegetative cover through mowing will be performed. Routine inspections of the former Sludge Lagoon will identify issues (e.g. erosion problems, stressed vegetation, presence of brush, shrubs, tree saplings, etc., settlement/subsidence, integrity of the fence and gates, missing signs, etc) that will be addressed by ArvinMeritor.

***b. The length of the post-closure care period may be:***

***(1) decreased by the Department if the owner demonstrates that the reduced period is sufficient to protect human health and the environment and this demonstration is approved by the Department; or***

ArvinMeritor reserves the right to request a reduction in the post-closure care period based on a demonstration that the reduced period will not adversely affect human health and the environment. If a reduced post-closure care period is approved by the Regional Administrator, ArvinMeritor will continue to perform the activities presented in the Plan pertaining to post-closure care requirements throughout the reduced time of the post-closure care period. The appropriate modification(s) to the Plan will be made in accordance with the permit modification procedures.

***(2) increased by the Department if the Department determines that the lengthened period is necessary to protect human health and the environment.***

ArvinMeritor will continue to perform the activities presented in the Plan pertaining to post-closure care requirements if the Regional Administrator extends the time of the post-closure care period. The appropriate modification(s) to the Plan will be made in accordance with the permit modification procedures.

***c. Post-closure care must consist of at least the following:***

***(1) maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, preventing run-on and run-off from eroding or otherwise damaging the final cover, and preventing the growth of trees on the landfill cover.***

To ensure the integrity of the closure activities and the continued proper functioning of the monitoring and management systems, scheduled site inspections will be performed. The site inspections of the closed Sludge Lagoon will coincide with the semi-annual (April and October) Site-wide groundwater monitoring program schedule. The site inspections will be performed by an inspector assigned to inspect and evaluate the performance of the items and systems listed in the former Sludge Lagoon Post-Closure Care Inspection Log provided in Appendix G. Copies of the Inspection Logs will be maintained at the facility and, upon request, may be viewed by the regulatory agency(ies). The following narrative provides a summary of the observations to be performed during the site inspection for the former Sludge Lagoon.

- Surface Water Management System
  - Run-off Swales
    - obstructions to flow;
    - erosion;
    - excessive siltation; and,
    - loose or missing riprap (if utilized).
- Final Cover System
  - Erosion;
  - Settlement/subsidence;
  - Adequate vegetation;
  - Surface water accumulation; and
  - The need for mowing.

- Site Security
  - Gates and locks
    - functioning properly;
    - presence or absence;
    - corrosion; and,
    - damage.
  - Fence
    - missing sections;
    - damage; and,
    - corrosion.
  - Signs
    - whether or not missing, and,
    - quality of lettering (readability).

Post-closure maintenance including activities to ensure the integrity of the final cover system will be performed as identified from the semi-annual inspections of the closed former Sludge Lagoon. If issue(s) are identified during the performance of the inspections, ArvinMeritor will address the issue(s) in a timely manner to minimize the potential impact to the integrity of the final cover system. The following narrative provides a discussion of the maintenance activities to be performed throughout the 30-year post-closure care period.

- Final Cover System
  - Mowing: At a minimum, ArvinMeritor will contract to have the vegetation mowed twice each year; spring and fall.
  - Erosion: The severity of the erosion will be assessed including whether or not the in final cover system has been compromised. Clean common borrow soil material will be placed, compacted, and graded to eliminate any rills, channels, or gullies. The disturbed area will be seeded to establish vegetation. Areas where erosion issues persist may need to have erosion matting and/or riprap installed to aid in the establishment of vegetation and to minimize the continuation of erosion.
  - Subsidence: In areas where subsidence/differential settlement has occurred, the severity of the subsidence will be assessed including whether or not the final cover system has been compromised. Clean common borrow soil material will be placed, compacted, and graded to fill the depression back to the level of the adjacent ground surface. The disturbed area will be seeded to establish vegetation.
  - Other vegetation: Vegetation other than grass (e.g. tree saplings, shrubs, bushes, brush, etc.) that appears on the surface of the closed former Sludge Lagoon will be removed. The vegetation will be removed by taking the plant and root system. Clean common borrow soil material will be placed, compacted, and graded to fill the resulting root ball area, if required. The disturbed area will be seeded to establish vegetation.
- Site Security
  - Perimeter Fence: Section(s) of the perimeter fence including the gate that have been compromised by vandalism and/or deterioration will be replaced. This may include fence fabric,

posts, stiffeners, etc. Locks that are not functioning properly will be removed and replaced.

- Signs: Signs that are loose or that have fallen off of the perimeter fence will be reattached to the fence fabric. Missing signs and signs where the lettering is determined to not be legible will be replaced.

A record of the maintenance activities performed will be kept with the Post-Closure Care Inspection Logs.

***(2) maintaining and operating any required leachate collection system in accordance with paragraph C of this section. The Department may allow the owner to stop managing leachate if the owner demonstrates that leachate no longer poses a threat to human health and the environment;***

Not applicable; there is no leachate collection system associated with the former Sludge Lagoon.

***(3) monitoring the groundwater in accordance with paragraph D of this section and maintaining the groundwater monitoring system, if applicable;***

The Site is undergoing corrective action through the HSWA portion of the RCRA Permit dated July 31, 1998 and modified on December 23, 2005. The monitoring and reporting requirements will continue to be addressed during the post-closure care period through the Site-wide groundwater monitoring program and the PRB which was identified as the migration source control measure for the Sludge Lagoon in the approved CMS for the Site. The groundwater monitoring program and PRB are discussed in numerous documents associated with the Site and will not be specifically addressed in the Plan.

***(4) maintaining and operating any required gas monitoring system in accordance with paragraph B.4 of this section.***

Not applicable; a gas monitoring system is not required and gas will not be generated from the stabilized/solidified sludge.

***d. Following completion of the post-closure care period for each MSWLF unit or other landfill, the owner must notify the Department that a certification, signed by an independent registered professional engineer, verifying that post-closure care has been completed in accordance with paragraph E.3 of this section, has been placed in the operating record. Such certification must be placed in the operating record within sixty (60) days after the completion of the post-closure care period.***

ArvinMeritor will, within 60 days of completion of the established post-closure care period, notify the Regional Administrator and place in the operating record certification that the post-closure care period for the former Sludge Lagoon is completed and was performed in accordance with the approved Plan. The Certification of Post-Closure Care will be signed by ArvinMeritor and by an independent registered professional engineer in the State of Mississippi.

# 3. FINANCIAL REQUIREMENTS

## 3.1 Section IV Part F Financial Assurance

***Financial assurance requirements under paragraph F apply to owners of MSWLF units and other commercial landfills, except owners who are State or Federal government entities whose debts and liabilities are the debts and liabilities of the State of Mississippi or the United States. The requirements of this paragraph may be applicable to other landfills as determined necessary by the Permit Board.***

### 1. Financial Assurance for Closure

***a. The owner must have a detailed written estimate, in current dollars, of the cost of hiring a third party to close the largest area ever requiring a final cover as required under paragraph E of this section, at any time during the active life. The owner must notify the Department that the estimate has been placed in the operating record.***

***(1) The cost estimate must equal the cost of closing the largest area ever requiring a final cover at any time during the active life when the extent and manner of its operation would make closure the most expensive.***

The opinion of probable closure cost was prepared to account for the largest area of the Sludge Lagoon requiring construction of the final cover system by an independent third-party. The opinion of probable closure cost is provided in Table 3.1 and Appendix H.

***(2) During the active life of the landfill, the owner must annually adjust the closure cost estimate for inflation.***

The opinion of probable closure cost will adjusted annually to account for the affects of inflation.

***(3) The owner must increase the closure cost estimate and the amount of financial assurance provided under paragraph F.1.b of this section if changes to any applicable closure plan or landfill conditions increase the maximum cost of closure at any time during the remaining active life.***

The opinion of probable closure cost and the amount of financial assurance will be adjusted if applicable changes to the approved Plan are made which cause an increase in the cost of closure during the performance of the final closure implementation.

***(4) Upon approval of the Department and notification in the operating record, the owner may reduce the closure cost estimate and the amount of financial assurance provided under paragraph F.1.b of this section if the cost estimate exceeds the maximum cost of closure at any time during the remaining life of the landfill.***

The opinion of probable closure cost and the amount of financial assurance will be adjusted if applicable changes to the approved Plan are made which cause an decrease in the cost of closure during the performance of the final closure implementation. The opinion of probable closure cost and the amount of

| Table 3-1. Opinion of Probable Closure Cost | | | | |
|---|---|---|---|---|
| **Item** | **Unit** | **Quantity** | **Unit Price** | **Total Cost** |
| Mobilization/Demobilization | LS | 1 | $39,390 | $39,390 |
| Clearing and Grubbing | | | | |
| Vegetation | | | | |
| Cut and Chip | Acre | 2.5 | $5,250 | $13,125 |
| Clear and Grub | Acre | 2.5 | $6,925 | $17,312 |
| Total Vegetation | | | | $30,437 |
| Existing Perimeter Fence | | | | |
| Removal | LF | 1,100 | $2.92 | $3,212 |
| Dumpster | Each | 1 | $1,276 | $1,276 |
| Transportation | Each | 1 | $215 | $215 |
| Disposal | Ton | 34 | $79 | $2,686 |
| Total Perimeter Fence | | | | $7,389 |
| TOTAL CLEARING AND GRUBBING | | | | $37,826 |
| Dewatering (Free standing water) | | | | |
| Sump | CF | 256 | $2.22 | $568 |
| Pumping | Day | 10 | $193 | $1,930 |
| TOTAL DEWATERING | | | | $2,498 |
| Sludge Solidification/Stabilization | | | | |
| Mixing | | | | |
| Sumps | CF | 1,024 | $2.22 | $2,273 |
| Water Control | Day | 60 | $193 | $11,580 |
| Type I Portland Cement | Ton | 501.4 | $142.50 | $71,450 |
| Lime Kiln Dust | Ton | 1,336.9 | $67.50 | $90,241 |
| Mixing, Handling, Placement | CY | 8,239.5 | $15 | $123,593 |
| Total Mixing | | | | $299,137 |
| Grading | CY | 8,239.5 | $2.28 | $18,786 |
| TOTAL SLUDGE SOLIDIFICATION/STABLILZATION | | | | $317,923 |
| Grade Berms | CY | 1,585 | $2.75 | $4,359 |
| Subbase | | | | |
| Excavate, Load, Haul, Place, Grade, and Compact | CY | 10,570 | $11.90 | $125,783 |
| Finish Grading | SY | 10,555 | $1.39 | $14,671 |
| Dust Control | Day | 18 | $820 | $14,760 |
| TOTAL SUBBASE | | | | $155,214 |
| Final Cover System Installation | | | | |
| Geomembrane | SF | 106,550 | $0.55 | $58,603 |
| Geocomposite | SF | 106,550 | $0.45 | $47,948 |

| Table 3-1. Opinion of Probable Closure Cost (cont.) | | | | |
|---|---|---|---|---|
| **Item** | **Unit** | **Quantity** | **Unit Price** | **Total Cost** |
| Protective Material | | | | |
| Excavate, Load, Haul, Place, Grade, and Compact | CY | 5,278 | $11.90 | $62,808 |
| Finish Grading | SY | 10,555 | $1.39 | $14,671 |
| Dust Control | Day | 18 | $820 | $14,760 |
| Total Protective Material | | | | $92,239 |
| Topsoil | | | | |
| Topsoil Material, Excavation, Loading, Hauling, and Grading | CY | 1,760 | $28.71 | $50,530 |
| Finish Grading | SY | 10,555 | $1.39 | $14,670 |
| Total Topsoil | | | | $65,200 |
| TOTAL FINAL COVER SYSTEM INSTALLATION | | | | $263,990 |
| Vegetation | | | | |
| Hydroseeding (Seed Mix, Fertilizer, and Mulch) | MSF | 95 | $63 | $5,985 |
| TOTAL VEGETATION | | | | $5,985 |
| Security | | | | |
| Perimeter Fence | LF | 1,488 | $9.28 | $13,809 |
| Gate | Each | 1 | $1,325 | $1,325 |
| Signs | Each | 36 | $49.50 | $1,782 |
| TOTAL SECURITY | | | | $16,916 |
| OPINION OF PROBABLE CLOSURE COST TOTAL CAPITAL | | | | $844,101 |
| Engineering and Certification | | | | |
| Surveying | LS | 1 | $10,000 | $10,000 |
| CQA Oversight and Testing | LS | 1 | $75,000 | $75,000 |
| Closure Certification Report | LS | 1 | $25,000 | $25,000 |
| Administration @ 5% | LS | 1 | $42,205 | $42,205 |
| TOTAL ENGINEERING AND CERTIFICATION | | | | $152,205 |
| OPINION OF PROBABLE CLOSURE COST SUBTOTAL | | | | $996,306 |
| CONTINGENCY @ 15% | | | | $149,446 |
| **OPINION OF PROBABLE CLOSURE COST** | | | | **$1,145,752** |

financial assurance will not be adjusted without the approval of the Regional Administrator.

***b. The owner must establish financial assurance for closure in compliance with paragraph F.4 of this section. The owner must provide continuous coverage for closure until released from financial assurance requirements by demonstrating compliance with paragraph E.2 of this section.***

The financial assurance for closure in accordance with paragraph F.4 is in affect with the most current (as of March 31, 2008) copy provided in Appendix J. The coverage will be continuous throughout the final closure implementation period until receipt of written notification from the Regional Administrator that financial assurance for closure of the Sludge Lagoon is no longer required at which time Textron Automotive Company will void the financial assurance mechanism for closure in accordance with the applicable requirements of this Part.

## 2. Financial Assurance for Post-Closure Care

***a. The owner must have a detailed written estimate, in current dollars, of the cost of hiring a third party to conduct post-closure care for the landfill in compliance with paragraph E. of this section. The post-closure cost estimate used to demonstrate financial assurance in paragraph F.2.b of this section must account for the total costs of conducting post-closure care, including annual and periodic costs over the entire post-closure care period. The owner must notify the Department that the estimate has been placed in the operating record.***

The opinion of probable post-closure care cost was prepared to account for an independent third-party performing the required post-closure care activities. The opinion of probable post-closure care cost is provided in Table 3.2 and Appendix I.

***(1) The cost estimate for post-closure care must be based on the most expensive costs of post-closure care during the post-closure care period.***

The opinion of probable post-closure care cost was prepared to account for the most expensive costs anticipated to occur throughout the post-closure care period.

***(2) During the active life of the landfill and during the post-closure care period, the owner must annually adjust the post-closure cost estimate for inflation.***

The opinion of probable post-closure care cost will adjusted annually to account for the affects of inflation.

***(3) The owner must increase the post-closure care cost estimate and the amount of financial assurance provided under paragraph F.2.b of this section if changes in any applicable post-closure plan or landfill conditions increase the maximum costs of post-closure care.***

The opinion of probable post-closure care cost and the amount of financial assurance will be adjusted if applicable changes to the approved Plan are made which cause an increase in the cost of post-closure care during the post-closure care period.

***(4) The owner may reduce the post-closure cost estimate and the amount of financial assurance provided under paragraph F.2.b of this section if the cost estimate exceeds the maximum costs of post-closure care remaining over the post-closure care period. The owner must notify the Department that the justification for the reduction of the post-closure cost estimate and the amount of financial assurance has been placed in the operating record.***

The opinion of probable post-closure care cost and the amount of financial assurance will be adjusted if

| Table 3-2. Opinion of Probable Post-Closure Care Cost | | | | |
|---|---|---|---|---|
| **Item** | **Unit** | **Quantity** | **Unit Price** | **Total Cost** |
| Surface Water Management System | Year | 30 | $500 | $15,000 |
| Final Cover System | | | | |
| Erosion Maintenance | Year | 30 | $2,343 | $70,290 |
| Repair/Replacement | Year | 30 | $6,580 | $197,400 |
| Revegetation | Year | 30 | $1,575 | $47,250 |
| Vegetation Maintenance | Year | 30 | $600 | $18,000 |
| Total Final Cover System | | | | $332,940 |
| Inspections | Year | 60 | $125 | $7,500 |
| Site Security | | | | |
| Perimeter Fence | LF | 200 | $9.28 | $1,856 |
| Gate | Each | 1 | $1,325 | $1,325 |
| Signs | Each | 10 | $49.50 | $495 |
| Total Site Security | | | | $3,676 |
| Certification of Post-Closure Care | | | | $25,000 |
| Subtotal Opinion of Probable Post-Closure Care Cost | | | | $384,116 |
| Contingency @ 15% | | | | $57,617 |
| **OPINION OF PROBABLE POST-CLOSURE CARE** | | | | **$441,733** |
| **TOTAL PRESENT WORTH (6.0%; Present Worth Factor – 0.1741; 30-Year Period)** | | | | **$76,906** |

applicable changes to the approved Plan are made which cause an decrease in the cost of post-closure care during the post-closure care period. ArvinMeritor will provide justification for the reduction of the opinion of probable post-closure care cost and the amount of financial assurance for post-closure care will not be adjusted without the approval of the Regional Administrator.

***b. The owner must establish, in a manner in accordance with paragraph F.4 of this section, financial assurance for the costs of post-closure care as required under paragraph E.3.c of this section. The owner must provide continuous coverage for post-closure care until released from financial assurance requirements for post-closure care by demonstrating compliance with paragraph E.3.d of this section.***

The financial assurance for post-closure care in accordance with paragraph F.4 is in affect with the most current (as of March 31, 2008) copy provided in Appendix J. The coverage will be continuous throughout the post-closure care period until receipt of written notification from the Regional Administrator that financial assurance for post-closure care of the former Sludge Lagoon is no longer required at which time Textron Automotive Company will void the financial assurance mechanism for post-closure care in accordance with the applicable requirements of this Part.

## 3. Financial Assurance for Corrective Action

***a. An owner required to undertake a corrective action program under paragraph D.8 of this section must have a detailed written estimate, in current dollars, of the cost of hiring a third party to perform the corrective action in accordance with the program required under paragraph D.8 of this section. The corrective action cost estimate must account for the total costs of corrective action activities as described in the corrective action plan for the entire corrective action period. The owner must notify the Department that the estimate has been placed in the operating record.***

***(1) The owner must annually adjust the estimate for inflation until the corrective action program is completed in accordance with paragraph D.8.f of this section.***

Not applicable.

***(2) The owner must increase the corrective action cost estimate and the amount of financial assurance provided under paragraph F.2.b of this section if changes in the corrective action program or landfill conditions increase the maximum costs of corrective action.***

Not applicable.

***(3) The owner may reduce the amount of the corrective action cost estimate and the amount of financial assurance provided under paragraph F.3.b of this section if the cost estimate exceeds the maximum remaining costs of corrective action. The owner must notify the Department that the justification for the reduction of the corrective action cost estimate and the amount of financial assurance has been placed in the operating record.***

Not applicable.

***b. The owner required to undertake a corrective action program under paragraph D.8 of this section must establish, in a manner in accordance with paragraph F.4 of this section, financial assurance for the most recent corrective action program. The owner must provide continuous coverage for corrective action until released from financial assurance requirements for corrective action by demonstrating compliance with paragraphs D.8.(f) and D.8.(g) of this section.***

Not applicable.

## 4. Criteria for Allowable Mechanisms

***The mechanisms used to demonstrate financial assurance under this section must ensure that the funds necessary to meet the costs of closure, post-closure care, and corrective action for known releases will be available whenever they are needed. Owners must choose from the options specified in paragraphs F.4.a through F.4.i of this section.***

Textron Automotive Company will provide financial assurance for closure and post-closure care as specified in paragraph F.4. A copy of the current (as of March 31, 2008) financial assurance mechanism for the site is provided in Appendix J. For purposes of clarity and efficiency, the specific regulation citations for paragraphs F.4.a through F.4.i have been removed from the Plan text.

***j. Use of Multiple Financial Mechanisms.***

***An owner may satisfy the requirements of this section by establishing more than one financial mechanism per facility. The mechanisms must be as specified in paragraphs F.4.a through F.4.i of this section, except that it is the combination of mechanisms, rather than the single mechanism, which must provide financial assurance for an amount at least equal to the current cost estimate for closure, post-closure care or corrective action, whichever is applicable. The financial test and a guarantee provided by a corporate parent, sibling, or grandparent may not be combined if the financial statements of the two firms are consolidated.***

Not applicable; multiple financial mechanisms will not be used.

***k. The language of the mechanisms listed in paragraphs F.4.a through F.4.i of this section must ensure that the instruments satisfy the following criteria:***

***(1) the financial assurance mechanisms must ensure that the amount of funds assured is sufficient to cover the costs of closure, post-closure care, and corrective action for known releases when needed;***

Refer to the financial assurance mechanism provided in Appendix J.

***(2) the financial assurance mechanisms must ensure that funds will be available in a timely fashion when needed;***

Refer to the financial assurance mechanism provided in Appendix J.

***(3) the financial assurance mechanisms must be obtained by the owner by the effective date of these regulations in the case of closure and post-closure care, and no later than 120 days after the corrective action remedy has been selected in accordance with the requirements of paragraph D.8. of this section, until the owner is released from the financial assurance requirements under paragraphs F.1, F.2 and F.3 of this section; and***

The financial assurance mechanism for the Site is in affect with the most current (as of March 31, 2008) copy provided in Appendix J.

***(4) the financial assurance mechanisms must be legally valid, binding, and enforceable under State of Mississippi and Federal law.***

The financial assurance mechanism is legally valid, binding, and enforceable under State of Mississippi and Federal law.

# 4. LIMITATIONS

## Document Limitations

This document was prepared solely for ArvinMeritor, Inc. in accordance with professional standards at the time the services were performed. This document is governed by the specific scope of work authorized by ArvinMeritor, Inc.; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work.

# APPENDIX A

## Lagoon Solidification/Stabilization Study

KEMRON
ENVIRONMENTAL SERVICES
1359-A Ellsworth Industrial Boulevard • Atlanta, GA 30318 • TEL 404-636-0928 • FAX 404-636-7162

14 November 2007

Mr. Bruce Alleman
Brown and Caldwell
4700 Lakehurst Court
Suite 100
Columbus, Ohio 43016
(614) 923-0858

**Re: Lagoon Solidification / Stabilization Study**
**KEMRON Project #: SE0229**

Dear Mr. Alleman:

**KEMRON Environmental Services, Inc.** (KEMRON) is pleased to present Brown and Caldwell with the results of bench-scale testing performed on lagoon sludge materials provided to KEMRON by Brown and Caldwell. The treatability study was performed to evaluate in-situ solidification / stabilization (S/S) techniques capable of stabilizing and improving the materials' physical characteristics which would allow the support of a clean soil cap. The following sections of this report include information regarding the protocols followed during each phase of the study and the results of all testing performed.

**Untreated Material Characterization**

KEMRON received three untreated soil samples from the site labeled "L-1 NE", "L-2 NW", and "L-3 SE". Each site material was received in 5-gallon containers. Upon receipt, the samples were logged into KEMRON's sample tracking database and placed in refrigerated storage at a temperature of 4 degrees Celsius (°C). A copy of the original chain of custody record is presented as **Attachment A**.

Upon authorization to proceed, KEMRON individually homogenized the samples by placing the contents of the containers into a stainless steel mixing pan and gently mixing with stainless steel utensils. For treatability testing, KEMRON typically removes all particles or debris larger than 0.5 inches (in.) in diameter. Once homogenized, the untreated materials were placed back into the original shipping containers and returned to refrigerated storage.

KEMRON performed physical characterization testing of the site materials as outlined in the original scope of work. Geotechnical characterization testing data is used to prepare cost estimates and design specifications with regard to full-scale treatment. The information generated is critical to making sound engineering decisions. The following geotechnical characterization tests were conducted on the untreated soil in accordance with the referenced test methods:

| PARAMETER | METHOD |
|---|---|
| Particle Size Distribution | ASTM D422 |
| Solid Specific Gravity | ASTM D854 |
| Moisture Content | ASTM D2216 |
| Bulk Density | ASTM D2937 Mod. |
| Material pH | Method 9045C |
| Void Ratio / Porosity | Calculated |
| One-Dimensional Consolidation | ASTM D2435 |

The results of the physical characterization testing performed on the untreated site materials are presented in **Table 1**, except the one-dimensional consolidation data which is presented in the **Attachments**. Complete physical data reports including triplicate results of untreated material characterizations are included as **Attachment B**. The following are summaries of the data presented in **Table1.** Note that the tables presented in the text of this document are for discussion purposes and may not include all information presented in the Attachments.

**TABLE 1**

| TESTING PARAMETER | TEST METHOD | UNIT | RESULTS L-1 NE | L-2 NW | L-3 SE |
|---|---|---|---|---|---|
| **CHEMICAL PROPERTIES** | | | | | |
| **Material pH** | EPA 9045 | s.u. | 6.07 | 6.14 | 6.27 |
| **PHYSICAL PROPERTIES** | | | | | |
| **Unit Weight** | ASTM D2937 | lb/ft³ | 69.0 | 68.6 | 68.8 |
| **Moisture Content** | ASTM D2216 | % | 318.73 | 463.98 | 335.73 |
| **Percent Solids** | EPA | % | 23.88 | 17.73 | 22.95 |
| **Specific Gravity** | ASTM D854 | - | 1.84 | 2.14 | 1.86 |
| **Particle Size** | ASTM D422 | | | | |
| Gravel | | % | 0.0 | 0.0 | 0.0 |
| Sand | | % | 1.5 | 1.2 | 1.4 |
| Silt | | % | 87.4 | 75.8 | 84.2 |
| Clay | | % | 11.1 | 23.0 | 14.4 |
| **Porosity** | Calculated | % | 85.6 | 90.9 | 86.4 |

**Solidification / Stabilization Evaluations**

Overview

Solidification / stabilization is a well know and proven technology for remediation that can be utilized to remediate a wide range of materials and contaminants. Typically binding agents such as Portland cement, slag, kiln dusts, and fly ashes may be blended with soils, sludges and sediments to treat hazardous wastes through mechanisms such as binding excess moisture, macro and micro-encapsulation of contaminants to reduce leaching, hydraulic conductivity reduction, pH adjustment, and chemically altering contaminants of concern.

Screening

Upon completion of untreated material characterization testing, KEMRON proceeded with solidification / stabilization treatment evaluations. Prior to completing the proposed scope of work, KEMRON performed internal solidification / stabilization screening. The internal screens were completed on the L-2 NW material as it appeared to be the "worst case" of the three materials received. This screening provided additional information related to the visual setting properties of the treatment of the L-2 NW material with various reagents and reagent blends.

Treatment

Following the observations collected from the internal screening tests, KEMRON moved forward with the proposed stabilization treatment. KEMRON developed a total of 9 mixtures for each of the three untreated materials, resulting in a total of twenty-seven mixtures. The mixture designs utilized were based on visual observations from the screening performed and are presented in **Table 2**.

Mixtures were prepared using a bench-scale Hobart-type mixer. The mixer has a 4½ quart stainless steel mixing bowl and "flat beater" type paddles. Treatment utilizing this mixer is intended to simulate, to the extent possible on the bench-scale, potential full-scale remediation options. This approach is routinely utilized to simulate a wide range of potential full-scale remediation approaches, including both in situ and ex situ applications. Note that KEMRON's approach to performing bench-scale testing has been reviewed and is routinely accepted by EPA and full-scale solidification / stabilization contractors.

Treatments in this phase of the study consisted of Type I Portland Cement in combination with Hydrated Lime, Lime Kiln Dust, or Cement Kiln Dust at varying reagent percentages with water addition included in some of the reagent designs. During screening, low strength conditions were observed indicating that some organic interference may exist. As a result, the mix designs with water addition were included based on KEMRON's experience that organic compounds present in site materials may inhibit the setting of pozzolonic reagents such as those utilized in this study. Those reagent combinations including potable water were prepared to form a paste like consistency prior to mixing with the untreated site materials. The paste reagent mixture was then thoroughly mixed with the untreated site material.

The following provides specific mix preparation steps. The percent reagent and water addition is based on the total weight of reagent relative to the total weight of the untreated "as received" aliquot. For example, in a mixture with a 15 percent (%) addition of Portland cement, 10% of Hydrated Lime, and 15% of water, 15 grams of cement, 10 grams of Lime and 15 grams of potable water were added for every 100 grams of untreated "as received" material. As previously mentioned, KEMRON used a Hobart-type mixer to prepare each mixture. Mixing was conducted at approximately 40 to 60 rotations per minute (rpm), for approximately 60 to 90 seconds, or until visually homogenous.

Specimen Curing and Evaluation

Immediately following mix development, each treated material was placed into plastic cylindrical curing molds and placed in a humid environment for curing. Throughout the curing process KEMRON evaluated each mixture for potential setting via pocket penetrometer testing. At the 14-day curing interval each treated material was subjected to UCS testing in accordance with ASTM D2166 and volumetric expansion was determined. At the 28-day curing interval, KEMRON and Brown and Caldwell selected 6 mixture designs, two from each untreated material, for one-dimensional consolidation testing in accordance with ASTM D2435. These

mixtures were selected based on the results of UCS testing.

## Treatment Data Evaluations

### Review of Strength Data

The results of penetrometer and UCS testing performed on the treated mixtures are presented in **Tables 3 and 4**. Review of the penetrometer data indicates that materials treated with Portland cement and LKD exhibited the greatest strength increase at the 14 cure interval.

At 14 days of curing, each treated specimen was subjected to Unconfined Compressive Strength (UCS) testing in accordance with the American Society of Testing and Materials (ASTM) method D2166. While no specific strength criteria were outlined for this project, KEMRON's experience is that as little as 12 to 15 psi is often sufficient to support standard construction equipment as well as a soil cap.

The following is a presentation combining **Tables 3 and 4** for discussion purposes.

| KEMRON SAMPLE No. | POCKET PENETROMETER RESULTS (tons/ft$^2$) | | | | | | | | UCS (lbs/in$^2$) |
|---|---|---|---|---|---|---|---|---|---|
| | 1 Day | 3 Day | 4 Day | 5 Day | 6 Day | 7 Day | 8 Day | 14 Day | |
| 0229-001 | 0 | - | - | - | 0.25 | 0.5 | 0.5 | 1 | 15.0 |
| 0229-002 | 0 | - | - | - | 0.25 | 0.75 | 1 | 1.5 | 21.7 |
| 0229-003 | 0 | - | - | - | 0 | 0.5 | 0.5 | 1.75 | 24.1 |
| 0229-004 | 0 | - | - | - | 1.25 | 1.5 | 2 | 2.2 | 27.1 |
| 0229-005 | 0 | - | - | - | 1.5 | 1.75 | 2 | 2.8 | 37.3 |
| 0229-006 | 0 | - | - | - | 2 | 2.25 | 2.75 | 3.25 | 42.5 |
| 0229-007 | - | - | 0 | - | 0 | 0 | 0 | 0 | * |
| 0229-008 | - | - | 1.25 | - | 1.25 | 1.25 | 1.25 | 1.35 | 17.3 |
| 0229-009 | - | - | 1 | - | 1.5 | 1.5 | 1.85 | 2 | 26.4 |
| 0229-010 | - | - | 0 | - | 0 | 0 | 0 | 0 | * |
| 0229-011 | - | - | 0 | - | 0 | 0 | 0 | 0.25 | 7.5 |
| 0229-012 | - | - | 0 | - | 0 | 0 | 0 | 0.25 | 8.2 |
| 0229-013 | - | - | 0 | - | 0 | 0.25 | 0.25 | 0.6 | 10.2 |
| 0229-014 | - | - | 0.5 | - | 0.75 | 0.75 | 1 | 1.75 | 16.4 |
| 0229-015 | - | - | 0 | - | 0.5 | 1 | 1 | 1.75 | 19.8 |
| 0229-016 | - | - | 0 | - | 0 | 0 | 0 | 0 | * |
| 0229-017 | - | - | 0 | - | 0 | 0 | 0.25 | 0.6 | 10.6 |
| 0229-018 | - | - | 0 | - | 0.25 | 0.5 | 0.5 | 1 | 14.5 |
| 0229-019 | - | - | 0 | - | 0 | 0 | 0 | 0 | * |
| 0229-020 | - | - | 0 | - | 0 | 0.25 | 0.6 | 1 | 24.2 |
| 0229-021 | - | - | 0 | - | 0 | 0 | 0 | 1 | 15.1 |
| 0229-022 | - | 0.25 | - | 1 | 1.25 | 1.5 | - | 2.15 | 27.4 |
| 0229-023 | - | 1 | - | 1.75 | 2 | 2 | - | 3.25 | 39.3 |

| KEMRON SAMPLE No. | POCKET PENETROMETER RESULTS (tons/ft$^2$) | | | | | | | | UCS (lbs/in$^2$) |
|---|---|---|---|---|---|---|---|---|---|
| | 1 Day | 3 Day | 4 Day | 5 Day | 6 Day | 7 Day | 8 Day | 14 Day | |
| 0229-024 | - | 1 | - | 1.25 | 1.75 | 2.5 | - | 4.25 | 45.1 |
| 0229-025 | - | 0.0 | - | 0.0 | 0.0 | 0.0 | - | 0.0 | * |
| 0229-026 | - | 0.0 | - | 0.0 | 0.0 | 0.0 | - | 0.0 | 7.2 |
| 0229-027 | - | 0.75 | - | 1.5 | 1.65 | 2.25 | - | 2.75 | 27.0 |

* Samples lacked sufficient cohesion to test.

In general, penetrometer trends strongly correlate with UCS trends within any given set of mixtures. That is, in treatments using cement and lime kiln dust, increasing penetrometer results were associated with increasing UCS results. Although this is the case, looking further at the data, actual penetrometer strength data can only be loosely correlated to potential UCS strength data. For instance, materials exhibiting a penetrometer strength of 1.0 ton per square foot (TSF) at the 14 day cure had UCS values ranging from 14.5 to 24.2 psi. Mixtures exhibiting penetrometer strengths ranging from 2.0 to 3.0 TSF had UCS values of approximately 27 psi. This data indicates that especially at lower penetrometer readings a significant range of UCS values may be realized.

Note that no significant increase in strength was observed with the water additions to the different mixture designs. The data demonstrates that the addition of Portland cement and Lime Kiln Dust resulted in the greatest increase in strength of all reagent blends at the 14 day cure interval. Mixtures involving untreated sample "L-2 NW" had overall lower strength results when compared with other materials. KEMRON believes that this is primarily due to the higher liquid, moisture, content this material exhibited compared to "L-1 NE" and "L-3 SE".

Review of Volumetric Expansion Data

Volumetric expansion is a measurement of the difference between the untreated volume and the volume generated following the 14-day cure time of the treated material. The preparation for this test includes partially filling 2" diameter x 4" diameter molds. Immediately after preparing the specimens, the heights of the material in the 2" diameter molds are recorded. Following the 14-day cure time, the height is again determined for volumetric expansion. The volumetric expansion (or shrinkage) is determined from the difference in heights observed. Based on the data presented in **Table 2**, the volumetric expansion ranges from -5.45% to 27.15% when reviewing all mix designs. For L-1 NE the volumetric expansion ranges from -5.45% to 27.15%, exhibiting the widest range in the determination for all mix designs. For L-2 NW, the volumetric expansion ranges from 10.18% to 25.24%; and for L-3 SE the range spans 8.01% to 26.95%. Within each reagent combination, the volumetric expansion increases with increasing reagent addition. The largest change in a volumetric expansion was demonstrated with the untreated sample L-1 NE with the Type I Portland Cement and Hydrated Lime reagent combination. The smallest change in a volumetric expansion was demonstrated with the untreated sample L-2 NW with the Type I Portland Cement and the Hydrated Lime.

Review of One-Dimensional Consolidation Data

One-Dimensional Consolidation tests were performed on two mix designs for each untreated material. KEMRON and Brown and Caldwell selected the 6 mixture designs based on the 14-day UCS data. Specifically, the mixtures evaluated included mixture designs utilizing Type I Portland cement in combination with lime kiln dust at addition rates of 7.5 and 20% respectively,

and 10 and 20% respectively. Mixtures, 004, 005, 022 and 023 exhibited UCS values of approximately 27 psi at the lower cement addition rate and from 37 to 39 psi at the higher addition. Mixtures 013 and 014 had strengths of 10.2 psi at the lower cement addition and 16.4 psi at the higher rate. This data again indicates that the higher liquid content of the L-2 NW material may have reduced the effectiveness of treatment as it relates to strength.

Based on information provided to KEMRON by Brown and Caldwell, the testing was completed based on a standard loading schedule with a maximum of 4 tons per square foot (TSF). Additionally, this material was not inundated with water due to its intended placement above the existing site water table.

Complete data reports for one-dimensional consolidation testing are included in the attachments.

Because KEMRON was not contracted for geotechnical engineering services, no interpretation of the consolidation data has been included. However, cursory review of the data indicates that at a load of 0.5 TSF, the treated materials exhibited percent strains ranging from approximately 1.3 to 4, which is a significant improvement from the 32 to 53% seen in the untreated materials.

**Conclusions**

Based on the results of testing, it appears that site materials L-1 and L-3 are very similar in physical characteristics and treatability. Specifically, treatment of the site materials using a combination of Type I Portland cement and lime kiln dust, at a minimum cement addition rate of 7.5% and a minimum LKD addition rate of 20%, resulted in strength values greater than 25 psi for both site materials L-1 and L-3. Additionally, strength comparisons of other mixtures developed using these two site materials indicate that similar results were observed when using similar reagent addition rates. The volumetric expansion also shows greater overall increases in expansion for the L-1 and L-3 as compared to the L-2 material. Testing performed on site material L-2 indicates that significantly lower strengths were recorded compared to the same mixtures performed on the other two site samples. KEMRON feels that the lower strength results are predominantly due to the higher liquid content exhibited in sample L-2. More beneficial treatment results as it relates to strength may be achieved if additional liquid is removed from site material L-2.

**Disclaimer**

When performing treatability studies, KEMRON Environmental Services is typically provided with samples from a given site. These samples usually have been collected by site personnel and are intended to be representative of site materials. The treatability study, however, is only as accurate as the sample taken in the field. Since KEMRON has no control over the sample collection, the results of the study are assumed to be only estimations of the anticipated results.

KEMRON has applied our best technical and scientific knowledge to the performance of the work under the economic and schedule parameters of this study. The information contained in this report in no way guarantees the same results in full-scale adaptation and is only intended as an estimate of potential site conditions.

Furthermore, the study period defined by the client limits the evaluations of site materials to a specified time frame. KEMRON can evaluate the samples based on this time frame, however, we cannot comment on the long term-results.

Pilot scale testing can provide additional data as to the overall treatment effectiveness of the

mix designs presented in this study.

**KEMRON Environmental Services, Inc.** is pleased to present Brown and Caldwell with this final letter report for the Lagoon Solidification / Stabilization treatability study. If you have any questions, or require additional information, please contact either of the undersigned.

Sincerely,
**KEMRON ENVIRONMENTAL SERVICES, INC.**

Mark Clark
Applied Technologies Group
Project Manager
mclark@KEMRON.com

Kelly Clemons
Applied Technologies Group
Department Manager
kclemons@KEMRON.com

Attachments

*TABLES*


*Data contained on this sheet shall not be disclosed without prior approval from KEMRON Environmental Services, Inc. (Proprietary)*

Kemron ENVIRONMENTAL SERVICES

# BROWN AND CALDWELL
# LAGOON STABILIZATION STUDY

## TABLE 1
## UNTREATED MATERIAL CHARACTERIZATION

| TESTING PARAMETER | TEST METHOD | UNIT | RESULTS | | |
|---|---|---|---|---|---|
| | | | L-1 NE | L-2 NW | L-3 SE |
| **CHEMICAL PROPERTIES** | | | | | |
| **Material pH** | EPA 9045 | s.u. | 6.07 | 6.14 | 6.27 |
| **PHYSICAL PROPERTIES** | | | | | |
| **Unit Weight** | ASTM D2937 | lb/ft³ | 69.0 | 68.6 | 68.8 |
| **Moisture Content** | ASTM D2216 | % | 318.73 | 463.98 | 335.73 |
| **Percent Solids** | EPA | % | 23.88 | 17.73 | 22.95 |
| **Specific Gravity** | ASTM D854 | - | 1.84 | 2.14 | 1.86 |
| **Particle Size** | ASTM D422 | | | | |
| Gravel | | % | 0.0 | 0.0 | 0.0 |
| Sand | | % | 1.5 | 1.2 | 1.4 |
| Silt | | % | 87.4 | 75.8 | 84.2 |
| Clay | | % | 11.1 | 23.0 | 14.4 |
| **Porosity** | Calculated | % | 85.6 | 90.9 | 86.4 |

s.u. - standard unit

KEMRON ENVIRONMENTAL SERVICES

# BROWN AND CALDWELL
# LAGOON STABILIZATION STUDY

## TABLE 2
## MIXTURE DESIGNS, PERCENT BULKING, VOLUMETRIC EXPANSION

| KEMRON SAMPLE ID | UNTREATED MATERIAL | REAGENT | REAGENT ADDITION (%) | WATER ADDITION (%) | VOLUMETRIC EXPANSION (%) |
|---|---|---|---|---|---|
| SE0229-001 | L-1 NE | Type I Portland Cement / Hydrated Lime | 7.5 / 10 | 0 | -5.45 |
| SE0229-002 | L-1 NE | Cement / H-lime | 10 / 12.5 | 0 | 8.59 |
| SE0229-003 | L-1 NE | Cement / H-lime | 15 / 10 | 15.0 | 15.04 |
| SE0229-004 | L-1 NE | Cement / Lime Kiln Dust | 7.5 / 20 | 0 | 10.94 |
| SE0229-005 | L-1 NE | Cement / Lime Kiln Dust | 10 / 20 | 0 | 13.28 |
| SE0229-006 | L-1 NE | Cement / Lime Kiln Dust | 15 / 30 | 15.8 | 21.09 |
| SE0229-007 | L-1 NE | Cement / Cement Kiln Dust | 7.5 / 20 | 0 | 10.51 |
| SE0229-008 | L-1 NE | Cement / Cement Kiln Dust | 10 / 20 | 0 | 11.52 |
| SE0229-009 | L-1 NE | Cement / Cement Kiln Dust | 15 / 30 | 18.3 | 27.15 |
| SE0229-010 | L-2 NW | Type I Portland Cement / Hydrated Lime | 7.5 / 10 | 0 | 10.18 |
| SE0229-011 | L-2 NW | Cement / H-lime | 10 / 12.5 | 0 | 15.07 |
| SE0229-012 | L-2 NW | Cement / H-lime | 15 / 10 | 16.7 | 15.46 |
| SE0229-013 | L-2 NW | Cement / Lime Kiln Dust | 7.5 / 20 | 0 | 15.46 |
| SE0229-014 | L-2 NW | Cement / Lime Kiln Dust | 10 / 20 | 0 | 14.09 |
| SE0229-015 | L-2 NW | Cement / Lime Kiln Dust | 15 / 30 | 15.3 | 24.07 |
| SE0229-016 | L-2 NW | Cement / Cement Kiln Dust | 7.5 / 20 | 0 | 14.68 |
| SE0229-017 | L-2 NW | Cement / Cement Kiln Dust | 10 / 20 | 0 | 18.00 |
| SE0229-018 | L-2 NW | Cement / Cement Kiln Dust | 15 / 30 | 21.9 | 25.24 |
| SE0229-019 | L-3 SE | Type I Portland Cement / Hydrated Lime | 7.5 / 10 | 0 | 8.01 |
| SE0229-020 | L-3 SE | Cement / H-lime | 10 / 12.5 | 0 | 10.55 |
| SE0229-021 | L-3 SE | Cement / H-lime | 15 / 10 | 16.3 | 17.38 |
| SE0229-022 | L-3 SE | Cement / Lime Kiln Dust | 7.5 / 20 | 0 | 9.37 |
| SE0229-023 | L-3 SE | Cement / Lime Kiln Dust | 10 / 20 | 0 | 14.26 |
| SE0229-024 | L-3 SE | Cement / Lime Kiln Dust | 15 / 30 | 17.6 | 25.78 |
| SE0229-025 | L-3 SE | Cement / Cement Kiln Dust | 7.5 / 20 | 0 | 12.89 |
| SE0229-026 | L-3 SE | Cement / Cement Kiln Dust | 10 / 20 | 0 | 14.06 |
| SE0229-027 | L-3 SE | Cement / Cement Kiln Dust | 15 / 30 | 21.0 | 26.95 |

All reagent additions were determined on a by-weight basis according to the initial weight of the untreated aliquot utilized. Multiple reagents were first mixed dry then blended with the untreated material. In the mixtures where water was used, The reagents were mixed with water to form a paste in order to hydrate the reagents then the reagent paste was blended with the untreated material. For clarification in a mixture with 7.5% cement and 10% hydrated lime, 7.5 grams of cement was blended with 10 grams of hydrated lime and then mixed with 100 grams of the untreated material.

KEMRON ENVIRONMENTAL SERVICES

# Brown and Caldwell
## LAGOON STABILIZATION STUDY
### TABLE 3
### Mixture Development and Unconfined Compressive Strength Testing Results ASTM D2166

| KEMRON SAMPLE No. | UNTREATED MATERIAL TYPE | REAGENT TYPE | Reagent Addition (%) | Water Addition (%) | Cure Time (days) | UNCONFINED COMPRESSIVE STRENGTH | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Moisture Content (%) | Bulk Density (lbs/ft$^3$) | Dry Density (lbs/ft$^3$) | UCS (lbs/in$^2$) |
| 0229-001 | L-1 NE | Portland Cement / Hydrated Lime | 7.5 / 10 | 0.0 | 14 | 151.66 | 76.4 | 30.4 | 15.0 |
| 0229-002 | L-1 NE | Portland Cement / Hydrated Lime | 10 / 12.5 | 0.0 | 14 | 144.2 | 77.3 | 31.6 | 21.7 |
| 0229-003 | L-1 NE | Portland Cement / Hydrated Lime | 15 / 10 | 15.0 | 14 | 158.54 | 76 | 29.4 | 24.1 |
| 0229-004 | L-1 NE | Portland Cement / Lime Kiln Dust | 7.5 / 20 | 0.0 | 14 | 128.34 | 80.4 | 35.2 | 27.1 |
| 0229-005 | L-1 NE | Portland Cement / Lime Kiln Dust | 10.0 / 20 | 0.0 | 14 | 118.38 | 81.1 | 37.2 | 37.3 |
| 0229-006 | L-1 NE | Portland Cement / Lime Kiln Dust | 15 / 30 | 15.8 | 14 | 109.42 | 83.2 | 39.7 | 42.5 |
| 0229-007 | L-1 NE | Portland Cement / Cement Kiln Dust | 7.5 / 20 | 0.0 | 14 | * | * | * | * |
| 0229-008 | L-1 NE | Portland Cement / Cement Kiln Dust | 10.0 / 20 | 0.0 | 14 | 127.14 | 81.1 | 35.7 | 17.3 |
| 0229-009 | L-1 NE | Portland Cement / Cement Kiln Dust | 15 / 30 | 18.3 | 14 | 128.3 | 81.8 | 35.8 | 26.4 |
| 0229-010 | L-2 NW | Portland Cement / Hydrated Lime | 7.5 / 10 | 0.0 | 14 | * | * | * | * |
| 0229-011 | L-2 NW | Portland Cement / Hydrated Lime | 10 / 12.5 | 0.0 | 14 | 180.2 | 77.1 | 27.5 | 7.5 |
| 0229-012 | L-2 NW | Portland Cement / Hydrated Lime | 15 / 10 | 16.7 | 14 | 197.55 | 76.3 | 25.6 | 8.2 |
| 0229-013 | L-2 NW | Portland Cement / Lime Kiln Dust | 7.5 / 20 | 0.0 | 14 | 153 | 80.4 | 31.8 | 10.2 |
| 0229-014 | L-2 NW | Portland Cement / Lime Kiln Dust | 10.0 / 20 | 0.0 | 14 | 143.58 | 80.6 | 33.1 | 16.4 |
| 0229-015 | L-2 NW | Portland Cement / Lime Kiln Dust | 15 / 30 | 15.3 | 14 | 123.16 | 83.7 | 37.5 | 19.8 |
| 0229-016 | L-2 NW | Portland Cement / Cement Kiln Dust | 7.5 / 20 | 0.0 | 14 | * | * | * | * |
| 0229-017 | L-2 NW | Portland Cement / Cement Kiln Dust | 10.0 / 20 | 0.0 | 14 | 153.33 | 79.8 | 31.5 | 10.6 |
| 0229-018 | L-2 NW | Portland Cement / Cement Kiln Dust | 15 / 30 | 21.9 | 14 | 145.01 | 81.3 | 33.2 | 14.5 |
| 0229-019 | L-3 SE | Portland Cement / Hydrated Lime | 7.5 / 10 | 0.0 | 14 | * | * | * | * |
| 0229-020 | L-3 SE | Portland Cement / Hydrated Lime | 10 / 12.5 | 0.0 | 14 | 147.89 | 77.1 | 31.1 | 24.2 |
| 0229-021 | L-3 SE | Portland Cement / Hydrated Lime | 15 / 10 | 16.3 | 14 | 165.42 | 76.2 | 28.7 | 15.1 |
| 0229-022 | L-3 SE | Portland Cement / Lime Kiln Dust | 7.5 / 20 | 0.0 | 14 | 133.4 | 80.2 | 34.3 | 27.4 |
| 0229-023 | L-3 SE | Portland Cement / Lime Kiln Dust | 10.0 / 20 | 0.0 | 14 | 124.6 | 81.5 | 36.3 | 39.3 |
| 0229-024 | L-3 SE | Portland Cement / Lime Kiln Dust | 15 / 30 | 17.6 | 14 | 119.5 | 82.3 | 37.5 | 45.1 |
| 0229-025 | L-3 SE | Portland Cement / Cement Kiln Dust | 7.5 / 20 | 0.0 | 14 | * | * | * | * |
| 0229-026 | L-3 SE | Portland Cement / Cement Kiln Dust | 10.0 / 20 | 0.0 | 14 | 138.5 | 80.9 | 33.9 | 7.2 |
| 0229-027 | L-3 SE | Portland Cement / Cement Kiln Dust | 15 / 30 | 21.0 | 14 | 127.1 | 80.9 | 35.6 | 27.0 |

* Samples lacked sufficient cohesion to test.

KEMRON ENVIRONMENTAL SERVICES

**BROWN AND CALDWELL**

**LAGOON STABILIZATION STUDY**

**TABLE 4**

**SUMMARY OF POCKET PENETROMETER TESTING**

| KEMRON SAMPLE No. | POCKET PENETROMETER RESULTS (tons/ft$^2$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 Day | 3 Day | 4 Day | 5 Day | 6 Day | 7 Day | 8 Day | 14 Day |
| 0229-001 | 0 | - | - | - | 0.25 | 0.5 | 0.5 | 1 |
| 0229-002 | 0 | - | - | - | 0.25 | 0.75 | 1 | 1.5 |
| 0229-003 | 0 | - | - | - | 0 | 0.5 | 0.5 | 1.75 |
| 0229-004 | 0 | - | - | - | 1.25 | 1.5 | 2 | 2.2 |
| 0229-005 | 0 | - | - | - | 1.5 | 1.75 | 2 | 2.8 |
| 0229-006 | 0 | - | - | - | 2 | 2.25 | 2.75 | 3.25 |
| 0229-007 | - | - | 0 | - | 0 | 0 | 0 | 0 |
| 0229-008 | - | - | 1.25 | - | 1.25 | 1.25 | 1.25 | 1.35 |
| 0229-009 | - | - | 1 | - | 1.5 | 1.5 | 1.85 | 2 |
| 0229-010 | - | - | 0 | - | 0 | 0 | 0 | 0 |
| 0229-011 | - | - | 0 | - | 0 | 0 | 0 | 0.25 |
| 0229-012 | - | - | 0 | - | 0 | 0 | 0 | 0.25 |
| 0229-013 | - | - | 0 | - | 0 | 0.25 | 0.25 | 0.6 |
| 0229-014 | - | - | 0.5 | - | 0.75 | 0.75 | 1 | 1.75 |
| 0229-015 | - | - | 0 | - | 0.5 | 1 | 1 | 1.75 |
| 0229-016 | - | - | 0 | - | 0 | 0 | 0 | 0 |
| 0229-017 | - | - | 0 | - | 0 | 0 | 0.25 | 0.6 |
| 0229-018 | - | - | 0 | - | 0.25 | 0.5 | 0.5 | 1 |
| 0229-019 | - | - | 0 | - | 0 | 0 | 0 | 0 |
| 0229-020 | - | - | 0 | - | 0 | 0.25 | 0.6 | 1 |
| 0229-021 | - | - | 0 | - | 0 | 0 | 0 | 1 |
| 0229-022 | - | 0.25 | - | 1 | 1.25 | 1.5 | - | 2.15 |
| 0229-023 | - | 1 | - | 1.75 | 2 | 2 | - | 3.25 |
| 0229-024 | - | 1 | - | 1.25 | 1.75 | 2.5 | - | 4.25 |
| 0229-025 | - | 0.0 | - | 0.0 | 0.0 | 0.0 | - | 0.0 |
| 0229-026 | - | 0.0 | - | 0.0 | 0.0 | 0.0 | - | 0.0 |
| 0229-027 | - | 0.75 | - | 1.5 | 1.65 | 2.25 | - | 2.75 |

# APPENDIX B

## Bearing Capacity Calculations

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| 06/06/08 | REW | 131016.002.002 | RAI | 06/05/08 | 3 | 1 of 1 |

| Project | Subject |
|---|---|
| Grenada Sludge Lagoon Closure Plan | Bearing Capacity Calculation |

**OBJECTIVE:** Estimate the bearing capacity of the final cover system subbase.

**METHODOLOGY:** Use the Terzaghi bearing capacity analysis to estimate the factor of safety against bearing capacity failure for the final cover system subbase.

**ANALYSIS:** Use the Terzaghi formula for bearing capacity:

$$q_{ultimate} = cN_c + 0.5\gamma_s N_\gamma B + N_q \gamma_w D_f$$

Where:

$q_{ultimate}$ = ultimate bearing capacity [pounds per square foot (psf)]
$C$ = cohesion of subbase (psf)
$\gamma_w$ = unit weight of material above subbase (pcf)
$D_f$ = maximum thickness of final cover system (ft)
$\gamma_s$ = unit weight of subbase (pcf)
$B$ = width of foundation (ft)
$N_c, N_q, N_\gamma$ = bearing capacity factors, function of subbase friction angle

Assumed soil properties for the subbase and final cover system:

| Property | Subbase | Final Cover |
|---|---|---|
| Unit Weight ($\gamma$) | 120 pcf | 115 pcf |
| Cohesion (c) | 0 psf | 0 psf |
| Friction Angle ($\Phi$) | 30° | 30° |
| $N_c$ | 30.14 | 30.14 |
| $N_q$ | 18.4 | 18.4 |
| $N_\gamma$ | 15.1 | 15.1 |
| Thickness (feet) | $\geq$2 | 2 |

$q_{ultimate} = cN_c + 0.5\gamma_s N_\gamma B + N_q \gamma_w D_f$
$q_{ultimate}$ = (0 x 30.14) + (0.5 x 120 pcf x 15.1 x 2 ft) + (18.4 x 115 pcf x 2 ft)
$q_{ultimate}$ = 6,044 psf

Assuming a Factor of Safety of 3; the allowable bearing capacity of the subbase:

$q_{allowable}$ = 6,044 psf ÷ 3 = 2,015 psf

The maximum applied load on the subbase is as follows:
Maximum applied load = weight of the final cover system
Maximum applied load = (115 pcf x 2 ft)
Maximum applied load = 230 psf

A comparison of the maximum applied load versus the allowable bearing capacity provides:
$q_{allowable}$ of 2,015 psf > $q_{applied}$ of 230 psf

**CONCLUSION:** Based on the analysis, the allowable bearing capacity of the subbase is 2,015 psf which is greater than the maximum anticipated load exerted by the final cover system of 230 psf; therefore, the subbase will possess adequate bearing capacity.

References/Notes

Bearing capacity factors obtained from *"Foundation Analysis and Design"*, Joseph E. Bowles, 1977.

The weight attributable to the geomembrane and geocomposite components of the final cover system is considered negligible.

# APPENDIX C

## HELP Model Results

References/Notes

**OBJECTIVE:** To determine the effectiveness of the proposed final cover system in minimizing the amount of surface water infiltration into the solidified/stabilized sludge below the proposed final cover system. This calculation will also demonstrate that the maximum head on the 60-mil, textured HDPE geomembrane does not exceed 12 inches.

**METHODOLOGY:** The Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.07 was used to simulate the proposed final cover system and surface water generation from the geocomposite drainage component. The model utilizes climatologic, soil and design data, and performs a solution technique that accounts for the effects of surface layer storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage to calculate a surface water generation volume.

**Climatological Data:** The HELP Model utilizes historical precipitation data and generates synthetic temperature and solar radiation data for various cities in the United States. The nearest pre-defined climatic data location to the Site is Jackson, Mississippi. This data was used to evaluate the effectiveness of the proposed final cover system over a period of five years.

**Soil and Design Data:** To model the effectiveness of the proposed final cover system, two scenarios were considered and are discussed below. The scenarios model the proposed final cover system which includes a geocomposite drainage layer overlayed with a protective/vegetative cover layer.

Each scenario models a protective/vegetative layer thickness of 2-feet above the geocomposite drainage layer installed on top of the 60-mil, textured HDPE geomembrane. The surface slope of 8.0 percent and a slope length of 160 feet are used to calculate the SCS runoff curve number.

Scenario No. 1 is intended to model the proposed final cover system under the "bare ground" condition (i.e. no vegetation growing). Scenario No. 2 is intended to model the proposed final cover system with a "fair stand" of grass present. The two scenarios represent the final cover system at two distinct points: Scenario No. 1 at the completion of the final cover installation and Scenario No. 2 at a point in time when adequate vegetative cover is present.
The following tables summarize the scenarios for each condition in ascending order from the top down and present the following data: HELP Model default material texture number, component thickness, and component permeability. The default material texture number classifies each component within the given scenario with specific default values for the proposed soil and liner components. Each material has default values for total porosity, field capacity, wilting point, and saturated hydraulic conductivity.

**Scenario No. 1 – Bare Ground**

| | Layer | Texture No. | Thickness | Permeability (cm/sec) |
|---|---|---|---|---|
| **Layer 1** | Protective/Vegetative Cover | 5 | 24 inches | 1.00E-03 |
| **Layer 2** | Geocomposite Drainage Layer | 20 | 250 mils | 1.00E+01 |
| **Layer 3** | Geomembrane Barrier Layer | 35 | 60 mils | 2.00E-13 |
| **Layer 4** | Subbase | 5 | 196.8 inches | 1.00E-03 |

References/Notes

**Scenario No. 2 – Fair Stand of Grass**

| | Layer | Texture No. | Thickness | Permeability (cm/sec) |
|---|---|---|---|---|
| **Layer 1** | Protective/Vegetative Cover | 5 | 24 inches | 1.00E-03 |
| **Layer 2** | Geocomposite Drainage Layer | 20 | 250 mils | 1.00E+01 |
| **Layer 3** | Geomembrane Barrier Layer | 35 | 60 mils | 2.00E-13 |
| **Layer 4** | Subbase | 5 | 196.8 inches | 1.00E-03 |

**ANALYSIS:** The results of the HELP Model provided the following:

| | Peak Daily Values | |
|---|---|---|
| | **Drainage from Layer 2** | **Maximum Head on Layer 3** |
| Scenario No. 1 | 3,630 CF (27,159 gallons) | 0.070 inches |
| Scenario No. 2 | 6,032 CF (45,119 gallons) | 0.119 inches |

**CONCLUSIONS:** For each scenario, the geocomposite drainage layer, Layer 2 provides adequate flow of infiltrated surface water resulting from rainfall events away from Layer 3 (the geomembrane) which results in a maximum head value of much less than the allowable 12 inches.

The potential amount of surface water infiltration into the solidified/stabilized sludge below the proposed final cover system is 0.12835 cubic feet (0.96 gallons) and 0.18145 cubic feet (1.36 gallons) for Scenario No. 1 and Scenario No. 2, respectively. Therefore, the final cover system as proposed is effective in minimizing both the amount of surface water infiltration into the solidified/stabilized sludge and the head of infiltrated surface on top of the geomembrane.

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.002.002 | RAI | 06/13/08 | 4 | 3 of 3 |

| Project | Subject |
|---|---|
| Grenada Sludge Lagoon Closure Plan | Final Cover Effectiveness |

References/Notes

**Attachment 1**

**Help Model Output Files**

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\DATA4.D4
TEMPERATURE DATA FILE:        C:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\DATA13.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\DATA11.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\BARE.D10
OUTPUT DATA FILE:             C:\HELP3\BARE.OUT


TIME:  16:20      DATE:    6/13/2008


******************************************************************************

    TITLE:  Sludge Lagoon Closure - Final Cover Design: Bare Ground

******************************************************************************


    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   5
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4570 VOL/VOL
          FIELD CAPACITY               =      0.1310 VOL/VOL
          WILTING POINT                =      0.0580 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3182 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
```

```
                    MATERIAL TEXTURE NUMBER  20
THICKNESS                        =      0.25    INCHES
POROSITY                         =      0.8500 VOL/VOL
FIELD CAPACITY                   =      0.0100 VOL/VOL
WILTING POINT                    =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.0815 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =   10.0000000000      CM/SEC
SLOPE                            =      8.00    PERCENT
DRAINAGE LENGTH                  =    160.0     FEET


                         LAYER  3
                         --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
THICKNESS                        =      0.06    INCHES
POROSITY                         =      0.0000 VOL/VOL
FIELD CAPACITY                   =      0.0000 VOL/VOL
WILTING POINT                    =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY              =      1.00    HOLES/ACRE
FML INSTALLATION DEFECTS         =      1.00    HOLES/ACRE
FML PLACEMENT QUALITY            =  3 - GOOD


                         LAYER  4
                         --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   5
THICKNESS                        =    196.80    INCHES
POROSITY                         =      0.4570 VOL/VOL
FIELD CAPACITY                   =      0.1310 VOL/VOL
WILTING POINT                    =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT       =      0.1310 VOL/VOL
EFFECTIVE SAT. HYD. COND.        =  0.100000005000E-02 CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 5 WITH BARE
          GROUND CONDITIONS, A SURFACE SLOPE OF  8.% AND
          A SLOPE LENGTH OF  160. FEET.

SCS RUNOFF CURVE NUMBER                =     84.60
FRACTION OF AREA ALLOWING RUNOFF       =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE     =      1.000   ACRES
EVAPORATIVE ZONE DEPTH                 =     10.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE      =      3.182   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE     =      4.570   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE     =      0.580   INCHES
INITIAL SNOW WATER                     =      0.000   INCHES
```

| | | | |
|---|---|---|---|
| INITIAL WATER IN LAYER MATERIALS | = | 33.438 | INCHES |
| TOTAL INITIAL WATER | = | 33.438 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
JACKSON MISSISSIPPI

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 32.33 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 0.00 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 61 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 328 | |
| EVAPORATIVE ZONE DEPTH | = | 10.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 7.40 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 74.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 73.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 78.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 77.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSON MISSISSIPPI

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 5.00 | 4.48 | 5.86 | 5.85 | 4.83 | 2.94 |
| 4.40 | 3.71 | 3.55 | 2.62 | 4.18 | 5.40 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSON MISSISSIPPI

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 45.70 | 49.10 | 56.30 | 65.10 | 72.50 | 79.20 |
| 81.90 | 81.20 | 76.40 | 65.00 | 54.90 | 48.60 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSON MISSISSIPPI
AND STATION LATITUDE = 32.33 DEGREES

**********

## ANNUAL TOTALS FOR YEAR 1

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|

| | | | |
|---|---|---|---|
| PRECIPITATION | 49.22 | 178668.609 | 100.00 |
| RUNOFF | 3.016 | 10948.225 | 6.13 |
| EVAPOTRANSPIRATION | 26.503 | 96205.633 | 53.85 |
| DRAINAGE COLLECTED FROM LAYER 2 | 19.7009 | 71514.328 | 40.03 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001191 | 4.322 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0019 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001130 | 4.103 | 0.00 |
| CHANGE IN WATER STORAGE | -0.001 | -3.614 | 0.00 |
| SOIL WATER AT START OF YEAR | 35.010 | 127085.391 | |
| SOIL WATER AT END OF YEAR | 35.009 | 127081.781 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.070 | 0.00 |

**********

**********

ANNUAL TOTALS FOR YEAR 2

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 52.79 | 191627.672 | 100.00 |
| RUNOFF | 6.160 | 22361.500 | 11.67 |
| EVAPOTRANSPIRATION | 26.817 | 97344.734 | 50.80 |
| DRAINAGE COLLECTED FROM LAYER 2 | 22.9561 | 83330.820 | 43.49 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001343 | 4.874 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0022 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001398 | 5.076 | 0.00 |
| CHANGE IN WATER STORAGE | -3.144 | -11414.337 | -5.96 |
| SOIL WATER AT START OF YEAR | 35.009 | 127081.781 | |
| SOIL WATER AT END OF YEAR | 31.864 | 115667.445 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.114 | 0.00 |

**********

**********

ANNUAL TOTALS FOR YEAR 3

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 58.86 | 213661.766 | 100.00 |
| RUNOFF | 5.231 | 18989.881 | 8.89 |
| EVAPOTRANSPIRATION | 28.042 | 101792.992 | 47.64 |
| DRAINAGE COLLECTED FROM LAYER 2 | 24.9648 | 90622.312 | 42.41 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001442 | 5.233 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0024 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001527 | 5.542 | 0.00 |
| CHANGE IN WATER STORAGE | 0.620 | 2251.143 | 1.05 |
| SOIL WATER AT START OF YEAR | 31.864 | 115667.445 | |
| SOIL WATER AT END OF YEAR | 32.484 | 117918.586 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.110 | 0.00 |

**********

**********

ANNUAL TOTALS FOR YEAR 4

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 47.14 | 171118.219 | 100.00 |
| RUNOFF | 2.401 | 8715.821 | 5.09 |
| EVAPOTRANSPIRATION | 27.930 | 101386.867 | 59.25 |
| DRAINAGE COLLECTED FROM LAYER 2 | 16.5866 | 60209.273 | 35.19 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001110 | 4.028 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0016 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.000989 | 3.591 | 0.00 |
| CHANGE IN WATER STORAGE | 0.221 | 802.676 | 0.47 |

| | | | |
|---|---|---|---|
| SOIL WATER AT START OF YEAR | 32.484 | 117918.586 | |
| SOIL WATER AT END OF YEAR | 32.706 | 118721.258 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.005 | 0.00 |

**********

**********

ANNUAL TOTALS FOR YEAR 5

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 56.07 | 203534.078 | 100.00 |
| RUNOFF | 4.726 | 17154.428 | 8.43 |
| EVAPOTRANSPIRATION | 29.200 | 105996.266 | 52.08 |
| DRAINAGE COLLECTED FROM LAYER 2 | 21.8662 | 79374.352 | 39.00 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001327 | 4.819 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0021 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001318 | 4.783 | 0.00 |
| CHANGE IN WATER STORAGE | 0.277 | 1004.335 | 0.49 |
| SOIL WATER AT START OF YEAR | 32.706 | 118721.258 | |
| SOIL WATER AT END OF YEAR | 32.982 | 119725.594 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.079 | 0.00 |

**********

**********

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| PRECIPITATION | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 3.80 | 3.65 | 5.41 | 5.50 | 5.64 | 3.86 |
| | 4.92 | 4.51 | 2.90 | 2.95 | 4.32 | 5.35 |
| STD. DEVIATIONS | 3.95 | 1.25 | 2.37 | 4.10 | 3.14 | 1.00 |
| | 2.30 | 2.07 | 1.25 | 1.89 | 1.75 | 3.39 |

RUNOFF

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.298 | 0.147 | 0.612 | 0.537 | 0.824 | 0.127 |
| | 0.178 | 0.518 | 0.190 | 0.259 | 0.321 | 0.297 |
| STD. DEVIATIONS | 0.478 | 0.126 | 0.708 | 0.812 | 0.957 | 0.126 |
| | 0.206 | 0.954 | 0.302 | 0.529 | 0.307 | 0.355 |

EVAPOTRANSPIRATION

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 1.569 | 1.958 | 2.522 | 2.619 | 3.175 | 2.774 |
| | 3.525 | 2.640 | 1.881 | 1.805 | 1.722 | 1.507 |
| STD. DEVIATIONS | 0.231 | 0.282 | 0.752 | 0.892 | 1.550 | 0.395 |
| | 1.079 | 0.520 | 1.085 | 0.617 | 0.242 | 0.148 |

LATERAL DRAINAGE COLLECTED FROM LAYER 2

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 3.2134 | 1.4598 | 2.2500 | 1.9252 | 2.4921 | 0.7553 |
| | 1.4076 | 1.1823 | 0.6556 | 1.2929 | 1.5903 | 2.9904 |
| STD. DEVIATIONS | 2.1043 | 1.3156 | 1.3916 | 1.4403 | 1.6735 | 0.5672 |
| | 0.9277 | 0.9061 | 0.6446 | 1.0566 | 1.0099 | 1.4710 |

PERCOLATION/LEAKAGE THROUGH LAYER 3

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 |
| STD. DEVIATIONS | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0000 | 0.0001 |

PERCOLATION/LEAKAGE THROUGH LAYER 4

| | | | | | | |
|---|---|---|---|---|---|---|
| TOTALS | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| STD. DEVIATIONS | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0001 |

---

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

---

DAILY AVERAGE HEAD ON TOP OF LAYER 3

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0037 | 0.0018 | 0.0026 | 0.0023 | 0.0029 | 0.0009 |
| | 0.0016 | 0.0014 | 0.0008 | 0.0015 | 0.0019 | 0.0034 |
| STD. DEVIATIONS | 0.0024 | 0.0017 | 0.0016 | 0.0017 | 0.0019 | 0.0007 |
| | 0.0011 | 0.0010 | 0.0008 | 0.0012 | 0.0012 | 0.0017 |

**********

**********

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 52.82 | ( 4.803) | 191722.1 | 100.00 |
| RUNOFF | 4.307 | ( 1.5623) | 15633.97 | 8.154 |
| EVAPOTRANSPIRATION | 27.698 | ( 1.0762) | 100545.30 | 52.443 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 21.21494 | ( 3.21060) | 77010.219 | 40.16763 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.00128 | ( 0.00013) | 4.655 | 0.00243 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.002 | ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00127 | ( 0.00021) | 4.619 | 0.00241 |
| CHANGE IN WATER STORAGE | -0.405 | ( 1.5472) | -1471.96 | -0.768 |

**********

**********

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 4.79 | 17387.699 |
| RUNOFF | 2.221 | 8063.9995 |
| DRAINAGE COLLECTED FROM LAYER 2 | 1.00026 | 3630.92725 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.000035 | 0.12835 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.036 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 0.070 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 1.0 FEET | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000073 | 0.26547 |
| SNOW WATER | 1.18 | 4291.8257 |

| | |
|---|---|
| MAXIMUM VEG. SOIL WATER (VOL/VOL) | 0.3298 |
| MINIMUM VEG. SOIL WATER (VOL/VOL) | 0.0674 |

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

**********

**********

FINAL WATER STORAGE AT END OF YEAR 5

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 5.6239 | 0.2343 |
| 2 | 0.0055 | 0.0221 |
| 3 | 0.0000 | 0.0000 |
| 4 | 25.7808 | 0.1310 |
| SNOW WATER | 0.000 | |

**********
**********

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\DATA4.D4
TEMPERATURE DATA FILE:        C:\HELP3\DATA7.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\DATA13.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\DATA11.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\GRASS.D10
OUTPUT DATA FILE:             C:\HELP3\GRASS.OUT


TIME:  16:36      DATE:   6/13/2008


******************************************************************************

    TITLE:  Sludge Lagoon Closure - Final Cover Design: Fair Grass Stand

******************************************************************************


    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   5
        THICKNESS                    =     24.00   INCHES
        POROSITY                     =      0.4570 VOL/VOL
        FIELD CAPACITY               =      0.1310 VOL/VOL
        WILTING POINT                =      0.0580 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.3170 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------
```

```
                TYPE 2 - LATERAL DRAINAGE LAYER
                  MATERIAL TEXTURE NUMBER  20
THICKNESS                      =      0.25    INCHES
POROSITY                       =      0.8500 VOL/VOL
FIELD CAPACITY                 =      0.0100 VOL/VOL
WILTING POINT                  =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.2400 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =   10.0000000000      CM/SEC
SLOPE                          =      8.00    PERCENT
DRAINAGE LENGTH                =    160.0     FEET


                          LAYER  3
                          --------

                TYPE 4 - FLEXIBLE MEMBRANE LINER
                  MATERIAL TEXTURE NUMBER  35
THICKNESS                      =      0.06    INCHES
POROSITY                       =      0.0000 VOL/VOL
FIELD CAPACITY                 =      0.0000 VOL/VOL
WILTING POINT                  =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY            =      1.00    HOLES/ACRE
FML INSTALLATION DEFECTS       =      1.00    HOLES/ACRE
FML PLACEMENT QUALITY          =  3 - GOOD


                          LAYER  4
                          --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   5
THICKNESS                      =    196.80    INCHES
POROSITY                       =      0.4570 VOL/VOL
FIELD CAPACITY                 =      0.1310 VOL/VOL
WILTING POINT                  =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT     =      0.1310 VOL/VOL
EFFECTIVE SAT. HYD. COND.      =  0.100000005000E-02 CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
         FAIR STAND OF GRASS, A SURFACE SLOPE OF  8.%
         AND A SLOPE LENGTH OF  160. FEET.

SCS RUNOFF CURVE NUMBER                =     67.10
FRACTION OF AREA ALLOWING RUNOFF       =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE     =      1.000   ACRES
EVAPORATIVE ZONE DEPTH                 =     22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE      =      6.950   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE     =     10.054   INCHES
```

| | | | |
|---|---|---|---|
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 1.276 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 33.449 | INCHES |
| TOTAL INITIAL WATER | = | 33.449 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
JACKSON MISSISSIPPI

| | | | |
|---|---|---|---|
| STATION LATITUDE | = | 32.33 | DEGREES |
| MAXIMUM LEAF AREA INDEX | = | 2.00 | |
| START OF GROWING SEASON (JULIAN DATE) | = | 61 | |
| END OF GROWING SEASON (JULIAN DATE) | = | 328 | |
| EVAPORATIVE ZONE DEPTH | = | 22.0 | INCHES |
| AVERAGE ANNUAL WIND SPEED | = | 7.40 | MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 74.00 | % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 73.00 | % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 78.00 | % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 77.00 | % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSON MISSISSIPPI

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 5.00 | 4.48 | 5.86 | 5.85 | 4.83 | 2.94 |
| 4.40 | 3.71 | 3.55 | 2.62 | 4.18 | 5.40 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSON MISSISSIPPI

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 45.70 | 49.10 | 56.30 | 65.10 | 72.50 | 79.20 |
| 81.90 | 81.20 | 76.40 | 65.00 | 54.90 | 48.60 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR JACKSON MISSISSIPPI
AND STATION LATITUDE = 32.33 DEGREES

**********

ANNUAL TOTALS FOR YEAR 1

---

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 49.22 | 178668.609 | 100.00 |
| RUNOFF | 0.059 | 213.374 | 0.12 |
| EVAPOTRANSPIRATION | 26.308 | 95497.320 | 53.45 |
| DRAINAGE COLLECTED FROM LAYER 2 | 22.8526 | 82955.109 | 46.43 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001318 | 4.784 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0022 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001252 | 4.544 | 0.00 |
| CHANGE IN WATER STORAGE | 0.000 | -1.703 | 0.00 |
| SOIL WATER AT START OF YEAR | 35.021 | 127124.523 | |
| SOIL WATER AT END OF YEAR | 35.020 | 127122.820 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.044 | 0.00 |

**********

**********

ANNUAL TOTALS FOR YEAR 2

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 52.79 | 191627.672 | 100.00 |
| RUNOFF | 0.572 | 2075.569 | 1.08 |
| EVAPOTRANSPIRATION | 27.616 | 100246.461 | 52.31 |
| DRAINAGE COLLECTED FROM LAYER 2 | 27.8445 | 101075.617 | 52.75 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001474 | 5.352 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0027 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001524 | 5.534 | 0.00 |
| CHANGE IN WATER STORAGE | -3.244 | -11775.482 | -6.14 |
| SOIL WATER AT START OF YEAR | 35.020 | 127122.820 | |
| SOIL WATER AT END OF YEAR | 31.776 | 115347.344 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |

| | | | |
|---|---|---|---|
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.019 | 0.00 |

**********

**********

ANNUAL TOTALS FOR YEAR 3

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 58.86 | 213661.766 | 100.00 |
| RUNOFF | 0.412 | 1494.999 | 0.70 |
| EVAPOTRANSPIRATION | 31.905 | 115815.133 | 54.20 |
| DRAINAGE COLLECTED FROM LAYER 2 | 25.9192 | 94086.773 | 44.04 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001464 | 5.313 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0025 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001589 | 5.770 | 0.00 |
| CHANGE IN WATER STORAGE | 0.622 | 2259.112 | 1.06 |
| SOIL WATER AT START OF YEAR | 31.776 | 115347.344 | |
| SOIL WATER AT END OF YEAR | 32.398 | 117606.453 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.028 | 0.00 |

**********

**********

ANNUAL TOTALS FOR YEAR 4

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 47.14 | 171118.219 | 100.00 |
| RUNOFF | 0.014 | 51.728 | 0.03 |
| EVAPOTRANSPIRATION | 28.467 | 103336.531 | 60.39 |
| DRAINAGE COLLECTED FROM LAYER 2 | 19.2158 | 69753.211 | 40.76 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001196 | 4.341 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0019 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001238 | 4.495 | 0.00 |

| | | | |
|---|---|---|---|
| CHANGE IN WATER STORAGE | -0.559 | -2027.765 | -1.19 |
| SOIL WATER AT START OF YEAR | 32.398 | 117606.453 | |
| SOIL WATER AT END OF YEAR | 31.840 | 115578.687 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | 0.025 | 0.00 |

**********

**********

ANNUAL TOTALS FOR YEAR 5

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 56.07 | 203534.078 | 100.00 |
| RUNOFF | 0.249 | 902.102 | 0.44 |
| EVAPOTRANSPIRATION | 28.044 | 101801.469 | 50.02 |
| DRAINAGE COLLECTED FROM LAYER 2 | 26.7958 | 97268.742 | 47.79 |
| PERC./LEAKAGE THROUGH LAYER 3 | 0.001481 | 5.377 | 0.00 |
| AVG. HEAD ON TOP OF LAYER 3 | 0.0026 | | |
| PERC./LEAKAGE THROUGH LAYER 4 | 0.001235 | 4.483 | 0.00 |
| CHANGE IN WATER STORAGE | 0.980 | 3557.302 | 1.75 |
| SOIL WATER AT START OF YEAR | 31.840 | 115578.687 | |
| SOIL WATER AT END OF YEAR | 32.820 | 119135.992 | |
| SNOW WATER AT START OF YEAR | 0.000 | 0.000 | 0.00 |
| SNOW WATER AT END OF YEAR | 0.000 | 0.000 | 0.00 |
| ANNUAL WATER BUDGET BALANCE | 0.0000 | -0.013 | 0.00 |

**********

**********

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 3.80 | 3.65 | 5.41 | 5.50 | 5.64 | 3.86 |
| | 4.92 | 4.51 | 2.90 | 2.95 | 4.32 | 5.35 |
| STD. DEVIATIONS | 3.95 | 1.25 | 2.37 | 4.10 | 3.14 | 1.00 |
| | 2.30 | 2.07 | 1.25 | 1.89 | 1.75 | 3.39 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.001 | 0.000 | 0.062 | 0.028 | 0.075 | 0.000 |
| | 0.000 | 0.082 | 0.003 | 0.002 | 0.000 | 0.008 |
| STD. DEVIATIONS | 0.001 | 0.000 | 0.132 | 0.062 | 0.114 | 0.000 |
| | 0.000 | 0.183 | 0.006 | 0.004 | 0.001 | 0.015 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 1.407 | 1.818 | 2.360 | 2.672 | 4.785 | 3.310 |
| | 3.532 | 2.982 | 1.869 | 1.539 | 1.130 | 1.063 |
| STD. DEVIATIONS | 0.242 | 0.288 | 0.721 | 0.509 | 1.408 | 0.635 |
| | 1.600 | 1.573 | 1.130 | 0.311 | 0.114 | 0.112 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 2** | | | | | | |
| TOTALS | 3.6794 | 1.7910 | 2.8053 | 2.5535 | 3.0962 | 1.0984 |
| | 1.3521 | 1.2921 | 0.6174 | 1.2837 | 1.5041 | 3.4524 |
| STD. DEVIATIONS | 2.7225 | 1.2885 | 2.0391 | 2.5234 | 2.5031 | 0.2472 |
| | 0.5625 | 0.7628 | 0.3000 | 0.9671 | 0.7203 | 1.7009 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 3** | | | | | | |
| TOTALS | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.0002 |
| STD. DEVIATIONS | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| TOTALS | 0.0001 | 0.0001 | 0.0002 | 0.0001 | 0.0002 | 0.0001 |
| | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.0002 |
| STD. DEVIATIONS | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0001 | 0.0000 |

## AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

| | | | | | | |
|---|---|---|---|---|---|---|
| **DAILY AVERAGE HEAD ON TOP OF LAYER 3** | | | | | | |
| AVERAGES | 0.0042 | 0.0023 | 0.0032 | 0.0030 | 0.0035 | 0.0013 |
| | 0.0015 | 0.0015 | 0.0007 | 0.0015 | 0.0018 | 0.0040 |
| STD. DEVIATIONS | 0.0031 | 0.0016 | 0.0023 | 0.0030 | 0.0029 | 0.0003 |
| | 0.0006 | 0.0009 | 0.0004 | 0.0011 | 0.0009 | 0.0019 |

**********

**********

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

| | INCHES | | CU. FEET | PERCENT |
|---|---|---|---|---|
| PRECIPITATION | 52.82 | ( 4.803) | 191722.1 | 100.00 |
| RUNOFF | 0.261 | ( 0.2352) | 947.55 | 0.494 |
| EVAPOTRANSPIRATION | 28.468 | ( 2.0847) | 103339.38 | 53.901 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 2 | 24.52559 | ( 3.50371) | 89027.898 | 46.43591 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.00139 | ( 0.00013) | 5.033 | 0.00263 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.002 | ( 0.000) | | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.00137 | ( 0.00017) | 4.965 | 0.00259 |
| CHANGE IN WATER STORAGE | -0.440 | ( 1.6744) | -1597.71 | -0.833 |

**********

**********

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 4.79 | 17387.699 |
| RUNOFF | 0.409 | 1485.5272 |
| DRAINAGE COLLECTED FROM LAYER 2 | 1.66167 | 6031.85937 |
| PERCOLATION/LEAKAGE THROUGH LAYER 3 | 0.000050 | 0.18145 |
| AVERAGE HEAD ON TOP OF LAYER 3 | 0.059 | |
| MAXIMUM HEAD ON TOP OF LAYER 3 | 0.119 | |
| LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN) | 0.0 FEET | |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.000077 | 0.27783 |
| SNOW WATER | 1.18 | 4291.8257 |

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3296

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0580

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

**********

**********

FINAL WATER STORAGE AT END OF YEAR 5

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 5.4642 | 0.2277 |
| 2 | 0.0028 | 0.0112 |
| 3 | 0.0000 | 0.0000 |
| 4 | 25.7808 | 0.1310 |
| SNOW WATER | 0.000 | |

**********
**********

# APPENDIX D

## Construction Quality Assurance Plan

# SOLID WASTE MANAGEMENT UNIT 4 – SLUDGE LAGOON CLOSURE AND POST-CLOSURE CARE PLAN

## CONSTRUCTION QUALITY ASSURANCE PLAN

Prepared for

ArvinMeritor™

# SOLID WASTE MANAGEMENT UNIT 4 – SLUDGE LAGOON CLOSURE AND POST-CLOSURE CARE PLAN

# CONSTRUCTION QUALITY ASSURANCE PLAN

Prepared for

ArvinMeritor

Troy, Michigan
September 19, 2008

BROWN AND CALDWELL

4700 Lakehurst Court, Suite 100
Dublin, Ohio 43016

# TABLE OF CONTENTS

LIST OF FIGURES ..... III

LIST OF TABLES ..... III

1. GENERAL ..... 1-1
   1.1 Introduction ..... 1-1
   1.2 Definitions and Terms ..... 1-1
      1.2.1 Construction Quality Assurance and Construction Quality Control ..... 1-1
   1.3 Project Management ..... 1-1
      1.3.1 Project Team ..... 1-1
      1.3.2 Qualifications ..... 1-2
      1.3.3 Role of the CQA Consultant ..... 1-4
   1.4 Scope of Construction Quality Assurance ..... 1-6
   1.5 Site and Project Control ..... 1-6
      1.5.1 Coordination Meetings ..... 1-6
      1.5.2 Project Closeout ..... 1-7

2. SLUDGE LAGOON CLOSURE CQA ..... 2-1
   2.1 Introduction ..... 2-1
   2.2 Soils Construction Quality Assurance ..... 2-1
      2.2.1 Final Cover System Subbase Layer ..... 2-1
      2.2.2 Protective/Vegetative Cover ..... 2-3
   2.3 Sludge Stabilization/Solidification Quality Assurance ..... 2-3
      2.3.1 Supplier's Documentation ..... 2-3
      2.3.2 Delivery ..... 2-4
      2.3.3 Handling and Stabilization Procedures ..... 2-4
   2.4 Geomembrane Construction Quality Assurance ..... 2-6
      2.4.1 Supplier's Documentation ..... 2-6
      2.4.2 Delivery ..... 2-6
      2.4.3 Conformance Testing of Delivered Geomembrane ..... 2-11
      2.4.4 Handling and Placement ..... 2-12
      2.4.5 Seaming and Testing ..... 2-14
      2.4.6 Geosynthetics Certification/Acceptance ..... 2-22
      2.4.7 Materials in Contact with Geomembranes ..... 2-23
   2.5 Geocomposite Construction Quality Assurance ..... 2-23
      2.5.1 Introduction ..... 2-23
      2.5.2 Shipment and Storage ..... 2-25
      2.5.3 Conformance Testing of Delivered Geocomposite ..... 2-26
      2.5.4 Handling ..... 2-26
      2.5.5 Installation and Repair ..... 2-27
      2.5.6 Placement of Materials on Geocomposite ..... 2-28

2.6 Geotextile Construction Quality Assurance ..... 2-28
2.6.1 Introduction ..... 2-28
2.6.2 Shipment and Storage ..... 2-28
2.6.3 Conformance Testing of Delivered Geotextile ..... 2-30
2.6.4 Handling and Placement ..... 2-31
2.6.5 Installation and Repair ..... 2-31
2.6.6 Placement of Materials on Geotextile ..... 2-32
2.7 Seeding Quality Assurance ..... 2-32
2.8 Aggregate Quality Assurance ..... 2-33
2.9 Erosion and Sediment Control ..... 2-34
2.10 Monitoring ..... 2-34

3. DOCUMENTATION ..... 3-1
3.1 Introduction ..... 3-1
3.2 Surveying ..... 3-1
3.3 Daily Recordkeeping ..... 3-1
3.3.1 Memoranda of Discussion with Contractor and Subcontractor ..... 3-1
3.3.2 Daily Observation and Testing Data Sheets ..... 3-2
3.3.3 Problem Management Sheets ..... 3-2
3.4 Photographic Records ..... 3-3
3.5 Design and/or Technical Specification Deviations ..... 3-3
3.6 Progress Reports ..... 3-3
3.7 Final Record Report of Construction ..... 3-3
3.8 Records Storage ..... 3-4

APPENDIX A ..... A
CQA Field Forms ..... A

## LIST OF FIGURES

Figure 2-4.1. Extrusion Welded Seams ..... 2-16
Figure 2-4.2. Fusion Welded Seams ..... 2-17

## LIST OF TABLES

Table 2-2-1. Soils Requirements ..... 2-9
Table 2-4-1. 60 Mil Textured HDPE Geomembrane QA/QC Testing ..... 2-14
Table 2-5-1. Double-Sided Geocomposite QA/QC Testing ..... 2-31
Table 2-6-1. Geotextile QA/QC Testing ..... 2-29
Table 2-7-1. Seeding Specifications ..... 2-33
Table 2-8-1. Aggregate Requirements ..... 2-34

# 1. GENERAL

## 1.1 Introduction

This Construction Quality Assurance Plan (CQAP) addresses the Construction Quality Assurance and Construction Quality Control (CQA and CQC) for the Sludge Lagoon Closure at the Grenada Manufacturing, LLC Site in Grenada, Mississippi. This CQAP is divided into three sections:

- General
- Sludge Lagoon Closure CQA
- Documentation

## 1.2 Definitions and Terms

### 1.2.1 Construction Quality Assurance and Construction Quality Control

CQA and CQC are defined as follows:

- CQA refers to the means and actions taken by the CQA Consultant and testing laboratories to assess the conformity of the Sludge Lagoon closure implementation activities to this CQAP, the design plans, and the technical specifications. CQA is provided by a party autonomous of the contractor in charge of implementing the closure activities.
- CQC refers to those actions taken by the suppliers, contractors, or owners so that the materials and quality of work meet the requirements of the design plans and technical specifications.

## 1.3 Project Management

### 1.3.1 Project Team

#### 1.3.1.1 Owner

The Owner is responsible for the Project Site. The term "Owner" refers specifically to ArvinMeritor, Inc (ArvinMeritor) whenever used in this CQAP.

#### 1.3.1.2 Design Engineer

The Design Engineer is responsible for the Closure Plan, design plan, technical specifications, and CQAP for the Sludge Lagoon closure. This includes providing technical support to the CQA Consultant, interpreting field and laboratory testing data, assuring construction activities are in accordance with the Closure Plan drawings, and making final determinations of the acceptability of installed work.

#### 1.3.1.3 Construction Quality Assurance Consultant

The Construction Quality Assurance (CQA) Consultant is a party independent from the contractor or supplier who is responsible for managing, coordinating, and implementing the CQA activities so that the CQA activities are performed in accordance with the Closure Plan, CQAP, design plans, and technical specifications for the Sludge Lagoon closure. The CQA Consultant is responsible for documenting the Sludge Lagoon closure implementation activities. The CQA Consultant can be the Design Engineer.

#### 1.3.1.4 Closure Contractor

The Closure Contractor is responsible for implementing the Sludge Lagoon closure work. The Closure Contractor is also responsible for any work performed by the Closure Contractor's subcontractor(s).

#### 1.3.1.5 Supplier(s)

The supplier(s) is(are) responsible for the production of the materials identified in the design plans and technical specifications to be used during implementation of the Sludge Lagoon closure. For the Sludge Lagoon closure, the materials include Type I Portland cement, lime kiln dust, and the geosynthetic materials (60-mil textured HDPE geomembrane and geocomposite).

#### 1.3.1.6 Transporter(s)

The transporter(s) will be responsible for transportation of the materials from the supplier(s) to the Site.

#### 1.3.1.7 Soils Construction Quality Assurance Laboratory

The Soils Construction Quality Assurance (CQA) Laboratory, independent from the contractor, supplier, transporter, and Design Engineer, is responsible for conducting tests in the laboratory on samples of solidified/stabilized sludge and soil. Samples will be collected from location(s) designated by the CQA Consultant for shipment to the Soils CQA Laboratory under strict chain-of-custody protocols.

#### 1.3.1.8 Geosynthetic Quality Assurance Laboratory

The Geosynthetic Quality Assurance (QA) Laboratory, independent from the contractor, supplier, transporter, and Design Engineer, is responsible for conducting tests in the laboratory on the geocomposite and geomembrane materials collected from the supplier(s) prior to and following delivery to the Site. The CQA Consultant will arrange for collection, handling, and shipment of samples to the Geosynthetic QA Laboratory under strict chain-of-custody protocols.

#### 1.3.1.9 Certified Surveyor

The certified surveyor (surveyor), independent from the owner, Design Engineer, contractor, supplier, transporter, or QA Laboratory(ies), is, at minimum, responsible for establishing control points, providing control during closure implementation, and providing final record documentation for all portion of the work.

### 1.3.2 Qualifications

The following qualifications are required of entities involved with the design and CQA of the Sludge Lagoon closure.

#### 1.3.2.1 Design Engineer

The Design Engineer should be an engineer, registered as a professional engineer in the State of Mississippi. The Design Engineer should have a history which demonstrates familiarity with the Sludge Lagoon closure activities, including design methods and procedures.

#### 1.3.2.2 Construction Quality Assurance Consultant

The CQA Consultant should be an engineer, registered as a professional engineer in the State of Mississippi. The CQA Consultant should have demonstrated experience in CQAP preparation and implementation and providing field oversight for activities specifically related to the closure of the Sludge Lagoon. The Design Engineer can also serve as the CQA Consultant.

#### 1.3.2.3 ClosureContractor

The Closure Contractor and/or subcontractor(s) and geosynthetics installer, working on the Sludge Lagoon closure, should demonstrate a history of at least six (6) similar successfully completed projects including material stabilization technology. The geosynthetics installer should also demonstrate the successful installation of a minimum of 1,000,000 square-feet of each type of geosynthetic (60-mil geomembrane and geocomposite) to be used in the Sludge Lagoon closure.

#### 1.3.2.4 Supplier(s)

Supplier(s) will be able to provide construction materials and qualified personnel to meet the demands of the project. The supplier will be required to submit certification(s) of specified materials required in the Sludge Lagoon closure. The geosynthetic supplier should show that they have successfully manufactured and/or fabricated a minimum of 5,000,000 square feet of geosynthetic materials.

#### 1.3.2.5 Transporter

All personnel responsible for the loading/unloading and transport of materials to be used for the Sludge Lagoon closure must be familiar with handling and transport constraints required by the supplier(s).

#### 1.3.2.6 Soils Construction Quality Assurance Laboratory

The Soils CQA Laboratory will have experience in performance of the required laboratory tests, meet applicable regulatory requirements, and be familiar with ASTM and other applicable standards. The Soils CQA Laboratory will be capable of providing test results in accordance with the requirements of the technical specifications.

#### 1.3.2.7 Geosynthetic Quality Assurance Laboratory

The Geosynthetic QA Laboratory will have experience in geosynthetic testing for projects related to the Sludge Lagoon closure, meet applicable regulatory requirements, and be familiar with ASTM and other applicable standards. The Geosynthetic QA Laboratory will be capable of providing test results in accordance with the requirements of the technical specifications.

#### 1.3.2.8 Certifying Surveyor

The certifying surveyor is to be retained by the contractor. The certifying surveyor will be a registered land surveyor in the State of Mississippi and be employed by a well-established surveying firm incorporated (or otherwise registered) in the United States.

### 1.3.3 Role of the CQA Consultant

The CQA Consultant provides CQA personnel, specifically a CQA Site Manager and CQA Monitor(s), who are located at the Site throughout the performance of the Sludge Lagoon closure activities. The CQA Consultant will involve the Design Engineer where appropriate. The role/duties of the CQA personnel are presented in the following sections.

#### 1.3.3.1 Design Engineer

The Design Engineer will be responsible for:

- Providing guidance and interpretation on technical issues or problems regarding the approved Closure Plan, design plan, and technical specifications;
- Providing general oversight on the implementation of the CQAP; and
- Overseeing and reviewing the final Construction Certification Report and certifying that the closure implementation activities have been completed and satisfactorily meets the requirements of the Sludge Lagoon Closure Plan.

#### 1.3.3.2 CQA Consultant

The CQA Consultant will be responsible for:

- Administering the CQAP, i.e., assigning and managing the CQA personnel, reviewing field reports, and providing engineering review of CQA-related issues;
- Providing quality control of the CQA personnel, including Site visits;
- Reviewing changes to the design plans and technical specifications;
- Gaining familiarity with design plans and technical specifications;
- Gaining familiarity with other site-specific documentation including proposed layouts, soils and the manufacturers' and installers' literature;
- Attending the pre-construction and progress meeting(s); and
- Reviewing the CQA and CQC documentation generated throughout the Sludge Lagoon closure.

##### 1.3.3.2.1 CQA Site Manager

The CQA Site Manager is an employee of the CQA Consultant responsible for:

- Acting as the on-site (resident) representative of the CQA Consultant;
- Familiarizing the CQA Monitor(s) with the Site and the CQA requirements for the Sludge Lagoon closure;
- Managing the daily activities of the CQA Monitor(s);
- Attending CQA-related meetings, i.e., pre-construction, progress, etc.;
- Overseeing the on-going production of the project record drawings;
- Assigning locations for testing and sampling;
- Reviewing CQA Monitor(s) daily reports and logs;
- Reporting to the CQA Consultant and logging daily reports any relevant observations reported by the CQA Monitor(s);
- Preparing a daily report;
- Reviewing and reporting results of laboratory data obtained from the contractor;

- Reporting unresolved deviations from the CQAP, design plans, and technical specifications to the CQA Consultant;
- Assisting the Design Engineer and CQA Consultant with the preparation of the final Construction Certification Report;
- Periodically checking materials for defects and variability and verifying that conformance testing is performed;
- Reviewing the work of the contractor's equipment operators to verify that proper care is undertaken to protect other portions of the work;
- Establishing additional testing requirements beyond those in the technical specifications, when necessary;
- Reviewing the contractor's personnel qualifications for conformance with those pre-approved for work on the Site;
- Assisting the CQA Consultant with administration of the construction contract and schedule; and
- Reviewing supplier, manufacturer, and installer certifications and documentation and making appropriate recommendations.

#### 1.3.3.2.2 CQA Monitor(s)

The duties of the CQA Monitor(s) are defined by the CQA Site Manager and include monitoring, logging, and/or documenting appropriate activities associated with the Sludge Lagoon closure.

The duties performed and activities monitored by the CQA Monitor(s) include:

- Observing and documenting materials delivery;
- Observing and documenting quality of soils, admixtures, geosynthetics, and other materials stockpiling, placement, and handling;
- Observing and documenting clearing and grubbing, excavation, hauling, backfill, compaction, grading and seeding operations;
- Observing and documenting implementation of erosion and sediment control and temporary surface water containment;
- Observing and documenting collection, transport, and treatment/disposal of water during dewatering activities;
- Observing and documenting sample collection for laboratory analysis;
- Observing and documenting efforts to protect areas of completed work;
- Observing the soil surface for signs of excessive wetting, desiccation, or other disturbance prior to placement of backfill materials, geosynthetics, or vegetation;
- Observing and documenting any scarification, recompaction, rewetting, or proof rolling required to repair deteriorated areas;
- Observing and documenting material unloading and on-site transport, storage, and handling;
- Observing and documenting material loading, on-site treatment (if any), off-site transport, and disposal;
- Verifying proper sludge mixing, adequate admixture use and solidification/stabilization time, and required compacted soil thicknesses;
- Observing and documenting sludge solidification/stabilization and soil placement;
- Observing, verifying, and documenting proper placement of geosynthetics;
- Observing and documenting repair operations;

- Documenting any proposed changes to the Sludge Lagoon closure implementation activities; and
- Observation and documentation of any approved changes to the Sludge Lagoon Closure Plan.

In addition to the specific duties, the CQA Monitor(s) is(are) responsible for noting any on-site activities that could result in damage to the solidified/stabilized sludge, geosynthetics, or cover soil and vegetation. Any activities noted will be reported as soon as possible to the CQA Site Manager. The CQA Site Manager can also serve as a CQA Monitor.

## 1.4 Scope of Construction Quality Assurance

The scope of the CQAP includes the CQA of the Sludge Lagoon closure implementation as directed in the approved Closure Plan, design plans, and technical specifications. The CQAP does not address CQC design guidelines, installation specifications, or selection of materials or other components. The CQC of the selection, evaluation, and testing of the various components is included in the design plans and technical specifications.

The CQA Consultant will review the contractor's submittals for each Sludge Lagoon closure component. The CQA Consultant will transmit to the contractor and CQA Site Manager each approved submittal. Submittals not approved will be noted and given to the contractor for re-submittal. The CQA Site Manager will observe installation and field quality control testing during the implementation of the Sludge Lagoon closure.

## 1.5 Site and Project Control

### 1.5.1 Coordination Meetings

To provide requisite quality during the Sludge Lagoon closure implementation, clear, open channels of communication are essential. Project meetings are a critical element in the establishment of communication throughout the Sludge Lagoon implementation. This section will describe meetings to be held throughout the Sludge Lagoon closure implementation to provide coordination between entities responsible for the successful completion of the Sludge Lagoon closure.

#### 1.5.1.1 Pre-Construction Meeting

A Pre-Construction Meeting will be held at the Site prior to initiation of closure activities by the contractor. The meeting will be attended by the owner, Design Engineer, the contractor, subcontractor(s), geosynthetics installer, and the CQA Consultant (i.e., CQA Site Manager, and the CQA Monitor(s)). Items addressed at the pre-construction meeting include:

- Review the responsibilities of each party;
- Review lines of authority and communication;
- Establish work area security and safety protocol;
- Review methods for documenting, reporting, and distributing documents and reports;
- Communicate to parties any change/modification in the project documents;
- Review critical design details of the project;
- Establish protocols for testing;
- Establish protocols for handling deficiencies, repairs, and retesting;
- Review the time schedule for operations;

- Outline procedures for packaging and storing archive samples;
- Establish material staging locations; and
- Conduct a Site walk-around to review material staging locations, limits of work, and locations of sensitive areas.

The meeting will be documented by the CQA Consultant and a summary of meeting minutes will be delivered to the Pre-Construction Meeting attendees.

#### 1.5.1.2 Progress Meetings

A weekly progress meeting will be held between the CQA Site Manager, the CQA Monitor(s), the contractor, geosynthetics installer, and other concerned entities. The progress meeting will be used to discuss the current progress of the project, planned activities for the next week, any changes or revisions to the work, and issues or problems. The CQA Site Manager will log the issues, problems, or questions and the resolutions arising at the progress meeting in the daily reports. Any matter requiring action which is raised in the progress meeting will be reported to the appropriate entities.

#### 1.5.1.3 Problems or Work Deficiency Meetings

A special meeting will be held when and if a problem or deficiency is present or likely to occur. The meeting will be attended by the contractor, geosynthetics installer, CQA Consultant, the CQA Site Manger and CQA Monitor(s). If the problem requires a design modification, the Design Engineer will also be present. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

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

The meeting will be documented by the CQA Site Manager and minutes will be delivered to the meeting attendees.

### 1.5.2 Project Closeout

A completion inspection (walk-through), to be attended by ArvinMeritor, the contractor, geosynthetics installer, and the CQA Consultant, will be conducted when the contractor provides notification of substantial completion of the Sludge Lagoon closure implementation activities. The completion inspection will be used to verify the completeness of the Sludge Lagoon closure. A punch list identifying outstanding items, proposed activities for resolution, and schedule for final completion will be produced. Following completion of the punch list items, a final inspection will be conducted to check that items have been addressed and that complete contractor demobilization from the Site has been completed. The final inspection will be attended by ArvinMeritor, the Closure Contractor, the CQA Consultant, and the U.S. EPA.

# 2. SLUDGE LAGOON CLOSURE CQA

## 2.1 Introduction

This section of the CQAP addresses the components of the Sludge Lagoon closure and outlines the CQA Program to be implemented with regard to materials selection and evaluation, laboratory test requirements, field test requirements, and treatment of problems.

## 2.2 Soils Construction Quality Assurance

### 2.2.1 Final Cover System Subbase Layer

A variable thickness compacted soil subbase layer (subbase) will be constructed above the solidified/ stabilized sludge material upon which the final cover system will be installed. The criteria for the subbase are as follows:

- One hundred percent of material with a maximum particle size of 2 inches;
- No more than 10 percent of material, by weight, having a particle size greater than 0.75 inches; and
- With at least 50 percent of the particles, by weight, passing through the No. 200 sieve.

Results of pre-construction testing of the borrow soils performed on representative samples shall be submitted to the CQA Consultant no later than seven days prior to the intended use of the material in the construction of the subbase. Refer to Table 2-2-1 for a summary of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the subbase.

Subbase installation shall immediately follow sludge solidification/stabilization, after adequate curing time. Prior to placement of the subbase, the surface of the solidified/stabilized sludge material and soil shall be prepared to accept the subbase. The surface shall be free of debris, rocks, vegetation and organic materials, frozen materials, foreign objects, excess silt, and soft areas.

The subbase shall be placed in 8-inch thick maximum loose lifts. Soil clods shall be broken down to 3 inches or half the lift thickness, whichever is less. Moisture conditioning may be conducted to preserve the homogeneity of the soil and to obtain relatively uniform moisture content throughout the soil mass. The subbase will be compacted to a density of at least 95 percent of the Standard Proctor maximum dry density or 90 percent of the Modified Proctor maximum dry density at moisture content of at or above the optimum moisture content. For each lift, the density and moisture shall be tested at a frequency of five tests per acre and all penetrations will be filled with bentonite.

The surface of the subbase shall be smoothed-rolled to be hard, uniform, and smooth. Surveying shall be performed to document that finished dimensions are as specified in the design. The CQA Consultant shall approve the installation of the subbase prior to the placement of the overlying geosynthetics.

**Table 2-2-1. Soils Requirements**

| COMPONENT | REQUIRED TEST | MINIMUM FREQUENCY | ACCEPTANCE CRITERIA | SAMPLE SIZE |
|---|---|---|---|---|
| SUBBASE | Visual Observation | Placed Material | Reasonably free of debris, plant materials, and foreign objects. | N/A |
| | Sieve and Hydrometer (ASTM D422) | 1 per 3,000 cu.yd. | 100% ≤ 2-inch, 90% ≤ 3/4-inch, and 50% ≤ No. 200 sieve. | 5-10 lbs. |
| | Unified Soil Classification (ASTM D2487) | 1 per 3,000 cu.yd. | Prior to placement. | 5-10 lbs. |
| | Density/Moisture Relationship (ASTM D698 or D1557) | 1 per 3,000 cu.yd. | Prior to placement. | 50 lbs. |
| | Specific Gravity (ASTM D854) | 1 per 3,000 cu.yd. | N/A | 5-10 lbs. |
| | Nuclear Density Gauge In-Place Density (ASTM D2922) and Moisture Content (ASTM D3017) | Placed Material: 5 tests per acre/lift | ≥ 95% of Standard Proctor maximum dry density or ≥ 90% of Modified Proctor maximum dry density with a moisture content at or above optimum. | N/A |
| | Moisture Content (ASTM D2216) | At discretion of CQA firm. | N/A; To confirm nuclear density gauge moisture correction. | Varies |
| | Lift Depth | Placed Material | ≤ 8 inches uncompacted depth | N/A |
| | Total Thickness | Placed Material | Varies; required thickness verified by survey | N/A |
| PROTECTIVE/VEGETATIVE COVER | Visual Observation | Placed Material | Reasonably free of debris, plant materials, and foreign objects. | N/A |
| | Sieve and Hydrometer (ASTM D422) | 1 per 3,000 cu.yd. | $d_{85} \geq 0.09$ mm | 5-10 lbs. |
| | Total Thickness | Placed Material | 24 inches verified through survey or direct measurement | N/A |

### 2.2.2 Protective/Vegetative Cover

The protective/vegetative cover shall have a thickness of at least 24 inches. The upper portion of the protective/vegetative cover soil shall consist of soil material capable of supporting vegetation and be reasonably free of large particles, frozen materials, foreign objects and organics. The physical characteristics of the soil material shall be evaluated through visual observation both before and during placement of the protective/vegetative cover soil.

The protective/vegetative cover shall be placed in one or more uniform lifts so that thickness and slopes meet the design specifications. During placement of the protective/vegetative cover, care shall be taken such that wrinkles do not develop in the underlying geosynthetics. The CQA Monitor(s) shall be present as necessary during protective/vegetative cover soil placement to determine that no damage to the underlying geosynthetics occurs and that no unacceptable materials are placed.

The protective/vegetative cover soil shall be placed and spread to the required thickness using a low ground pressure or other suitable earth moving equipment. Equipment used for spreading the soil material shall be low ground pressure dozers or backhoes that result in low contact pressure to the geosynthetics under the protective/vegetative cover. The protective/vegetative cover installation shall proceed upslope only; at no time will equipment be permitted to push/grade protective/vegetative cover soil down slope. The operators of all equipment used in transporting or spreading the soil material shall be advised to use gradual turns and stop/starts.

The final surface of the protective/vegetative cover shall be scarified, seeded, mulched, and fertilized as required to establish a dense vegetative growth. Surveying shall be performed to document that finished final cover dimensions are as specified in the approved Closure Plan and the design drawings.

A summary of the field and laboratory testing to be performed, sample locations, sample sizes, test frequencies, and acceptance criteria for the protective/vegetative cover soil is provided in Table 2-2-1.

## 2.3 Sludge Stabilization/Solidification Quality Assurance

### 2.3.1 Supplier's Documentation

Prior to delivery, the Type I Portland cement and lime kiln dust (LKD) suppliers shall provide documentation that demonstrates that the property values of the material meet the project requirements. Delivered parcels must be appropriately labeled.

#### 2.3.1.1 Portland Cement

Portland cement shall be ASTM C150 Type I, low alkali, containing less than 0.60 percent alkalies.

#### 2.3.1.2 Lime Kiln Dust

The LKD shall be between 20-30 percent free lime.

#### 2.3.1.3 Certification of Property Values

The Suppliers of the Type I Portland cement and the LKD shall provide to the CQA Site Manager certification that the materials delivered meet the design requirements and technical specifications. The QC certifications shall contain results of the Supplier's CQC testing ensuring that the physical properties of the products are in accordance with the Supplier's specifications.

## 2.3.2 Delivery

### 2.3.2.1 Packing and Labeling

The Type I Portland cement and LKD shall be protected from damage during shipment. The Supplier shall identify all packages with the following information:

- Supplier's name;
- Product identification;
- Batch number; and
- Package weight.

In addition, if any special handling of the Type I Portland cement or LKD is required, it shall be so marked on the outside covering of the package. The CQA Monitor(s) shall examine the packages upon delivery and any deviation from the above requirements shall be reported to the CQA Site Manager.

### 2.3.2.2 Transportation and Handling

Transportation of the Type I Portland cement and LKD is the responsibility of the respective Suppliers and Transporters. All handing on the site is the responsibility of the Contractor.

The CQA Monitor(s) will confirm that:

- Handling equipment used on the site is adequate and; and
- The Contractor's personnel handle the materials carefully.

The Type I Portland cement and LKD shall be shipped in accordance with the Supplier's recommendations. Upon delivery to the site, the Contractor and CQA Monitor(s) shall review all materials for defects and damage. The CQA Consultant shall indicate to the CQA Site Manager those materials with minor flaws and those which should be rejected because of severe damage.

### 2.3.2.3 Storage

The Contractor shall be responsible for the storage of the Type I Portland cement and LKD on-site. The CQA Site Manager shall provide storage space in one or more locations such that on-site transportation and handling are minimized. Storage space shall protect the Type I Portland cement and LKD from vandalism, passage of vehicles, exposure to weather, etc.

The Type I Portland cement and LKD shall be stored on a prepared surface protected from weather. The CQA Monitor(s) shall document that storage of the Type I Portland cement and LKD provides adequate protection against weather, dirt, impact, and other sources of damage.

## 2.3.3 Handling and Stabilization Procedures

### 2.3.3.1 Handling

The Type I Portland cement and LKD shall be handled carefully and protected from dirt and moisture until they are utilized.

### 2.3.3.2 Weather Conditions

Stabilization should take place during dry conditions, at temperatures between 40°F and 100° F. Solidification/Stabilization activities shall be stopped if the weather becomes inclement. The CQA

Monitor(s) will document the weather conditions during the performance of the solidification/stabilization activities.

#### 2.3.3.3 Dewatering

Dewatering is required for portions of the sludge material with excessive moisture content. Dewatering shall be performed using the sump system presented in the approved Plan and technical specifications. Water collected from the dewatering work will be pumped to the onsite wastewater treatment plant (WWTP). Sludge material in the northwest section of the Sludge Lagoon shall be dewatered until the moisture content has decreased by approximately 30 percent.

The CQA Monitor(s) will be present during dewatering activities to ensure that sufficient water is removed from the sludge material and that the water is properly disposed of through the on-site WWTP.

#### 2.3.3.4 Materials Mixing

##### 2.3.3.4.1 Proportions of Materials

The sludge material will be combined with 7.5 percent Type I Portland cement and 20 percent LKD. The CQA Monitor(s) will be present during mixing activities to ensure that required proportions of materials are used. The CQA Monitor(s) will document the materials used and report to the CQA Site Manager any problems or issues.

##### 2.3.3.4.2 Mixing

The sludge material will be solidified/stabilized by adding Type I Portland cement and LKD in ratios to provide an unconfined compressive strength (UCS) of 12-15 pounds per square inch (psi) (refer to the Lagoon Solidification/Stabilization Study included in Appendix G of the approved Plan). A hydraulic excavator will be used to blend the Type I Portland cement and LKD into the sludge material. The hydraulic excavator operator will possess knowledge and expertise with mixing and blending reagents using the bucket in order to obtain the required UCS of the solidified/stabilized sludge. Controls will be used throughout the solidification/stabilization process to account for dust suppression and surface water issues related to the water within the sludge material and water from rainfall events. Debris large enough to inhibit proper mixing will be removed before the mixing operation can continue. The CQA Monitor(s) will be present during mixing activities to document the amount of reagents used and that proper mixing is performed.

#### 2.3.3.5 Curing

Adequate curing time, approximately 14 days, shall be allowed for the solidified/stabilized sludge to reach the required unconfined compressive strength (UCS). Vehicle and foot traffic will be prohibited during the curing period, as will any source of stress that may cause damage to the solidified/stabilized sludge while curing.

#### 2.3.3.6 Testing

Samples of the uncured mixture will be collected during the solidification/stabilization work. The samples will be tested for slump to ensure proper consistency has been reached. Solidified/stabilized sludge samples will be allowed to cure in cylindrical molds for submittal to the laboratory for UCS testing. In addition, the strength of the cured solidified/stabilized sludge will be tested on-site using a pocket penetrometer.

##### 2.3.3.6.1 Failures

Should the solidified/stabilized sludge not achieve the UCS required by the end of the 14-day curing period, an additional 14 days will be allowed before a second UCS test is performed.

## 2.4 Geomembrane Construction Quality Assurance

### 2.4.1 Supplier's Documentation

Prior to delivery, the Geosynthetics Supplier shall provide documentation that demonstrates that the property values of the material meet the project requirements. Delivered rolls of geomembrane must be appropriately labeled. Sixty-mil textured HDPE flexible membrane liner (FML) will be used in the final cover system.

#### 2.4.1.1 Raw Material

The polyethylene shall be an unmodified HDPE containing no plasticizers, fillers, chemical additives, reclaimed polymers, or extenders. Resins used during the manufacturing shall conform to either the resin/geosynthetics manufacturing specifications or to the specified values in Table 2-4-1 whichever is more stringent.

#### 2.4.1.2 Certification of Property Values

The Geosynthetics Supplier shall provide the CQA Site Manager with a list of guaranteed minimum average roll values (MARV) for the types of geomembrane to be supplied. The Geosynthetics Supplier shall supply the resin quality control certificates provided by the resin manufacturer. The Geosynthetics Supplier shall provide to the CQA Site Manager quality control certification for each roll of geomembrane shipped to the site confirming that each roll meets or exceeds the guaranteed minimum requirements of the Geosynthetics Supplier. The QC certifications shall contain results of the Geosynthetics Supplier's CQC testing ensuring that the physical properties of the final product are in accordance with the Geosynthetics Supplier's specifications and that of Table 2-4-1.

### 2.4.2 Delivery

#### 2.4.2.1 Packing and Labeling

The geomembrane rolls shall be protected from damage during shipment. The central core shall be accessible for handling. The Geosynthetics Supplier shall identify all rolls of geomembrane with the following information:

- Supplier's name;
- Product identification, including thickness and material type;
- Lot number;
- Roll number;
- Roll weight; and
- Roll dimensions.

The geomembrane roll number or lot number shall directly correspond to the resin identification.

In addition, if any special handling of the geomembrane is required, it shall be so marked on the outside covering of the geomembrane roll. The CQA Monitor(s) shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the CQA Site Manager.

Table 2-4-1. 60-mil Textured HDPE Geomembrane QA/QC Testing

| PROPERTY | TEST METHOD | REQUIRED VALUES(1) | MANUFACTURER QC TEST FREQUENCY | QUALITY ASSURANCE TEST FREQUENCY |
|---|---|---|---|---|
| **REQUIRED PHYSICAL PROPERTIES** | | | | |
| THICKNESS (mil) | ASTM D5199 | 54 minimum<br>60 minimum average | Each Roll | Every 100,000 sf |
| SHEET DENSITY (g/cm³) (min) | ASTM D1505 or<br>ASTM D792 | 0.940 | See Note 2. | Every 100,000 sf |
| TENSILE PROPERTIES (min, each direction<br>Yield Strength (lb/in)<br>Yield Elongation (%)<br>Break Strength (lb/in)<br>Break Elongation (%) | ASTM D6693 Type IV | 126<br>12<br>228<br>700 | See Note 2. | Every 100,000 sf |
| CARBON BLACK CONTENT (allowable range in %) | ASTM D1603 | 2.0-3.0% | See Note 2. | Every 100,000 sf |
| CARBON BLACK DISPERSION (acceptable levels) | ASTM D5596 | 9 in Categories 1 or 2, and 1 in Category 3 | See Note 2. | Every 100,000 sf |
| PUNCTURE RESISTANCE (avg. min.) (lb) | ASTM D4833 | 108 | See Note 2. | Every 100,000 sf |
| TEAR RESISTANCE (avg. min.) (lb) | ASTM D1004 | 42 | See Note 2. | Every 100,000 sf |
| OXIDATIVE INDUCTION TIME<br>Standard (avg. min.) or<br>High Pressure (avg. min.) | ASTM D3895<br>ASTMD5885 | 100 min<br>400 min | See Note 2. | See Note 3 |
| OVEN AGING AT 85°C<br>Standard OIT (min avg. % retained after 90 days) or<br>High Pressure OIT (min avg. % retained after 90 days) | ASTM D5721<br>ASTM D3895<br>ASTM D5885 | 55%<br><br>80% | Certify Each Formulation | See Note 3 |
| UV RESISTANCE<br>High Pressure OIT (min. avg. % retained after 1600 hours) | ASTM D5885 | 50% | Certify Each Formulation | See Note 3 |
| STRESS CRACK RESISTANCE | ASTM D5397 | 200 hours | Per GRI GM 10 | See Note 3 |
| **GEOMEMBRANE RESIN** | | | | |
| DENSITY (min. g/ml) | ASTM D 1505/D792 | 0.932 | Each Resin Batch | See Note 3 |
| MELT FLOW INDEX (g/10 min) (max.) | STEM D1238 | 1.0 | Each Resin Batch | See Note 3 |

**Table 2-4-1. 60-mil Textured HDPE Geomembrane QA/QC Testing**

| INSTALLATION TESTING SUMMARY | | | | |
|---|---|---|---|---|
| **PROPERTY** | **TEST METHOD** | **SAMPLE SIZE** | **FIELD TEST FREQUENCY** | **ACCEPTANCE CRITERIA(5)** |
| **TRIAL SEAM TESTING(4):** | | | | |
| PEEL TEST (lb/in) Fusion Welds | ASTM D6392 | As Needed | Minimum 1 test per welder/machine combination; and prior to each seaming period. | The average of the 3 tests shall be greater than 78 lb/in with one result being less than 78 lb/in but greater than 63 lb/in. Three (3) out of three (3) tests shall not have a break code of AD. AD-BRK is only an acceptable break code if seam incursion is less than 25%. Refer to Figure 2-4.2 for break codes. |
| PEEL TEST (lb/in) Extrusion Welds | ASTM D6392 | | Minimum 1 test per welder/machine combination; and prior to each seaming period. | The average of the 3 tests shall be greater than 72 lb/in with one result being less than 72 lb/in but greater than 58 lb/in. Three (3) out of three (3) tests shall not have one with the following break codes: AD1, AD2, AD-BRK or AD-WLD. Refer to Figure 2-4.1 for break codes. |
| **DESTRUCTIVE SEAM TESTING(4):** | | | | |
| PEEL TEST (lb/in) Fusion Welds | ASTM D6392 | As Needed | Minimum 1 per 500 lf of seaming per devices | The average of the 5 tests shall be greater than 78 lb/in with one result being less than 78 lb/in but greater than 63 lb/in. Five (5) out of five (5) tests shall not have a break code of AD. AD-BRK is only an acceptable break code if seam incursion is less than 25%. Refer to Figure 2-4.2 for break codes. |
| PEEL TEST (lb/in) Extrusion Welds | ASTM D6392 | | Minimum 1 per 500 lf of seaming per devices | The average of the 5 tests shall be greater than 72 lb/in with one result being less than 72 lb/in but greater than 58 lb/in. Five (5) out of five (5) tests shall not have one of the following break codes: AD1, AD2, AD-BRK or AD-WLD. Refer to Figure 2-4.1 for break codes |
| **NON-DESTRUCTIVE SEAM TESTING:** | | | | |
| Air-Pressure | GRI GM6 | | Every fusion-welded seam | No more than 3 psi drop with initial pressure of 30 to 35 psi for 5 minutes. |
| Vacuum | ASTM D5641 | | Every extrusion weld | Examine weld for 10 seconds with minimum vacuum of 3 psi. |

*Notes:*

*(1) Required values are from GRI Test Method GM 13, Standard Specification for "Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene Smooth and Textured Geomembranes."*

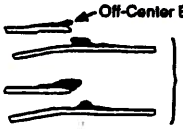
*(2) Testing shall be completed at the manufacturer's standard testing frequency.*

*(3) Not required.*

*(4) For double fusion welded seams, both tracks shall be tested for compliance with the minimum property values listed.*

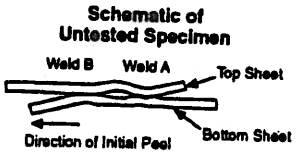
*(5) Accepted specifications for breaks and unacceptable break codes obtained from the standard specifications in GRI-GM19*

**Schematic of Untested Specimen**

| Types of Break | Location of Break Code | Break Description |
|---|---|---|
| | AD1 | Failure in adhesion. Specimens may also delaminate under the bead and break through the thin extruded material in the outer area. |
| | AD2 | Failure in adhesion. |
|   | AD-WLD(1) | Break through the fillet. |
| | SE1 | Break at seam edge in the bottom sheet (applicable to shear only). |
| | SE2 | Break at seam edge in the top sheet (applicable to shear only). |
| | SE3 | Break at seam edge in the bottom sheet (applicable to peel only). |
| | BRK1 | Break in the bottom sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area. |
| | BRK2 | Break in the top sheeting. A "B" in parebtheses following the code means the specimen broke in the buffed area. |
| | AD-BRK | Break in the bottom sheeting after some adhesion failure between the fillet and the bottom sheet. |
| | HT | Break at the edge of the hot tack for specimens which could not be delaminated in the hot tack. |
| | SIP | Separation in the plane of the sheet. |

(1) Acceptance of AD-WLD breaks may depend on whether test values meet a minimum specification value.

*Figure 2-4.1. Extrusion Welded Seams*




| Types of Break | Location of Break Code | Break Description |
|---|---|---|
| | AD | Adhesion Failure |
| | BRK | Break in sheeting. Break can be in either top or bottom sheet |
| | SE1 | Break in outer edge of seam. Break can be in either top or bottom sheet. |
| | SE2 | Break at inner edge of seam through both sheets. |
| | AD-BRK | Break in first seam after some adhesion failure. Break can be in either top or bottom sheet. |
| | SIP | Separation in the plane of the sheet. Break can be in either top or bottom sheet. |

*Figure 2-4.2. Fusion Welded Seams*

#### 2.4.2.2 Transportation and Handling

Transportation of the geomembrane is the responsibility of the Geomembrane Supplier, Geosynthetics Installer, and Transporter as directed by the Geosynthetic Installer. All handing on the site is the responsibility of the Geosynthetic Installer.

The CQA Monitor(s) will confirm that:

- Handling equipment used on the site is adequate and does not damage the geomembrane; and
- The Geosynthetics Installer's personnel handle the geomembrane with care.

The geomembrane shall be shipped in accordance with the Geosynthetic Supplier's recommendations. Upon delivery to the site, the Geosynthetics Installer and CQA Monitor(s) shall review all rolls for defects and damage. This review shall be conducted without unrolling the rolls unless defects or damages are found or suspected. The CQA Consultant shall indicate to the CQA Site Manager any rolls with minor repairable flaws and any rolls or portions of rolls which should be rejected because of severe flaws.

#### 2.4.2.3 Storage

The Geosynthetics Installer shall be responsible for the storage of the geomembrane on-site. The CQA Site Manager shall provide storage space in one or more locations such that on-site transportation and handling are minimized. Storage space shall protect the geomembrane from vandalism, passage of vehicles, etc.

The geomembrane shall be stored on a prepared surface no more than three rolls in height or as recommended by the Geosynthetics Supplier. The CQA Consultant shall inspect the storage area(s) to verify that the surface is smooth, flat, and free of rocks or other objects that could cut or puncture the geomembrane. The CQA Monitor(s) shall also document that storage of the geomembrane provides adequate protection against dirt, impact, and other sources of damage.

### 2.4.3 Conformance Testing of Delivered Geomembrane

Geomembrane sampling for conformance testing may take place at the geomembrane manufacturing plant by the Geomembrane Supplier, the Geosynthetics CQA Laboratory, or a representative of the Owner or the CQA Consultant. The samples shall be forwarded to the Geosynthetics CQA Laboratory. Conversely, the CQA Consultant may retrieve geomembrane samples from material delivered to the site and forward them to the Geosynthetics CQA Laboratory for conformance testing to determine compliance with the project specifications.

#### 2.4.3.1 Sampling Procedures

Sample locations shall be selected in accordance with the sampling frequency. Samples shall be taken across the entire width of the roll and shall not include the first three feet. Unless otherwise specified, samples shall be three feet long by the roll width. Samples of geomembrane shall be taken at the frequencies listed in Table 2-4-1. The sample shall be clearly marked and indicate the roll number from which the sample was taken.

#### 2.4.3.2 Test Results

The CQA Site Manager shall examine the results of laboratory conformance testing and shall report any non-conformance to the Project Manager. The minimum standards for the geomembrane are given in Table 2-4-1.

#### 2.4.3.3 Conformance Test Failure

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

- The Geosynthetics Supplier or CQA Consultant shall remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must conform to the Specifications. If either of these samples fail, testing will proceed on samples collected from the closest numerical roll to the failed roll until rolls are located that conform to the Specifications.
- The Geosynthetics Supplier shall replace any roll of geomembrane that is in non-conformance with the Specifications with a roll that meets the Specifications.

The CQA Monitor(s) shall document actions taken in conjunction with conformance test failures.

### 2.4.4 Handling and Placement

#### 2.4.4.1 Handling

The Geosynthetic Installer shall handle geomembrane in such a manner as to minimize damage to the geomembrane and comply with the following:

- The equipment or tools used for handling, trafficking, or other operations shall not cause damage to the geomembrane;
- Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in activities that will cause damage to the geomembrane;
- The equipment used to deploy the geomembrane shall not cause damage to the material underneath; and
- To prevent geomembrane uplift by wind, sand bags or tires shall be placed as frequently along the edges as deemed necessary.

#### 2.4.4.2 Installation Schedule

The Geosynthetics Installer shall obtain approval from the CQA Consultant prior to placing the field panels. Field panels shall be placed one at a time and each field panel shall be seamed on the same day as placement. The panels shall be shingled from the highest elevation toward the lowest elevation. Up-slope panels shall be shingled over down-slope panels to direct flow over the seam and not into the seam. When in position, the field panels shall be checked for any physical damage caused either during manufacture, storage, or during installation.

#### 2.4.4.3 Field Panel Identification

A field panel is the unit area of geomembrane that is to be seamed in the field. The CQA Monitor(s) shall document that the Geosynthetics Installer labels each field panel with an "identification code" (alphanumeric). This identification code will be decided by the CQA Consultant and Geosynthetics Installer during the Pre-Construction Meeting. The CQA Consultant may consider using P (for Panel) as an identification code. A seam between P1 and P2 may be identified as S 1/2 (Seam 1/2), where 1 and 2 are unique identifications for panels. It will be the responsibility of the Geosynthetics Installer to mark each field panel with the original roll number, date, and time of deployment. The roll number shall be conspicuously marked.

The CQA Monitor(s) will document the correspondence between roll numbers and field panel identification codes. The field panel identification code will be used for all quality assurance records.

#### 2.4.4.4 Weather Conditions

Geomembrane placement and welding shall not proceed at an ambient temperature below 35°F or above 110°F unless the Geosynthetics Installer can provide documentation to the CQA Site Manager that the resulting seam meets or exceeds the required seam properties as set forth in Table 2-4-1. In addition, the seaming procedure shall not cause any physical or chemical modifications to the geomembrane that will generate short or long-term damage. Geomembrane placement shall not be performed during significant precipitation, in an area of water accumulation, or in the presence of excessive winds.

The CQA Consultant shall verify that the above conditions are fulfilled. Additionally, the CQA Consultant shall verify that the underlying subbase has not been damaged by weather conditions.

The Geosynthetics Installer shall deploy the geomembrane from the higher elevation to the lower elevation. The CQA Monitor(s) shall note non-compliance and report it to the CQA Site Manager.

#### 2.4.4.5 Method of Placement

The CQA Monitor(s) shall document that the following conditions are satisfied by the Geosynthetics Installer:

- The surface of the subbase is free of debris, rocks, vegetation and organic materials, frozen materials, foreign objects, excess silt, and soft areas.
- Any equipment used does not damage the geomembrane or underlying subbase by handling, trafficking, excessive heat, leakage of machine operating fuels or oils, or other means;
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- No personnel working on the geomembrane will smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane;
- The method used to unroll the geomembrane does not cause scratches or crimps in the geomembrane and does not damage the underlying subbase;
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (In case of high winds, continuous loading by adjacent sand bags, or soil is recommended along edges of panels to minimize risk of wind flow under the panels); and
- Direct contact with the geomembrane is minimized, i.e., the geosynthetics are protected by geotextiles, extra geomembrane, or other suitable materials in areas where excessive traffic may be expected.

The CQA Consultant shall inform the Project Manager if the above conditions are not satisfied.

#### 2.4.4.6 Damage

The CQA Monitor(s) and Geosynthetics Installer shall inspect each geomembrane panel for damage prior to seaming. The CQA Monitor(s) shall advise the CQA Site Manager what panel or portions of panels shall be rejected. Damaged panels or portions of damaged panels that have been rejected shall be marked and their removal from the work area recorded by the CQA Monitor(s). Repairs to geomembrane shall be made according to procedures described in Section 2.4.5.9 of this Plan.

## 2.4.5 Seaming and Testing

### 2.4.5.1 Seaming Strategies

The Geosynthetics Installer shall provide the CQA Site Manager with the panel layout drawing(s). The CQA Consultant and the Geosynthetics Installer shall agree on the proposed layout before deployment of the geomembrane.

The layout drawing(s) shall meet the following requirements as far as practicable:

- Seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across the slope.
- If the area to be lined is an unusual geometric shape, the Geosynthetics Installer shall minimize the number or length of seams.
- For horizontal seams running perpendicular to the slope (i.e., on the floor), a distance of at least 10 feet shall be maintained from the toe and/or crest of slope.

The Geosynthetics Installer shall avoid seaming areas with wrinkles and "fishmouths." Before seaming can start, the Geosynthetics Installer shall confirm the following:

- The panels of the geomembrane have a finished overlap of a minimum of three inches for extrusion seaming and four inches for fusion seaming, or otherwise matching the Geosynthetic Installer's equipment. Sufficient overlap shall be provided to allow peel tests to be performed on the seam.
- No solvent or adhesive is used.
- The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.

The seams shall be marked with a seam numbering system compatible with the panel numbering system that shall be agreed upon at the Pre-Construction Meeting. Labeling of the seams shall include, seam identification, weld start time, welding equipment, equipment settings, weld technician, and all data related to the CQC testing of the seam integrity.

### 2.4.5.2 Seaming Equipment and Products

Approved processes for field seaming are extrusion welding and hot wedge (fusion) welding. Proposed alternate processes shall be documented and submitted to the CQA Consultant for approval. Only apparatus that have been specifically approved by make and model shall be used. The Geosynthetic Installer shall maintain spare operable seaming apparatus on-site.

The CQA Monitor(s) will also confirm that:

- Equipment used for seaming is not likely to damage the geomembrane;
- The electric generator is placed on a base such that no damage occurs to the geomembrane from puncture or leaking fluids;
- A smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage; and
- The geomembrane is protected from damage in heavy traffic areas.

#### 2.4.5.2.1 Extrusion Welder

The extrusion welder shall be equipped with gauges giving the relevant temperatures of the apparatus at the nozzle and extruder barrel. The extrusion welder shall be purged prior to beginning a seam until all heat-

degraded extrudate has been removed from the barrel. The Geosynthetics Installer shall certify that the extrudate is compatible with and is comprised of the same resin as the geomembrane and shall provide documentation regarding the extrudate to the CQA Site Manager.

#### 2.4.5.2.2 Fusion Welder

The fusion welding apparatus shall be equipped with gauges providing the applicable temperatures. Pressure settings shall be verified by the Geosynthetic Installer prior to initiating each seaming period. A double-wedge fusion welder produces a double seam with an enclosed air space between the seams. The Geosynthetics Installer shall prevent build-up of moisture between the panels. A moveable protective sheet may be used as required directly below each overlap of geomembrane that is to be seamed. The CQA Monitor(s) shall log ambient temperatures, seaming apparatus temperatures, and speeds.

### 2.4.5.3 Seam Preparation

The CQA Monitor(s) shall confirm that:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, oils, greases, debris of any kind, and foreign material;
- Seams are aligned with the proper overlap and the fewest possible number of wrinkles and fishmouths;
- If seam overlap grinding is required, the process is completed according to the Geosynthetics Supplier's instructions within 30 minutes of the seaming operation, and in a way that does not damage the geomembrane;
- The abrasion does not extend more than 0.25 inches on either side of the extrusion seam;
- The procedure used to temporarily bond seams together does not damage the geomembrane; and
- Solvents or adhesives are not be used.

### 2.4.5.4 Weather Conditions for Seaming

The normally required weather conditions for seaming are the same as those for deploying geomembrane discussed in Section 2.4.4.4, which are as follows:

- Unless authorized in writing by the CQA Consultant, no seaming shall be attempted at an ambient temperature below 35° F or above 110° F; and
- The geomembrane shall be dry and protected from wind.

If the Geosynthetics Installer wishes to use methods, which may allow seaming at ambient temperatures below 35°F or above 110°F, the Geosynthetics Installer shall demonstrate that such methods produce seams which are entirely equivalent to seams produced within the acceptable ambient temperature range, and that the overall quality of the geomembrane is not adversely affected. The Geosynthetics Installer is required to provide documentation that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane. If these requirements are met, the temperatures in the above quality assurance procedure shall be modified accordingly.

The CQA Monitor(s) shall document that those weather conditions are fulfilled and shall advise the CQA Site Manager if they are not.

#### 2.4.5.5 Trial Seams

Trial seams shall be made on fragments of geomembrane liner to document that seaming equipment and conditions are adequate. Such trial seams shall be made at the beginning of each seaming period for each operator/equipment combination used in the seaming period. A trial seam shall also be made in the event that the equipment is turned off, or an operator changes. Trial seams shall be made under the same conditions as actual seams.

The Geosynthetics Installer shall provide a tensiometer for on-site peel testing of geomembrane seams. The tensiometer shall be in good working order, built to ASTM specifications, and accompanied by evidence of recent calibration. The tensiometer shall be motor driven and have jaws capable of traveling at a measured rate of two inches per minute. It shall be equipped with a gauge that measures the force in pounds exerted between the jaws and have a digital readout.

The trial seam sample shall be the dimensions required by the Geosynthetics Installer with the seam centered lengthwise. Seam overlap shall be approximately three inches for extrusion welds and four inches for fusion welds or as required by Geosynthetic Installer equipment. Refer to Table 2-4-1 for the trial seam test method, test frequency and acceptance criteria.

In each type of test, all specimens shall meet the minimum strength requirements. If a trial seam fails, the entire operation should be repeated. If the additional trial seam fails, the seaming apparatus and operator shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

The CQA Monitor(s) shall observe all trial seam procedures. All trial seams shall be assigned a number and marked accordingly by the CQA Monitor(s). The CQA Monitor(s) shall log the date, hour, ambient temperature, number of seaming unit, name of the operator, and pass or fail description. The sample itself shall be cut into two pieces, one to be retained in the Owner's archives, one to be given to the Geosynthetics Installer.

#### 2.4.5.6 Seaming Procedure

##### 2.4.5.6.1 Extrusion Seaming

Unless otherwise specified, the general seaming procedure for extrusion seaming used by the Geosynthetics Installer shall be as follows:

- The upper sheet is lowered and laid flat against the lower sheet and all surface sheen in the area to be seamed must be removed. Sand paper coarser than No. 80 is unacceptable, because it can leave deep grooves in the weld area that represent potential stress points or leak channels. All material dust generated by grinding the liner sheets must be wiped or blown away from the seaming zone.
- Grind marks should never be deeper than 10 percent of the sheet thickness. Optimally, they should be about five percent of the sheet thickness. The only purpose of grinding is the removal of oxide layers and dirt from the liner surfaces, and the roughening of their interface for the extrudate.
- Grinding marks should not extend beyond 0.25 inches of either side of the extrudate after its placement. For example, if the final extrudate bead width is 1.5 inches, the width of the grinding trail should not exceed two inches.
- Seaming must take place no more than 30 minutes after grinding, so that surface oxide layers do not reappear where the extrudate must be placed.
- A hot air device (often called a "liester") may be used to temporarily bond or "tack" the two sheets together, ahead of the extrusion welder. The hot air device prepares the seam for the extrusion welder by

heating the ground surface and by creating a light bond between the two sheets, securing their position. The hot air gun is not meant to create a final seam. No heat distortion should be evident on the sheets.

- The extrusion welder's barrel shall be purged of all heat-degraded extrudate before starting a seam. This must be done every time the extruder is restarted after two or more minutes of inactivity. The purged extrudate shall not be discharged onto the surface of previously placed liner or subbase where it would eventually form a hard lump under the geomembrane and cause stress concentrations.
- The center of the extrudate shall pass directly along the edge of the upper panel, at sufficient width to completely cover the edge and most of the outlying grind marks, at least to within 0.25 inch of their extremity.
- The extrudate should be approximately twice the specified panel thickness, measured from the top of the bottom panel to the top or "crown" of the extrudate.
- Where possible, inspect the underside of the lower panel for heat distortion. This can be accomplished at the end of seams, and wherever samples are cut out of the seam. A slight amount of thermal "puckering" on relatively thin panels (less than 50-mil) is acceptable. It indicates that the heat penetrated entirely through the panel. However, if the underside is greatly distorted, either lower the temperature or increase the rate of seaming. Any change in the welding procedure requires replacement trial seams to be prepared.
- If the seaming process must be interrupted at mid-seam, the extrudate should trail off gradually, not terminate in a large mass of solidified extrudate. Where such welds are abandoned long enough to cool, they must be ground prior to continuing with new extrudate over the remainder of the seam. Grind where the extrudate trail-off begins. This restart procedure must be followed for patches, pipes, fittings, and appurtenances.

#### 2.4.5.6.2 Fusion Seaming Process

Unless otherwise specified, the general seaming procedures for fusion seaming used by the Geosynthetics Installer shall be as follows:

- The fusion seaming apparatus should be properly positioned for making the desired single or dual weld seam.
- Ambient variables such as temperature, cloud cover, and wind speed may make it necessary to vary the temperature of the wedge. It may be useful to document wedge temperatures used successfully in a variety of ambient conditions, so that the hot wedge can be more accurately adjusted if new conditions develop.
- The drive motor should be off when positioning the welding machine to seam. Place the machine where the panels overlap. Guide the overlapped material between the idlers and the wedge, and into the drive/nip rollers. When continuing a weld that has been abandoned mid-seam, the panels must be spread where the seam leaves off and loaded into the respective sides of the machine. Raise the machine a few inches, load the bottom panel first, and then load the top panel. When the nip rollers engage and the wedge is in position, turn on the drive motor. Immediately engage the panels when they are between the nip rollers to prevent an imminent melt-through. Move the hot wedge into position and lock it.
- The operator must constantly monitor the temperature controls, as well as the completed seam passing out of the machine. Occasional adjustments in temperature or speed may be necessary to maintain a consistent weld. Visual inspection and constant hand testing by the peel method (or other) is also recommended.

### 2.4.5.7 Non-Destructive Seam Continuity Testing

The Geosynthetics Installer shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), spark test, or other approved method. The testing shall be carried out to the accepted standards of the industry. The purpose of non-destructive tests is to check the seams for leaks. It does not provide any information on seam strength or quality of bonding. Non-destructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. Non-destructive testing shall be performed during daylight hours unless the Geosynthetics Installer demonstrates capabilities to do so.

The CQA Monitor(s) shall:

- Observe all non-destructive testing;
- Record location, date, test unit number, name of tester, and outcome of all testing; and
- Inform the Geosynthetics Installer and CQA Site Manager of any test failures and required repairs.

The Geosynthetics Installer shall complete any required repairs in accordance with Section 2.4.5.9 of this Plan.

The CQA Monitor(s) shall:

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

The Geosynthetics Installer shall use the following procedures at locations where seams cannot be non-destructively tested, such as double hot wedge segments that are short or areas where extrusion beads do not permit the vacuum box to completely seal:

- All such seams shall be cap-stripped with the same geomembrane; and
- Each cap strip shall be vacuum tested in accordance with Section 2.4.5.7.1.

The seam number, date of observation, name of tester, and outcome of the test or observation shall be recorded by the CQA Monitor(s).

#### 2.4.5.7.1 Vacuum Testing

The equipment shall be comprised of the following:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a gauge to indicate chamber vacuum;
- A steel vacuum tank and pump assembly equipped with a vacuum gauge and pipe connections;
- A rubber pressure/vacuum hose with fittings and connections;
- A bucket and wide brush, mop or spray assembly; and
- A soapy solution.

The following procedures shall be followed:

- Energize the vacuum pump;
- Wet a strip of geomembrane approximately 12 inches by 48 inches with a soapy solution;

- Place the box over the wet area;
- Close the bleed valve and open the vacuum valve;
- Ensure that a leak tight seal is created;
- At a vacuum of at least five psi, for a period of approximately 10 seconds, examine the geomembrane through the viewing window for the propagation of soap bubbles;
- Close the vacuum valve and open the bleed valve, move the box over the adjoining area with a minimum three inches overlap, and repeat the process;
- All areas where soap bubbles appear shall be marked and repaired in accordance with Section 2.4.5.9 of this Plan; and
- Vacuum tested seams shall be recorded.

#### 2.4.5.7.2 Air Pressure Testing (For Double Hot Wedge Seam Only)

The equipment shall be comprised of the following:

- An air pump (manual or motor driven) equipment with pressure gauge capable of generating a minimum pressure of 30 pounds per square inch (psi);
- A rubber hose with fittings and connections; and
- Hollow needle and clamp assembly or other approved pressure feed device.

The following procedures shall be followed:

- Seal one end of the seam to be tested;
- Insert needle or other approved pressure feed device into the air channel created by the fusion weld;
- Energize the air pump to a pressure of 30 to 35 psi, close valve, and hold pressure for approximately five minutes;
- If loss of pressure exceeds three psi, or does not stabilize, locate faulty area and repair in accordance with Section 2.4.5.9 of this Plan;
- Release air pressure by puncturing seam at opposite end of where pressure is applied to assure there is no blockage in the air channel and verify that the full seam has been pressurized;
- Remove needle or other approved pressure feed device and seal; and
- Pressure tested seams shall be recorded.

#### 2.4.5.7.3 Spark Testing

For those extrusion welded seams that are unable to be tested by a vacuum box, the spark test method shall be used. The spark test method utilizes a 24 gauge copper wire placed approximately 0.125 inch under the top panel overlap and a holiday detector operating at 20,000 volts.

The testing activities shall be performed by the Geosynthetics Installer by placing the electrically conductive wire beneath the seam prior to welding. A trial seam containing a non-welded segment shall be subject to a calibration test to ensure that such a defect (non-welded segment) will be identified under the planned machine settings and procedures.

Upon completion of the weld, enable the spark tester and hold approximately one inch above the weld moving slowly over the entire length of the weld in accordance with ASTM D6365. If there is no spark, the weld is considered to be leak free.

A spark indicates a hole in the seam. The faulty area shall be located, repaired, and retested by the Geosynthetics Installer.

Care shall be taken if flammable gases are present in the area to be tested.

#### 2.4.5.8 Destructive Testing

Destructive testing of seams shall be performed at locations selected by the CQA Monitor(s). The purpose of these tests is to evaluate seam strength and bonding efficiency, which indicates seam durability. Seam strength testing shall be performed as the seaming work progresses, not at the completion of all field seaming.

##### 2.4.5.8.1 Location and Frequency

The CQA Monitor(s) shall select locations where seam samples shall be cut out for laboratory testing. Those locations shall be established as follows:

- A minimum average frequency of one test location per 500 feet of seam length per seaming device for each type of seaming. This minimum frequency is to be determined as an average taken throughout the entire facility for each type of seaming.
- Test locations shall be random and shall be selected during seaming by the CQA Monitor(s). Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming.

The Geosynthetics Installer shall not be informed in advance of the locations where the seam samples shall be taken.

##### 2.4.5.8.2 Sampling Procedures

Samples shall be cut by the Geosynthetics Installer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material.

The CQA Monitor(s) shall:

- Select sample locations;
- Observe sample cutting;
- Assign a number to each sample, and mark it accordingly;
- Record the sample location on the as-built layout drawing; and
- Record any special reason for taking the sample at this location (e.g., suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired by capping in accordance with repair procedures described in Section 2.4.5.9.2 of this Plan. The continuity of the new seams in the repaired area shall be tested according to Section 2.4.5.7 of this Plan.

##### 2.4.5.8.3 Size of Samples

At a given sampling location, a destructive sample shall be cut from the seam by the Geosynthetic Installer with dimensions as stated in Table 2-4-1. The seam shall then be distributed as follows:

- One portion to be tested onsite by the Geosynthetics Installer;
- One portion to the Owner for archive storage; and
- One portion for Geosynthetics CQA Laboratory testing.

#### 2.4.5.8.4 Field Testing

Five 1-inch wide samples, or "bones" shall be tested by the Geosynthetic Installer in the field for peel strength using a tensiometer. The results of field testing shall meet the acceptance criteria shown on Table 2-4-1. If any field test sample fails, then the procedures outlined in Section 2.4.5.8.7 of this Plan shall be followed. If the field test sample passes, the sample shall be sent to the Geosynthetics CQA Laboratory for testing.

The CQA Monitor(s) shall document all field tests and mark all samples and portions with their number. The CQA Monitor(s) shall also log the date and time, number of seaming unit, name of technician, seaming apparatus temperatures and speeds, and pass or fail description.

#### 2.4.5.8.5 Geosynthetics CQA Laboratory Testing

Destructive test samples being forwarded to the geosynthetics CQA laboratory shall be packaged and shipped under the responsibility of the CQA Monitor(s) in a manner that will not damage the test sample. The CQA Consultant shall be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetics CQA Laboratory. The Geosynthetics CQA Laboratory shall be selected by the CQA Consultant.

The Geosynthetics CQA Laboratory shall provide test results no more than 24 hours after they receive the samples. The CQA Consultant shall review laboratory test results as soon as they become available. Refer to Table 2-4-1 for the test method and acceptance criteria.

#### 2.4.5.8.6 Geosynthetics Installer's Laboratory Testing

If performed, the Geosynthetics Installer's laboratory test results shall be presented to the CQA Consultant for review.

#### 2.4.5.8.7 Procedures for Destructive Test Failures

The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory, the Geosynthetics Installer's laboratory, or by field testing. The Geosynthetics Installer has two options:

- The Geosynthetics Installer can reconstruct the seam between any two passed destructive seam test locations; or
- The Geosynthetics Installer can trace the seaming path to an intermediate location at least 10 feet in both directions from the point of the failed test. Check the next seam welded using the same welding device if required to obtain additional sample (i.e., if one side of the seam is less than 10 feet long). A small sample for an additional field test at each location shall be taken. If these additional samples pass tensiometer testing, then full destructive laboratory samples are taken. If these destructive laboratory samples pass the tests, then the seam is reconstructed between these locations by capping. If either sample fails, the process is repeated to establish the segment in which the seam should be reconstructed.

If a fusion type seam fails destructive testing and the Geosynthetics Installer chooses to repair the seam, it shall be repaired as described in Section 2.4.5.9.2 of this Plan.

All acceptable seams must be bounded by two locations from which destructive samples passing laboratory tests have been taken. In cases exceeding 150 feet of reconstructed seam, a seam sample shall be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing or the procedure outlined in this Section must be repeated. The CQA Monitor(s) shall document all actions taken in conjunction with destructive test failures.

#### 2.4.5.9 Defects, Repairs, and Retests

##### 2.4.5.9.1 Defects

The CQA Monitor(s) shall visually monitor each panel and seam for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The geomembrane shall be clean at the time of the inspection. Any defects or damage shall be logged on deficiency forms. The actions taken to resolve or correct the problem along with non-destructive test results shall also be recorded on the form. Geomembrane shall not be covered at locations that have been repaired until test results with passing values are available.

##### 2.4.5.9.2 Repairs

Any portion of the geomembrane failing a destructive or non-destructive test shall be repaired. Prior to repairing a problem area, the CQA Consultant and the Geosynthetics Installer shall agree on the repair method to be used. If no concurrence is reached, the Design Engineer's decision shall be final. The procedures available include:

- Patching - used to repair holes and tears, along with tees, and wyes at the ends of a seam, and contamination by foreign matter;
- Buffing and re-welding - used to repair small sections of extruded seams;
- Spot welding or seaming - used to repair minor localized flaws; and
- Capping - used to repair large lengths of seams or panels.

In addition, the following provisions shall be satisfied:

- Surfaces of the geomembrane which are to be repaired shall be abraded no more than 30 minutes prior to the repair;
- All surfaces must be clean and dry at the time of the repair;
- All seaming equipment used in repair procedures must be approved;
- The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the CQA Consultant; and
- Patches or caps shall extend at least six inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least three inches.

##### 2.4.5.9.3 Retests

Each repair shall be non-destructively tested unless the CQA Consultant rules otherwise. If a repair passes the non-destructive test, it shall be documented as satisfactory by the CQA Monitor(s). Failed tests shall require the repair to be redone and retested until a passing test results.

### 2.4.6 Geosynthetics Certification/Acceptance

The Geosynthetics Installer and the Geosynthetics Suppliers shall retain all ownership and responsibility for the geosynthetic materials until they are accepted by the Owner.

The geosynthetics system shall be accepted by the Owner when:

- The installation is finished;
- Verification of the adequacy of all seams and repairs, including associated testing, is complete;

- Geosynthetics Installer's representative furnishes the CQA Consultant with documentation that the geomembrane was installed in accordance with the Geosynthetics Supplier and Geosynthetic Supplier's recommendations as well as the Drawings and Specifications;
- All documentation of installation is completed including the CQA Consultant's final report.

The CQA Monitor(s) shall document that installation has proceeded in accordance with this CQAP for the project except as noted to the Design Engineer.

### 2.4.7 Materials in Contact with Geomembranes

The quality assurance procedures indicated in this Section are only intended to assess that the installation of these materials does not damage the geomembrane. Additional quality assurance procedures are necessary to determine that systems built with these materials shall be constructed in such a way to enable proper performance.

#### 2.4.7.1 Geocomposite

The CQA Monitor(s) shall document that the geocomposite is installed in accordance with the procedures described in Section 2.5, Geocomposite Construction Quality Assurance, of this CQA/QC Plan. Care shall be exercised so as not to damage the geomembrane during placement of the geocomposite.

#### 2.4.7.2 Backfilling of Anchor Trench

Anchor trenches shall be adequately drained, to prevent water accumulation or otherwise softening of the adjacent soils while the anchor trench is open.

Care shall be taken when backfilling the anchor trenches to prevent any damage to the geosynthetics. The CQA Monitor(s) shall observe the backfilling operation and advise the CQA Site Manager of any problems.

## 2.5 Geocomposite Construction Quality Assurance

### 2.5.1 Introduction

A double-sided geocomposite consisting of a geonet with geotextile bonded to both sides will be installed within the final cover system of the Sludge Lagoon as the drainage layer.

Prior to delivery, the Geocomposite Supplier shall provide to the CQA Site Manager quality control certification for the geocomposite delivered to the site confirming that the material meets the guaranteed minimum requirements of the Geocomposite Supplier. The geotextile shall be a non-woven polypropylene or polyester material. The geonet shall consist of two or more traverse strands of high density polyethylene. The geocomposite shall be free of oil, grease, and other foreign materials.

#### 2.5.1.1 Certification of Property Values

The Geocomposite Supplier shall provide the CQA Site Manager with a list of guaranteed minimum average roll values (MARV) for the type of geocomposite to be supplied. The Geosynthetics Supplier shall provide to the CQA Site Manager quality control certification for each roll of geocomposite shipped to the site confirming that each roll meets or exceeds the guaranteed minimum requirements of the Geosynthetics Supplier. The QC certifications shall contain results of the Supplier's CQC testing ensuring that the physical properties of the final product are in accordance with the Supplier's specifications and that of Table 2-5-1.

**Table 2-5-1. Double-Sided Geocomposite QA/QC Testing**

| PROPERTY | TEST METHOD | REQUIRED VALUES | MANUFACTURER QC TEST FREQUENCY | QUALITY ASSURANCE TEST FREQUENCY |
|---|---|---|---|---|
| **GEONET COMPONENT** | | | | |
| DENSITY (g/cm$^3$) (min.) | ASTM D792 or ASTM D1505 | 0.940 | See Note 2. | Every 250,000 sf |
| CARBON BLACK CONTENT (%) (min.) | ASTM D1603 | 2.0-3.5 | See Note 2. | Every 250,000 sf |
| **GEONET COMPONENT** | | | | |
| MASS PER UNIT AREA oz/sy) (min.) | ASTM D5261 | 5.0 | See Note 2. | Every 250,000 sf |
| APPARENT OPENING SIZE (Sieve) | ASTM D4751 | 70 - 140 | See Note 2. | Every 250,000 sf |
| PERMITTIVITY (sec$^{-1}$) (min.) | ASTM D4491 | 1.2 | See Note 2. | Every 250,000 sf |
| GRAB STRENGTH (3) (lbs) (min.) | ASTM D4632 | 160 | See Note 2. | Every 250,000 sf |
| TRAPEZOIDAL TEAR (3) (lbs) (min.) | ASTM D4533 | 65 | See Note 2. | Every 250,000 sf |
| PUNCTURE STRENGTH (lbs) (min.) | ASTM D4833 | 80 | See Note 2. | Every 250,000 sf |
| UV RESISTANCE (%) (min.) At 500 hours of exposure | ASTM D4355 | 70 | See Note 2. | Every 250,000 sf |
| **GEOCOMPOSITE** | | | | |
| TRANSMISSIVITY (m$^2$/sec) (min.) | ASTM D4716 | 1.06 x 10$^{-3}$ | See Note 2. | Every 50,000 sf (4) |

*Notes:*

*(1) The geonet and geotextile components of the double-sided geocomposite shall be tested separately for the above parameters.*

*(2 Testing shall be completed at the manufacturer's standard testing frequency.*

*(3) Minimum values measured in machine and cross machine direction.*

*(4) Transmissivity testing shall be performed at a gradient of 0.333, at a normal load of 400 psf, and between soil and textured geomembrane.*

Prior to use in the manufacturing of the geonet, raw material resins used in their production shall be tested by the resin manufacturer or Geosynthetics Supplier. Results of all resin testing shall conform to either the resin/geosynthetics specifications or to the specified values in Table 2-5-1, whichever is more stringent.

## 2.5.2 Shipment and Storage

### 2.5.2.1 Packaging and Labeling

The finished geocomposite shall be completely wrapped and adequately secured with a durable opaque cover in order to provide protection from ultraviolet degradation of the geotextile, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions during shipping and storage. The central core shall be accessible for handling. The geocomposite rolls shall be marked or tagged with the following information:

- Supplier's name;
- Product identification;
- Lot or batch number;
- Roll number;
- Roll weight; and
- Roll dimensions.

In addition, if any special handling of the geocomposite is required, it shall be so marked on the top surface of the geocomposite, e.g., "This Side Up." The CQA Monitor(s) shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the CQA Site Manager.

### 2.5.2.2 Transportation and Handling

Transportation of the geocomposite is the responsibility of the Geocomposite Supplier, Geosynthetics Installer, or Transporter, as directed by the Geosynthetics Installer. All handling on site is the responsibility of the Geosynthetics Installer.

The CQA Monitor(s) will confirm that:

- Handling equipment used on the site is adequate and does not damage the geocomposite; and
- The geocomposite is handled with care.

The geocomposite shall be shipped in accordance with the Geocomposite Supplier's recommendations. Upon delivery to the site, the Geosynthetics Installer and CQA Monitor(s) shall review all rolls for defects and for damage. This review shall be conducted without unrolling the rolls unless defects or damages are found or suspected. The CQA Monitor(s) shall indicate to the CQA Site Manager any rolls with minor repairable flaws and any rolls or portions of rolls which should be rejected because of severe flaws.

### 2.5.2.3 Storage

The Geosynthetic Installer is responsible for storage of the geocomposite on site. The CQA Site Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should protect the geocomposite from vandalism passage of vehicles, weather, etc.

The rolls of geocomposite shall be stored in their original, unopened, wrapped cover in a clean, dry area. The geocomposite shall be protected from mud, dirt, dust, excessive heat or cold, puncture, cutting, or other

damaging or deleterious conditions. The rolls shall not be staked more than six rolls high, due to the possibility of thinning of the product at points of contact. Any additional procedures required by the Geocomposite Supplier shall be the Geosynthetics Installer's responsibility.

## 2.5.3 Conformance Testing of Delivered Geocomposite

The Geocomposite Supplier shall remove samples of geotextile for testing by the Geosynthetics CQA Laboratory to confirm that the geotextile used in the geocomposite meets the requirements for material acceptance. The geotextile samples shall be removed before the geotextile is bonded to the geonet.

Geocomposite sampling for conformance testing may take place at the geocomposite manufacturing plant by the Geocomposite Supplier, the Geosynthetics CQA Laboratory, or a representative of the Owner or the CQA Consultant. The samples shall be forwarded to the Geosynthetics CQA Laboratory. Conversely, the CQA Consultant may retrieve geocomposite samples from material delivered to the site and forward them to the Geosynthetics CQA Laboratory for conformance testing to determine compliance with the project specifications. The CQA Consultant will document that the delivered geocomposite meets the requirements in Table 2-5-1 for material acceptance.

### 2.5.3.1 Sampling Procedures

Samples of geotextile shall be taken from the rolls of geotextile used in the geocomposite to be delivered to the site. Samples shall be taken across the entire width of the roll and shall be taken prior to the geotextile being bonded to the geonet. Samples of geocomposite shall be taken across the entire width of the roll and will not include the first three linear feet. Unless otherwise specified, all samples shall be three feet long by the roll width. The machine direction shall be marked on the samples with an arrow. Samples of geotextile and/or geocomposite shall be taken at the rates specified in Table 2-5-1.

### 2.5.3.2 Test Results

The CQA Site Manager shall examine the results from laboratory conformance testing and shall report non-conformance to the CQA Consultant.

### 2.5.3.3 Conformance Test Failure

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

- The Geosynthetics Installer shall remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must conform to the Specifications. If either of these samples fail, testing will proceed on samples from the closest numerical roll to the failed roll until rolls are located that conform to the Specifications.
- The Geosynthetics Installer shall replace the roll of geocomposite that is in non-conformance with the Specifications with a roll that meets the Specifications.

The CQA Consultant shall document actions taken in conjunction with conformance test failures.

## 2.5.4 Handling

As each geocomposite roll is moved from the storage area, the labels shall be removed by the Geosynthetics Installer and submitted to the CQA Monitor(s). The Geosynthetics Installer shall handle the geocomposite in such a manner as to minimize damage and comply with the following:

- The equipment or tools used for handling, trafficking, or other operations shall not cause damage to the geocomposite;
- Personnel working on the geocomposite shall not smoke, wear damaging shoes, or engage in activities which will cause damage to the geocomposite; and
- The equipment used to deploy the geocomposite shall not cause damage to the underlying layers.

## 2.5.5 Installation and Repair

### 2.5.5.1 Installation

The surfaces on which the geocomposite will be placed shall be free of objects that could damage the material. The CQA Monitor(s) shall visually inspect the surface prior to geocomposite installation and document the findings. The Geosynthetics Installer shall remove all materials that may potentially damage the geocomposite. Prior to and during installation, the Geosynthetics Installer shall observe the following:

- Equipment does not damage the geocomposite or underlying materials by handling, trafficking, excessive heat, leakage of machine operating fuels or oils, or other means;
- Care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system and/or stones that could damage the material. If dirt, excessive dust, and or stones are entrapped in the geocomposite, the geocomposite shall be cleaned prior to placement of material on top;
- Tying devices shall be placed every five feet along the slope, every two feet across the slope, every six inches in the anchor trench, and every 10 feet on horizontal surfaces;
- Horizontal seams on the slopes shall be staggered;
- The material overlap for butted panels on slopes shall be a minimum of two feet. The tie spacing for butted panels on the slopes shall be two rows at 12-inch spacing. Ties in the two rows shall be offset;
- Geocomposite shall be placed parallel to the slope;
- Wrinkles and "fishmouths" shall be eliminated before sewing of the top geotextile work can begin;
- All geotextile bonded to the geonet shall have a minimum of 20-inch overlap at the seams. Only the top seams shall be sewn. Sewn seams shall be "prayer" type with a double lock stitch using polymeric thread;
- The minimum geonet overlap on seams shall be four inches;
- The geonet overlaps shall be secured by tying using strings, plastic fasteners, or polymer braid. Tying devices will be of any visible color other than black for easy observation. Metallic devices are not permitted;
- If white colored geotextile is used on the geocomposite, precautions, such as sunglasses, shall be taken against "snow blindness" of personnel;
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geocomposite shall be place to prevent uplift by wind; and
- The geocomposite shall be anchored as shown on the Drawings.

The CQA Monitor(s) shall note any non-compliance and report it to the CQA Site Manager.

### 2.5.5.2 Repair

Damaged geocomposite shall be repaired by overlapping the damaged area with the same geocomposite. The damaged area shall be overlapped on all sides a minimum of six inches and secured in place with ties ever six inches around the circumference of the path.

### 2.5.6 Placement of Materials on Geocomposite

The placement of materials on the geocomposite shall be such that:

- The geocomposite is not damaged;
- Minimal slippage of the geocomposite on the underlying layer occurs;
- No excess tensile stresses occur within the geocomposite; and
- Equipment used for placing the overlying soil material will not be driven directly on the geocomposite.

Non-compliance shall be noted by the CQA Monitor(s) and reported to the CQA Site Manager.

## 2.6 Geotextile Construction Quality Assurance

### 2.6.1 Introduction

A geotextile will be installed within the aggregate outlet of the drainage layer of the final cover system. A 16-oz/sy nominal nonwoven geotextile shall be utilized. The geotextile shall be a nonwoven polypropylene or polyester material and shall be free of oil, grease and other foreign materials.

#### 2.6.1.1 Certification of Property Values

The Geotextile Manaufacturer shall provide the CQA Site Manager with a list of guaranteed minimum average roll values (MARV) for each type of geotextile to be supplied. Prior to delivery, the Geotextile Manufacturer shall provide to the CQA Site Manager quality control certification for the geotextile delivered to the site confirming that the material meets the Specifications.

The CQA Site Manager shall examine manufacturer's certifications and CQC testing results to confirm that the property values meet those specified in Table 2-6-1. Deviations shall be reported to the CQA Consultant.

### 2.6.2 Shipment and Storage

#### 2.6.2.1 Packaging and Labeling

The finished geotextile shall be completely wrapped and adequately secured with a durable opaque polyethylene protective cover in order to provide protection from ultraviolet degradation of the geotextile, precipitation, mud, dirt dust, puncture, cutting, or any other damaging or deleterious conditions during shipping and storage. The central core shall be accessible for handling. The geotextile rolls shall be marked or tagged with the following information:

- Manufacturer's name;
- Product identification;
- Lot or batch number;
- Roll number;
- Roll weight; and
- Roll dimensions.

| Table 2-6-1. Geotextile QA/QC Testing | | | | |
|---|---|---|---|---|
| **PROPERTY** | **TEST METHOD** | **REQUIRED VALUES** | **MANUFACTURER QC TEST FREQUENCY** | **QUALITY ASSURANCE TEST FREQUENCY** |
| MASS PER UNIT AREA oz/sy) (MARV(1))(min.) | ASTM D5261 | 15.0 | See Note 1. | Every 250,000 sf |
| GRAB TENSILE STRENGTH (lbs) (min.) | ASTM D4632 | 370 | See Note 1. | Every 250,000 sf |
| TRAPEZOIDAL TEAR (lbs) (min.) | ASTM D4533 | 145 | See Note 1. | Every 250,000 sf |
| PUNCTURE STRENGTH (lbs) (min.) | ASTM D4833 | 170 | See Note 1. | Every 250,000 sf |
| UV RESISTANCE (%) (min.) At 500 hours of exposure | ASTM D4355 | 70 | Certify | NA |

*Notes:*

*(1) Testing shall be completed at the manufacturer's standard testing frequency.*

The CQA Site Manager shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the CQA Consultant.

#### 2.6.2.2 Transportation and Handling

Transportation of the geotextile is the responsibility of the Geotextile Manufacturer, Geosynthetics Installer, or Transporter, as directed by the Geosynthetic Installer. All handling on site is the responsibility of the Geosynthetics Installer.

The CQA Consultant will confirm that:

- Handling equipment used on the site is adequate and does not damage the geotextile; and
- The geotextile is handled with care.

The geotextile shall be shipped in accordance with the Geotextile Manufacturer's recommendations. Upon delivery to the site, the Geosynthetics Installer and CQA Site Manager shall review all rolls for defects and for damage. This review shall be conducted without unrolling the rolls unless defects or damages are found or suspected. The CQA Site Manager shall indicate to the CQA Consultant any rolls with minor repairable flaws and any rolls or portions of rolls which should be rejected because of severe flaws.

#### 2.6.2.3 Storage

The Geosynthetic Installer shall be responsible for the storage of the geotextile on site. The CQA Site Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should protect the geotextile from vandalism, passage of vehicles, precipitation, etc. The rolls of geotextile shall be stored in their original, unopened, wrapped cover in a clean dry area. The geotextile shall be protected from mud, dirt, dust, excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The rolls shall not be stacked more than six rolls high, due to the possibility of thinning of the product at points of contact. Any additional procedures required by the Geotextile Manufacturer shall be the Geosynthetics Installer's responsibility.

### 2.6.3 Conformance Testing of Delivered Geotextile

Conformance sampling may take place at the geotextile manufacturing plant by either the Geotextile Manufacturer, Geosynthetics CQA Laboratory, a representative of the Owner, or the CQA Consultant. The samples shall then be forwarded to the Geosynthetics CQA Laboratory for testing. Conversely, the CQA consultant may retrieve geotextile samples from material delivered to the site and forward them to the Geosynthetics CQA Laboratory for conformance testing to determine compliance with the project requirements in Table 2-6-1 for material acceptance.

#### 2.6.3.1 Sampling Procedures

Samples of geotextile shall be taken from the rolls of geotextile to be delivered to the site. Samples of geotextile shall be taken across the entire width of the roll and will not include the first three linear feet. Unless otherwise specified, all samples shall be three feet long by the roll width. The machine direction shall be marked on the samples with an arrow. Samples of geotextile shall be taken at the rates specified in Table 2-6-1.

#### 2.6.3.2 Test Results

The CQA Site Manager shall examine results from laboratory conformance testing and shall report non-conformance to the Project CQA Consultant.

#### 2.6.3.3 Conformance Test Failure

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

The Geosynthetics Manufacturer or CQA Consultant shall remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must conform to the specifications. If either of these samples fail, testing will proceed on samples collected from the closest numerical roll to the failed roll until rolls are located that conform to the specifications.

The Geosynthetics Manufacturer shall replace any roll of geotextile that is in non-conformance with the specifications with a roll that meets the specifications.

The CQA Consultant shall document actions taken in conjunction with conformance test failures.

### 2.6.4 Handling and Placement

The Geosynthetics Installer shall handle geotextile in such a manner as to minimize damage to the geotextile and comply with the following:

- In the presence of wind, all geotextile will be weighted with sandbags or the equivalent.
- Geotextile will deployed in a manner to minimize the presence of wrinkles in the geotextile.
- Geotextile will be cut using an approved geotextile cutter only. If in place, special care must be taken to protect other materials from damage, which could be caused by the cutting of geotextile.
- The Geosynthetics Installer shall take necessary precautions to prevent damage to underlying layers during placement of the geotextile.
- During placement of geotextile, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the material. If dirt, excessive dust, and/or stones are entrapped in the geotextile, the geotextile shall be cleaned prior to placement of material on it.
- After installation, a visual examination of the geotextile will be carried out over the entire surface to ensure that no potentially harmful foreign objects, such as needles, are present.
- If white geotextile is used, precautions, such as sunglasses, shall be taken against "snow blindness" of personnel.

The CQA Site Manager shall note non-compliance and report it to the CQA Consultant.

### 2.6.5 Installation and Repair

#### 2.6.5.1 Installation

The surfaces on which the geotextile will be placed shall be free of objects that may damage the material. The CQA Site Manager shall visually inspect the surface prior to geotextile installation. The Geosynthetics Installer shall remove all materials that may potentially damage the geotextile. Prior to and during installation, the Geosynthetics Installer and CQA Site Manager shall observe the following:

- All geotextiles shall be continuously sewn (i.e. spot sewing is not allowed). Geotextiles shall be overlapped at a minimum of six inches prior to seaming. Thermal bonding shall be allowed only after written approval of the CQA Consultant.

- There shall be no horizontal seams on side slopes steeper than 20 percent (i.e. seams shall be along, not across, slopes steeper than 5H:1V), except as part of a patch, unless approved by the Design Engineer.
- The Geosynthetics Installer shall pay particular attention at seams to ensure that no protective cover material could be inadvertently inserted beneath the geotextile.
- Geotextile sewing shall be done using polymeric thread.
- The geotextile shall be anchored as shown on the Drawings.

The CQA Site Manager shall note any non-compliance and report it to the CQA Consultant.

#### 2.6.5.2 Repair

Any holes or tears in the geotextile shall be repaired as follows:

- On slopes steeper than 20 percent. A patch made from the same geotextile shall be seamed into place no closer than one inch from any edge. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.
- On slopes less than or equal to 20 percent. A patch made from the same geotextile shall be spot-seamed in place with a minimum overlap of 24 inches in all directions.

### 2.6.6 Placement of Materials on Geotextile

The placement of materials on geotextile shall be such that:

- The geotextile is not damaged;
- Minimal slippage of the geotextile on the underlying layer occurs;
- No excess tensile stresses occurs within the geotextile;
- Equipment used for placing the overlying soil material shall not be driven directly on the geotextile;
- A minimum thickness of one foot of soil shall be required between a low ground-pressure dozer and the geotextile;
- A minimum thickness of two feet of soil shall be required between light-weight rubber-tired vehicles and the geotextile; and
- In areas of heavy vehicle traffic, the soil thickness shall be a minimum of three feet.

Non-compliance shall be noted by the CQA Site Manager and reported to the CQA Consultant.

## 2.7 Seeding Quality Assurance

Seeding shall be performed in accordance with the provisions of the National Resources Conservation Service (NRCS) Grenada Field Office as presented in the approved Plan. Specific references to sections and tables of the NRCS standards provide the products (i.e. type of seed, fertilizer, mulch, etc.) and methodology for the Contractor to perform the required seeding activities (see Table 2-7-1).

The CQA Monitor(s) will observe and document the seeding activities including, but not limited to, the following:

- Seed, fertilizer, and mulch is delivered to the site and stored in the original, sealed, labeled, and undamaged containers;
- Grass seed: seed is fresh, clean, dry, new-crop seed in proportions by weight and minimum percentages of purity, germination, and maximum percentage of weed seed complying with the NRCS standards. Obtain the seed tags from the seeding contractor for each grass species and variety used in the seeding activities;

Table 2-7-1. Seeding Specifications

| Plant Species | Seeding Rates (Per Acre) | | Seeding Dates | Planting Depth (Inches) | Fertilizer (Minimum Rates) | Mulch (Tons per Acre |
|---|---|---|---|---|---|---|
| | Alone | Mixture[1] | | | $N-P_2O_5-K_2O$ | |
| Bahiagrass, Pensacola | 30 lbs | 20 lbs | March-May<br>Sept – Oct[3] | 1/4 | 72-72-72[6] | 2 |
| Bermudagrass | | | | | | |
| Common (Hulled) | 8 lbs | 3 lbs | March -May | 1/4 | 72-72-72 | 2[7] |
| Hybrid[2] | 25,000 | 20,000 | March- June | 2-3 | -- | -- |
| Common (unhulled) | 10 lbs | 5 lbs | Sept – Oct[4] | 1/4 | 72-72-72 | 2 |
| Tall Fescuegrass | 30 lbs | 20 lbs | Sept- Oct<br>Feb 15 – March 15[5] | 1/4 – 1/2 | 72-72-72 | 2 |

**Notes:**

1. Planned seed mixtures must include at least one perennial grass specie.
2. May include coastal, Alicia, or Tifton. 20,000 springs = 1 bushel. 1 bushel = 1.25 cubic feet. Clippings not recommended.
3. Fall seeded bahiagrass will be seeded in combination with fescue, wheat, ryegrass, or cereal rye. Use 30 lbs bahia seed per acre.
4. Fall seeding will be in combination with fescue. Use 10 lbs unhulled seed per acre.
5. For cropland practices only.
6. Apply fertilizer when grass begins to green up.
7. Apply mulch only in March. Mulch for April and May is optional.

- Fertilizer: fertilizer is a commercial-type, fresh, clean, and dry complying with the NRCS standards. Obtain the labels/product information from the seeding contractor for the fertilizer used in the seeding activities;
- Mulch: mulch is fresh, clean, dry, and free from mold, Johnson grass or other noxious weeds complying with the NRCS standards. Obtain the labels/product information from the seeding contractor for the mulch used in the seeding activities;
- Obtain the labels/product information from the seeding contractor for the water management gel, tackifier, and inoculum if used in the seeding activities;
- Seed bed preparation;
- Planting season: record dates and times when the seeding is performed; limit seeding to when existing and forecast weather conditions are suitable;
- Hydroseeding: mix (i.e. seed, fertilizer, mulch, gel, tackifier, inoculum, and water) and that mixing produces uniformly blended homogenous slurry suitable for hydraulic application. Verify that the slurry is applied to all areas to be seeded in a one-step process complying with the NRCS standards; and
- Cleanup: seeding contractor has removed surplus seed, fertilizer, mulch, and waste materials from the site.

## 2.8 Aggregate Quality Assurance

The aggregate used in the drainage layer outlet shall be non-carbonate stones meeting the requirements of the American Association of State Highway and Transportation Officials (AASHTO) No. 57 gradation or equivalent. The coarse aggregate shall not contain organics, frozen material, foreign objects, or other deleterious materials. The CQA Site Manager shall examine the CQC testing results to confirm that the property values meet those specified in Table 2-8-1.

| Table 2-8-1. Aggregate Requirements | | | | |
|---|---|---|---|---|
| COMPONENT | REQUIRED TEST | MINIMUM FREQUENCY | ACCEPTANCE CRITERIA | SAMPLE SIZE |
| COARSE AGGREGATE | Sieve Analysis (ASTM D422) | 1 per 3,000 cu.yd. | AASHTO No. 57 gradation or equivalent with not more than 5% of the material passing through the No. 200 sieve. | 50 lbs. |
| | Permeability (ASTM D2434) | 1 per 3,000 cu.yd. | Permeability ≥ 0.12 cm/sec | 50 lbs. |
| | Carbonate Content (ASTM D3042) pH=4.0 | 1 per 3,000 cu.yd. | ≤ 5% | 50 lbs. |

The CQA Monitor(s) shall observe and document the placement, grading, and compaction of the aggregate to the lines and grades as specified in the approved Plan. Obtain from the Closure Contractor weigh tickets or other documentation specifying the volume of aggregate delivered to the site provided by the aggregate supplier.

## 2.9 Erosion and Sediment Control

The Contractor will be responsible for implementation of erosion and sediment control measures that are in accordance with design plans and technical specifications. The Closure Contractor will be required to install silt fence around any soil stockpiles generated during daily activities. Silt fence shall also be installed around the Sludge Lagoon where shown on the drawings. Submittals for the erosion and sediment control materials will be in accordance with the design plans and technical specifications. The CQA Consultant will review the Contractor's submittals for compliance with the design plans and technical specifications. Erosion and sediment control measures shall not start prior to approval of the submittals.

## 2.10 Monitoring

The CQA Monitor(s) will monitor and document the construction work during Sludge Lagoon closure activities. The monitoring activities consist of the following:

- Review of test data developed by the Closure Contractor to determine the material properties, moisture content, and other physical properties of the sludge stabilization materials, the geosynthetics, soils, and seeding materials during processing, placing, compaction, and grading;
- Monitoring the thickness of soil used in backfilling and grading;
- Monitoring the action of the compaction and heavy hauling equipment during placement of the geosynthetics;
- Monitoring the number of passes used during compaction; and
- Checking for debris/objects present that may damage the geosynthetics.

Testing used to evaluate the suitability of conformance of soil materials will be carried out by the Soils Construction QA Laboratory in accordance with the design plans and technical specifications and the current versions of the corresponding American Society for Testing and Materials (ASTM) test procedures except as noted herein.

Conformance testing of soil materials obtained from on or off site borrow sources shall be performed by the Contractor and submitted to the CQA Consultant to check that the soil meets the requirements of the design

plans and technical specifications. Testing shall be performed by the Closure Contractor on the soil materials prior to placement and compaction or any relevant construction activity.

The CQA Consultant will examine test results and report any nonconformance to the Design Engineer. The Design Engineer shall accept or reject the materials based on the requirements of the design plans and technical specifications.

Field testing will also be performed on the soil materials by the Closure Contractor as required by the design plans and technical specifications. Field tests will be conducted on samples taken from the soil materials during the course of the closure work.

The sampling frequency for the field tests are outlined in the design plans and technical specifications. The CQA Consultant will examine and check test results and report any nonconformance.

# 3. DOCUMENTATION

## 3.1 Introduction

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

The CQA Site Manager will provide the CQA Managing Engineer with signed descriptive remarks, data sheets, and logs to check that monitoring activities have been carried out. The Site CQA Manager will also maintain at the Project Site a file or design plans and technical specifications, CQAP checklists, test procedures, daily logs, and other pertinent documents.

## 3.2 Surveying

Certification surveying will be performed to provide documentation for record drawings, to verify quantities of solidification/stabilization materials and soils, to verify quantities of geosynthetics, to verify that the geometric requirements of the Sludge Lagoon closure project are met, and that erosion and sediment control measures have been achieved. The Contractor will be responsible for the work and coordination with the Surveyor. The Contractor is also responsible for providing all information to the CQA Consultant.

## 3.3 Daily Recordkeeping

Standard reporting procedures will include preparation of a daily report which, at a minimum, will consist of: (a) field notes, including memoranda of meetings and/or discussions with the Contractor; (b) observation logs and testing data sheets; and (c) construction problem and solution data sheets. This information will be regularly submitted to and reviewed by the CQA Managing Engineer. Example CQA field forms used to document the field activities are provided in Appendix A.

### 3.3.1 Memoranda of Discussion with Contractor and Subcontractor

A memorandum will be prepared, as needed, summarizing discussions between the CQA Site Manager and Contractor. The memorandum will include the following information:

- Date, project name, location, and other identification;
- Names of parties to discussion;
- Relevant subject matter or issues;
- Activities planned;
- Constraints or suggestions;
- Schedule; and
- Signature of the CQA Site Manager.

### 3.3.2 Daily Observation and Testing Data Sheets

Observation reports and testing data sheets will be prepared daily. These reports and data sheets will include the following information:

- An identifying sheet number for cross-referencing and document control;
- Date, project name, location, and other identification;
- Data on weather conditions;
- A reduced-scale Site Plan showing proposed work areas and test locations (if appropriate);
- Description and locations of ongoing construction;
- Equipment and personnel in each work area, including subcontractors;
- Descriptions and specific locations of areas, or units, or work being tested and/or observed and documented;
- Locations where tests and samples were taken;
- A summary of test results;
- Calibrations or recalibrations of test equipment and actions taken as a result of recalibration;
- Off-site materials received, including quality control documentation;
- Decisions made regarding acceptance of units of work, and /or corrective actions to be taken in instances of substandard quality; and
- The CQA Site Manager or CQA Monitor(s)'s signature.

### 3.3.3 Problem Management Sheets

Sheets describing special construction situations will be cross-referenced with specific daily observation reports and testing data sheets, and must include the following information, where available:

- An identifying sheet number for cross-referencing and document control;
- A description of the situation or deficiency;
- The location and probable cause of the situation or deficiency;
- How and when the situation or deficiency was found or located;
- Documentation of the response to the situation or deficiency;
- Final results of any responses;
- Any measures taken to prevent a similar situation from occurring in the future; and
- The signature of the CQA Site Manager and/or CQA Monitor(s), and signature of the CQA Managing Engineer indicating concurrence.

The CQA Managing Engineer will be made aware of any significant recurring non-conformance with design plans and technical specifications. The CQA Managing Engineer will then assess the cause of the non-conformance and recommend appropriate changes in design and /or technical specifications. When this type of evaluation is made, the results will be documented and any revision to design and/or technical specifications will be approved by the Owner and CQA Managing Engineer.

A summary of supporting data sheets along with final testing results and the Site CQA Manager's approval of the work will be required upon completion of construction.

## 3.4 Photographic Records

Photographic reporting data sheets, where used, will be cross-referenced with daily observation reports and testing data sheets and/or construction problem and solution data sheets.

These photographs will serve as a visual record of work progress, problems and mitigation activities. The basic file will contain numbered digital photographs and a record log with the following information:

- Photograph number;
- Date taken; and
- Description of activities in the photograph.

These records will be presented to the CQA Consultant upon completion of the project.

## 3.5 Design and/or Technical Specification Deviations

Design and/or technical specifications changes may be required during the Sludge Lagoon closure implementation activities. In such cases, the CQA Site Manager will notify the CQA Consultant.

Design and/or technical specifications changes will be made only with the written agreement of the CQA Consultant, the Design Engineer, and the Owner, and will take the form of an addendum to the design and/or specifications.

## 3.6 Progress Reports

The CQA Site Manager will prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. This report will include the following information:

- A unique identifying progress report number for cross-referencing and document control;
- The date, project name, location, and other information;
- A summary of work activities during the progress reporting period;
- A summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period;
- A summary of test results, failures, and retests; and
- The signature of the CQA personnel.

## 3.7 Final Record Report of Construction

At the completion of the project work, the CQA Consultant will compile the CQA documentation and prepare a Final Sludge Lagoon Certification of Closure Report (Report). This Report will document that the work has been performed in compliance with the approved Closure Plan, the design plans and technical specifications and physical sampling and testing, except as properly authorized and implemented, and that the summary document provides the necessary supporting information.

This Report will include: (a) summaries of construction activities; (b) weekly progress reports; (c) construction problems and solutions data sheets; (d) changes from design and/or technical specifications; (e) Record Drawings; and (f) a summary statement sealed and signed by a Professional Engineer registered in the State of Mississippi. The Record Drawings will include scale drawings depicting the location of the Sludge Lagoon closure work and details pertaining to the extent of the work (e.g. depths, plan dimensions, elevations, system component construction, etc.). Surveying and base maps required for development of the Record Drawings

will be developed by the contractor's licensed land surveyor. These Record Drawings will be reviewed by the CQA Consultant and included as part of the Final Sludge Lagoon Certification of Closure Report.

## 3.8 Records Storage

Handwritten data sheet originals, especially those containing signatures, will be stored by the Owner in a safe repository. Other reports may be stored by any standard method which allows for easy access.

# APPENDIX A

## CQA Field Forms

**Daily Field Report**

BROWN AND CALDWELL

# DAILY FIELD REPORT

**Project:** Sludge Lagoon Closure

**Project No:** 131016

**Location:** Grenada, Mississippi

**BC Personnel:** _____

_____

**Date:** _____, 2008

**Weather:**

## ITEMS WORKD ON:

- ☐ Clearing and Grubbing
- ☐ Dewatering
- ☐ Sludge Solidification/Stabilization
- ☐ Subbase Construction
- ☐ Geosynthetics Installation
- ☐ Protective/Vegetative Cover Installation
- ☐ Vegetation
- ☐ Perimeter Fence, Gate, and Signs Installation
- ☐ CQA Field Testing
- ☐ Other:

## Contractor/Subcontractors/Visitors:

_____

_____

## SUMMARY OF WORK:

_____

_____

_____

_____

_____

_____

_____

_____

## ATTACHMENTS:

- ☐ Moisture/Density Test Results (i.e. Troxler data)
- ☐ CQA Field Forms
- ☐ Other: _____

_____

_____

_____

CQA Monitor Signature

Date

**Weekly Field Report**

BROWN AND CALDWELL

# WEEKLY FIELD REPORT

**Project:** Sludge Lagoon Closure
**Location:** Grenada, Mississippi

**BC Personnel:** _____

_____

**Dates:** _____ --- _____, 2008

**Weather:**

## ITEMS WORKD ON:

- ☐ Clearing and Grubbing
- ☐ Dewatering
- ☐ Sludge Solidification/Stabilization
- ☐ Subbase Construction
- ☐ Geosynthetics Installation
- ☐ Protective/Vegetative Cover Installation
- ☐ Vegetation
- ☐ Perimeter Fence, Gate, and Signs Installation
- ☐ CQA Field Testing
- ☐ Other:

## VISITORS:

_____

_____

## SUMMARY OF WORK:

_____

_____

_____

_____

_____

_____

_____

_____

## ATTACHMENTS:

- ☐ Contractor Report
- ☐ Field Notes
- ☐ Other: _____

_____

_____

_____

CQA Consultant Signature  Date

**Field Compaction Test Data**

| BROWN AND CALDWELL | ArvinMeritor - Grenada | Grenada, MS |
|---|---|---|

# Field Compaction Test Data

Project Name: Sludge Lagoon Closure
Project Number: 131016
Tested By:
Date:

Gauge Model No.
Gauge Serial No.
Standard Moisture Content _____ % Change _____
Standard Density Count _____ % Change _____

| **Test Number** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Station | | | | | | | | | | |
| Offset | | | | | | | | | | |
| Lift Number | | | | | | | | | | |
| Number of Passes | | | | | | | | | | |
| Lift Thickness, inches | | | | | | | | | | |
| **Gauge Readings** | | | | | | | | | | |
| Mode/Probe Depth (inches) | | | | | | | | | | |
| Wet Density (pcf) | | | | | | | | | | |
| Dry Density (pcf) | | | | | | | | | | |
| Moisture (%) | | | | | | | | | | |
| **Laboratory Data** | | | | | | | | | | |
| Proctor Curve No. | | | | | | | | | | |
| Max Dry Density (pcf) | | | | | | | | | | |
| Optimum Moisture (%) | | | | | | | | | | |
| **Results** | | | | | | | | | | |
| % Compaction | | | | | | | | | | |
| Pass/Fail | | | | | | | | | | |
| Retest Number/Date | | | | | | | | | | |

Comments

# Solidification/Stabilization Summary

| BROWN AND CALDWELL | ArvinMeritor Grenada | Grenada, MS |
|---|---|---|

## Solidification/Stabilization Summary

Project Name: Sludge Lagoon Closure

CQA Monitor: _____

Project Number: 13106

| Material Inventory | | Mixing | | | | | Testing | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type I Portland Cement | Lime Kiln Dust | Date | Type I Portland Cement | | Lime Kiln Dust | | Date | Time | Field | | Laboratory | |
| Received (Tons) | Received (Tons) | | Tons | Percent | Tons | Percent | | | Temperature | Penetrometer | Unconfined Compressive Strength (UCS) | Permeability |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

## Solidification/Stabilization Summary - Comments

**Geomembrane Inventory**

| BROWN AND CALDWELL | ArvinMeritor Grenada | Grenada, MS |
|---|---|---|

## Geomembrane Initial Roll Inventory

Project Name: Sludge Lagoon Closure

Project Number: 131016

Material Type: _____

CQA Monitor: _____

| Roll Number | Lot Number | Width/Length | Confirmation Sample (Yes/No) | Certificate Sheet (Yes/No) | Date Shipped to Laboratory | Pass or Fail | Visual Inspection/Remarks |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

# Geocomposite Inventory

| BROWN AND CALDWELL | ArvinMeritor Grenada | Grenada, MS |
|---|---|---|

## Geocomposite Initial Roll Inventory

Project Name: Sludge Lagoon Closure

Project Number: 131016

Material Type: _____

CQA Monitor: _____

| Roll Number | Lot Number | Width/Length | Confirmation Sample (Yes/No) | Certificate Sheet (Yes/No) | Date Shipped to Laboratory | Pass or Fail | Visual Inspection/Remarks |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**Geotextile Inventory**

# Geotextile Initial Roll Inventory

Project Name: Sludge Lagoon Closure

Project Number: 131016

Material Type: _____

CQA Monitor: _____

| Roll Number | Lot Number | Width/Length | Confirmation Sample (Yes/No) | Certificate Sheet (Yes/No) | Date Shipped to Laboratory | Pass or Fail | Visual Inspection/Remarks |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**Daily Geosytnthetics Installation Summary**

# Daily Geosynthetic Installation Summary

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Date | HDPE Geomembrane | | | Geocomposite | Geotextile | Comments |
|---|---|---|---|---|---|---|
| | Total SF Installed. | Total LF Seamed | Total No. Dest. Marked | Total SF Installed | Total SF Installed | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**Geomembrane Panel Placement Summary**

| BROWN AND CALDWELL | ArvinMeritor Grenada | Grenada, MS |
|---|---|---|

## Geomembrane Panel Placement Summary

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Panel Number | Date | Time | Roll Number | Material ID | Final Length (FT) | Width (FT) | Thickness (mils) | Overlap | Final Area, (SF) | Subbase Condition | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

# Geomembrane Trial Weld Summary

BROWN AND CALDWELL

# ArvinMeritor Grenada

Grenada, MS

## Geomembrane Trial Weld Summary

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Test No. | Date | Time | Weather (Cloudy/ Sunny) | Amb. Temp. (°F) | Welder I.D. | Machine Number | Temp. Setting/ Speed | Weld Type F/E | PEEL (ppi) | | | | | | SHEAR (ppi) | | | Test Result (P/F) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Outside Weld | | | Inside Weld | | | | | | | |
| | | | | | | | | | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |

**Geomembrane Panel Seaming Summary**

| BROWN AND CALDWELL | ArvinMeritor Grenada | Grenada, MS |
|---|---|---|

# Geomembrane Panel Seaming Summary

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Seam Number | Date Seamed | Final Seam Length (FT) | Welder ID. | Weld Type | Machine Number | Machine Temp/ Speed or Preheat | Time | | Ambient Temp. (°F) | Seam End Destructive Results | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Start | Stop | | Begin | End | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

**Geosynthetic Temperature Monitoring Log**

# Geosynthetic Temperature Monitoring Log

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Date | Time | Seam Number | Temperature | Comments |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

| Date | Time | Seam Number | Temperature | Comments |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# Geomembrane Seam Testing Summary

BROWN AND CALDWELL

ArvinMeritor Grenada

Grenada, MS

## Geomembrane Panel Seaming, Non-Destructive Air Test, and Destructive Test Summary

**Project Name:** Sludge Lagoon Closure **Project Number:** 131016 **QA/QC Monitor:** _____

**Welder ID:** _____ **Machine Number:** _____ **Trial Weld No.** | | | |

**Weld Type:** _____ **Date:** _____ **Time** | | | |

| Seaming | | | | | | Air Testing | | | | | | Destructive Testing | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Non-Destructive Airtest Results | | | | | | | | | | | |
| Seam Number | Seam Length (FT) | Cum. Seam Length (FT) | Machine Temp/ Speed or Preheat | Seam Start Time | Amb. Temp. (°F) | Date Tested Complete | Start Time | Start Press. (PSI) | End Time | End Press. (PSI) | Results (P/F) | Destruct Number | Date Sampled | Field Test Results (P/F) | Third Party Test Results (P/F) | Installer Test Results (P/F) | Comments |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |
| / | | | | | | | | | | | | | | | | | |

**Daily Total Seam Length:** _____

# Geomembrane Non-Destructive Test Summary

| BROWN AND CALDWELL | ArvinMeritor Grenada | Grenada, MS |
|---|---|---|

# Geomembrane Non-Destructive Test Summary

Project Name: Sludge Lagoon Closure

CQA Monitor: _____

Project Number: 131016

| Seam Number | Distance | Air Test | | | | | | Vacuum Test | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Air Test Date | Air Pressure | | | | Air Test Results | Vacuum Test Date | Vacuum Test Results | |
| | | | Start | | End | | | | | |
| | | | PSI | Time | PSI | Time | (P/F) | | (P/F) | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

**Geomembrane Laboratory Destructive Sample Summary**

| BROWN AND CALDWELL | ArvinMeritor Grenada | Grenada, MS |
|---|---|---|

## Geomembrane Destructive Sample Summary

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Destructive Sample Number | Seam Number | Date Seamed | Welder ID | Machine Number | Date Sampled | Date Shipped | Sample Location | | Field Test Results (P/F) | Laborartory Results (P/F) | Installers Results (P/F) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | North | East | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

# Geomembrane Field Destructive Test Summary

| BROWN AND CALDWELL | ArvinMeritor Grenada | Grenada, MS |
|---|---|---|

## Geomembrane Field Destructive Test Summary

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Destructive Sample Number | Seam Number | Date Seamed | Welder ID | Machine Number | Date Sampled | Sample Location Description | Peel (ppi) | | Shear (ppi) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Inside Track | Outside Track | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

# Geomembrane Repair Summary

BROWN AND CALDWELL

# ArvinMeritor Grenada

Grenada, MS

## Geomembrane Repair Summary

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Repair Number | Date | Time | Seam/ Panel | Operator/ Machine | Repair Location | | Description | Size of Repair | Vacuum Test Date | Vacuum Test Results (P/F) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | North | East | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

# Geocomposite Panel Placement Summary

BROWN AND CALDWELL

# ArvinMeritor Grenada

Grenada, MS

## Geocomposite Panel Placement Summary

Project Name: Sludge Lagoon Closure

Project Number: 131016

CQA Monitor: _____

| Panel Number | Date | Time | Roll Number | Material ID | Final Length (FT) | Width (FT) | Thickness (mils) | Overlap | Final Area, (SF) | Subbase Condition | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

# APPENDIX E

## Soil Erosion Calculations

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| 06/10/08 | RAI | 131016.002.002 | REW | 06/06/08 | 5 | 1 of 1 |

| Project | Subject |
|---|---|
| Grenada Sludge Lagoon Closure Plan | Soil Loss Calculation |

**OBJECTIVE:** Estimate the soil loss from the lagoon cover system.

References/Notes

**METHODOLOGY:** The Revised Universal Soil Loss Equation (RUSLE) will be used to determine the soil loss from the soil cover.

**ANALYSIS:** RUSLE, an empirical equation, utilizes several coefficients to determine soil loss due to erosion.

$$E = R*K*T*C*P$$

Where:

E = Computed Soil Loss in tons/acre/year
R = Rainfall Energy Factor (Erosivity Index)
K = Soil Erodibility Factor
T = Topographic Factor
C = Crop Management Factor
P = Conservation Practice Factor

The Rainfall Energy Factor (R) for Grenada, Mississippi is 263 [R=263]
This number is based on the location of Grenada County in MS.

*Isoerodent Map of the U.S. Predicting Rainfall Losses, AH 537, USDA*

The Soil Erodibility factor (K) for the soil cover is 0.18 [K=0.18]
This number is based on a low-sand, low organic matter fine granular soil with moderate permeability.

*Figure 3 – Soil-erodibility Nomograph. Predicting Rainfall Losses, AH 537, USDA*

The Topographic Factor (T) is [T=3.24]
This number is based on the slope length and the percent slope of the cover system. The slope Length factor (L) = 2.20 and Slope Steepness factor (S) = 1.4733
T = L*S = 3.24

*Equations 4-1 and 4-4 Predicting Rainfall Losses, AH 537, USDA*

The Crop Management Factor (C) is 0.013. [C=0.013]
This number is based on the assumption that there will be no appreciable canopy surrounding the lagoon and that the cover system will be at least 95% covered with grass or grass-like vegetation.

*Table 10 – Factor C for permanent pasture, range, and idle land. Predicting Rainfall Losses, AH 537, USDA*

The Conservation Practice Factor (P) is 0.5 [P=0.5]
The slope of the cover system is 5%. The P value for slopes between 3-5% is 0.5.

*Table 13 – P values and slope-length limits for contouring. Predicting Rainfall Losses, AH 537, USDA*

$$E = 263*0.18*3.24*0.013*0.5 = 0.997 \text{ tons/acre/year}$$

**CONCLUSION:** The 0.997 tons/acre/year of soil loss from the protective/vegetative layer component of the proposed final cover system is considerably less then the universally accepted allowable soil loss of 5.0 tons/acre/year. Therefore, the configuration of the proposed final cover system is acceptable as designed.

# APPENDIX F

## Settlement Calculations

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| 06/10/08 | RAI | 131016.002.002 | REW | 06/10/08 | 6 | 1 of 3 |

| Project | Subject |
|---|---|
| Grenada Sludge Lagoon Closure Plan | Settlement Calculation |

References/Notes

**OBJECTIVE:** To determine the maximum potential differential settlement as a result of the proposed final cover system installation.

**ANALYSIS:** The soil used to construct the subbase and the protective/vegetative component of the proposed final cover system is assumed to have a density of 130 pcf including inherent moisture. The solidified/stabilized sludge has a bulk density of 80.4 pcf, which includes the weight of residual water. The Sludge Lagoon is located above the water table and therefore, no additional moisture will affect the solidified/stabilized sludge. The moisture content of the protective/vegetative soil cover will be affected due to infiltration from rainfall, but the geocomposite component will provide a mechanism to adequately drain the infiltrated water.

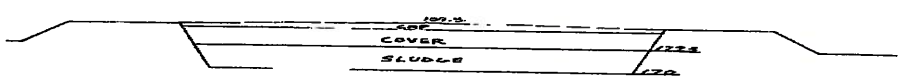
$$Settlement, S = \Sigma S_j$$

$$S_j = C_j \left[ \log\left( \frac{\overline{\sigma_0} + \Delta\sigma}{\overline{\sigma_0}} \right)_j \right] H_j$$

$$\overline{\sigma_0} = \sigma - u_w - \gamma_{mat} h_{mat} - \gamma_{water} h_{water}$$

NOTE: The Sludge Lagoon is above the water table, so $u_w$ is negligible. Also, $\gamma_{water} h_{water}$ is included in $\gamma_{mat} h_{mat}$

The Sludge Lagoon will be divided into three sections to determine the settlement, the proposed final cover system, the subbase, and the solidified/stabilized sludge.




**A. Determine the settlement in the proposed final cover system subbase:**

Assume $\gamma_{soil}$ = 130 pcf and $C_{cover}$ =0.45

$h_{cap}$=2 feet

$$\Delta\sigma = 130 pcf \times 2 ft = 260 psf$$

$$\overline{\sigma_0} = 130 pcf \times 4.1 ft = 533 psf$$

References/Notes

$$S_{cover} = 0.45\left[\log\left(\frac{533+260}{533}\right)\right]8.2$$

$$S_{cover} = 0.6367\,feet$$

NOTE: The weight of the geosynthetics (geocomposite and geomembrane) are considered negligible compared to the soil.

**B. Determine the settlement in the solidified/stabilized sludge:**

Assume $\gamma_{sludge}$ = 80.4 pcf and $C_{cover}$ =0.10

*$\gamma_{sludge}$ value from Kemron Report*

$$\Delta\sigma = 130\,pcf \times 10.2\,ft = 1326\,psf$$

$$\overline{\sigma_0} = 80.4\,pcf \times 4.65\,ft = 373.86\,psf$$

$$S_{sludge} = 0.10\left[\log\left(\frac{373.86+1326}{373.86}\right)\right]9.3$$

$$S_{sludge} = 0.6117\,feet$$

**C. Determine the maximum potential differential settlement:**

$$S = S_{cover} + S_{sludge}$$

$$S = 0.6367 + 0.6117 = 1.248\,feet$$

**CONCLUSION:** The maximum potential differential settlement as a result of the construction of the proposed final cover system is 1.248 feet. This magnitude of differential settlement is considered minimal and is not expected to adversely affect the proposed final cover system. If differential settlement occurs, the magnitude will be accessed and maintenance activities will be performed to mitigate the differential settlement affects on the proposed final cover system.

The strain on the 60-mil textured HDPE geomembrane resulting from the maximum potential differential settlement is compared to the allowable tensile strain of the 60-mil textured HDPE geomembrane.

Strain is defined by : $\varepsilon = \dfrac{\Delta l}{l_o}$

Where: $\Delta l$ = the change in length.

$\Delta l = (1.25^2 + 160^2)^{1/2} - 160 = 0.00488$ feet

$lo$ = the original length, 160-ft

References/Notes

$$\varepsilon = \frac{0.00488}{160} = 0.0000305 = 0.0031\%$$

The strain at yield for the 60-mil textured HDPE geomembrane is reported to be 13%; therefore, the 60-mil textured HDPE geomembrane is more than adequate to handle the estimated strain resulting from the maximum potential differential settlement of 1.248 feet.

# APPENDIX G

## Post-Closure Care Inspection Log

# SWMU 4 - SLUDGE LAGOON
# POST-CLOSURE CARE INSPECTION LOG
## GRENADA MANUFACTURING, LLC
## GRENADA, MISSISSIPPI

**INSPECTION DATE:** _____

| INSPECTION ITEM | OBSERVED CONDITION | | DESCRIPTION OF ISSUE | DATE RESOLVED |
|---|---|---|---|---|
| | Functioning Properly | | | |
| | Yes | No | | |
| **Surface Water Management System** | | | | |
| Run-Off Swales | | | | |
| Obstruction to flow | | | | |
| Erosion | | | | |
| Excessive siltation | | | | |
| Loose or missing riprap | | | | |
| Culverts | | | | |
| Clogging | | | | |
| Obstruction to flow | | | | |
| Corrosion/deterioration | | | | |
| **Final Cover System** | | | | |
| Erosion | | | | |
| Settlement/Subsidence | | | | |
| Adequate vegetation | | | | |
| Trees, shrubs, etc. present | | | | |
| Surface Water Accumulation | | | | |
| Mowing required | | | | |

# SWMU 4 - SLUDGE LAGOON
# POST-CLOSURE CARE INSPECTION LOG (cont.)
# GRENADA MANUFACTURING, LLC
# GRENADA, MISSISSIPPI

| INSPECTION ITEM | OBSERVED CONDITION | | DESCRIPTION OF ISSUE | DATE RESOLVED |
|---|---|---|---|---|
| | Functioning Properly | | | |
| | Yes | No | | |
| **Site Security** | | | | |
| Gates and Locks | | | | |
| Present | | | | |
| Functioning properly | | | | |
| Corrosion/deterioration | | | | |
| Damage | | | | |
| Fence | | | | |
| Section(s) missing | | | | |
| Damage | | | | |
| Corrosion/deterioration | | | | |
| Signs | | | | |
| Present | | | | |
| Lettering legible | | | | |

**Inspector's Signature** _____ **Date** _____

# APPENDIX H

## Opinion of Probable Closure Cost

| Table 3-1. Opinion of Probable Closure Cost | | | | |
|---|---|---|---|---|
| **Item** | **Unit** | **Quantity** | **Unit Price** | **Total Cost** |
| Mobilization/Demobilization | LS | 1 | $39,390 | $39,390 |
| Clearing and Grubbing | | | | |
| Vegetation | | | | |
| Cut and Chip | Acre | 2.5 | $5,250 | $13,125 |
| Clear and Grub | Acre | 2.5 | $6,925 | $17,312 |
| Total Vegetation | | | | $30,437 |
| Existing Perimeter Fence | | | | |
| Removal | LF | 1,100 | $2.92 | $3,212 |
| Dumpster | Each | 1 | $1,276 | $1,276 |
| Transportation | Each | 1 | $215 | $215 |
| Disposal | Ton | 34 | $79 | $2,686 |
| Total Perimeter Fence | | | | $7,389 |
| TOTAL CLEARING AND GRUBBING | | | | $37,826 |
| Dewatering (Free standing water) | | | | |
| Sump | CF | 256 | $2.22 | $568 |
| Pumping | Day | 10 | $193 | $1,930 |
| TOTAL DEWATERING | | | | $2,498 |
| Sludge Solidification/Stabilization | | | | |
| Mixing | | | | |
| Sumps | CF | 1,024 | $2.22 | $2,273 |
| Water Control | Day | 60 | $193 | $11,580 |
| Type I Portland Cement | Ton | 501.4 | $142.50 | $71,450 |
| Lime Kiln Dust | Ton | 1,336.9 | $67.50 | $90,241 |
| Mixing, Handling, Placement | CY | 8,239.5 | $15 | $123,593 |
| Total Mixing | | | | $299,137 |
| Grading | CY | 8,239.5 | $2.28 | $18,786 |
| TOTAL SLUDGE SOLIDIFICATION/STABLILZATION | | | | $317,923 |
| Grade Berms | CY | 1,585 | $2.75 | $4,359 |
| Subbase | | | | |
| Excavate, Load, Haul, Place, Grade, and Compact | CY | 10,570 | $11.90 | $125,783 |
| Finish Grading | SY | 10,555 | $1.39 | $14,671 |
| Dust Control | Day | 18 | $820 | $14,760 |
| TOTAL SUBBASE | | | | $155,214 |
| Final Cover System Installation | | | | |
| Geomembrane | SF | 106,550 | $0.55 | $58,603 |
| Geocomposite | SF | 106,550 | $0.45 | $47,948 |



DRAFT for review purposes only.
Use of contents on this sheet is subject to the limitations specified at the end of this document.
P:\ArvinMeritor\Grenada\Technical Review (131016)\Reports\Sludge Lagoon Closure\Opinion of Probable Closure Cost Table.doc

| Table 3-1. Opinion of Probable Closure Cost | | | | |
|---|---|---|---|---|
| **Item** | **Unit** | **Quantity** | **Unit Price** | **Total Cost** |
| Protective Material | | | | |
| Excavate, Load, Haul, Place, Grade, and Compact | CY | 5,278 | $11.90 | $62,808 |
| Finish Grading | SY | 10,555 | $1.39 | $14,671 |
| Dust Control | Day | 18 | $820 | $14,760 |
| Total Protective Material | | | | $92,239 |
| Topsoil | | | | |
| Topsoil Material, Excavation, Loading, Hauling, and Grading | CY | 1,760 | $28.71 | $50,530 |
| Finish Grading | SY | 10,555 | $1.39 | $14,670 |
| Total Topsoil | | | | $65,200 |
| TOTAL FINAL COVER SYSTEM INSTALLATION | | | | $263,990 |
| Vegetation | | | | |
| Hydroseeding (Seed Mix, Fertilizer, and Mulch) | MSF | 95 | $63 | $5,985 |
| TOTAL VEGETATION | | | | $5,985 |
| Security | | | | |
| Perimeter Fence | LF | 1,488 | $9.28 | $13,809 |
| Gate | Each | 1 | $1,325 | $1,325 |
| Signs | Each | 36 | $49.50 | $1,782 |
| TOTAL SECURITY | | | | $16,916 |
| OPINION OF PROBABLE CLOSURE COST TOTAL CAPITAL | | | | $844,101 |
| Engineering and Certification | | | | |
| Surveying | LS | 1 | $10,000 | $10,000 |
| CQA Oversight and Testing | LS | 1 | $75,000 | $75,000 |
| Closure Certification Report | LS | 1 | $25,000 | $25,000 |
| Administration @ 5% | LS | 1 | $89,188 | $42,205 |
| TOTAL ENGINEERING AND CERTIFICATION | | | | 152,205 |
| OPINION OF PROBABLE CLOSURE COST SUBTOTAL | | | | $996,306 |
| CONTINGENCY @ 15% | | | | $149,446 |
| **OPINION OF PROBABLE CLOSURE COST** | | | | **$1,145,752** |



DRAFT for review purposes only.
Use of contents on this sheet is subject to the limitations specified at the end of this document.
P:\ArvinMeritor\Grenada\Technical Review (131016)\Reports\Sludge Lagoon Closure\Opinion of Probable Closure Cost Table.doc

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.002.002 | RAI | 6-10-08 | 1 | 1 / 7 |

| Project | Subject |
|---|---|
| GRENADA SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE CLOSURE COST |

OBJECTIVE: Prepare the Opinion of Probable Closure Cost for the Sludge Lagoon

ANALYSIS: The Sludge Lagoon will be closed by installing a final cover system over the solidified/stabilized sludge material existing within the dike (berm) walls of the Sludge Lagoon. The solidification/stabilization will be accomplished by adding and mixing a prescriptive volume of reagents (Portland cement and lime kiln dust) to the existing sludge material. The solidified/stabilized sludge material will be graded to control surface water accumulation resulting from storm events as the final cover system is constructed. The Sludge Lagoon berm will be graded into the interior of the Sludge Lagoon and common borrow soil will be placed on top of the solidified/stabilized sludge material to create the subbase on which the final cover system will be constructed. The final cover system will consist of a 60-mil textured HDPE geomembrane overlain by a geocomposite with geotextile heat-bonded to each side of the geonet which will be overlain by a 24-inch layer of common borrow soil used as both a protective cover for the geosynthetics and a vegetation layer for growth of grass cover. The cost of the following components will be determined for the Opinion of Probable Closure Cost:

(A) Mobilization/Demobilization
(B) Clearing and Grubbing
  1. Vegetation
  2. Existing perimeter fence and gate(s)
(C) Dewatering
(D) Sludge Solidification/Stabilization
  1. Mixing
  2. Grading
(E) Grade Berms
(F) Common Borrow Soil - Subbase
(G) Final Cover System Installation
  1. Geomembrane
  2. Geocomposite
  3. Protective/Vegetative Material
  4. Topsoil
(H) Vegetation
(I) Security Items
  1. Perimeter Fence
  2. Gate
  3. Signs

(A) Mobilization/Demobilization

Includes personnel, equipment, facilities, erosion/sediment control

Assume 5 percent of costs exclusive of the security items

Cost - $ 787,793.21 x 0.05 = $ 39,389.66

References/Notes

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.052.002 | RAI | 6/10/08 | 1 | 2 / 7 |

| Project | Subject |
|---|---|
| GREI SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE CLOSURE COST |

(B) Clearing and Grubbing

Remove vegetation (grass, shrubs, bushes, trees, etc) including removal of stumps and root balls

Cut and chip medium (on average) trees to 12-inch diameter

Cost - $5,250/acre × 2.5 acres = $13,125

Clear and grub dense brush including stumps

Cost - $6,925/acre × 2.5 acres = $17,312.50

References/Notes: RS Means Site Work and Landscape Cost Data 2008 31-11-10.10 0200; 31-11-10.10 0260

1. TOTAL VEGETATION

| | |
|---|---|
| Cut and Chip | $13,125 |
| Clear and Grub | 17,312.50 |
| TOTAL | $30,437.50 |

Remove existing perimeter fence and gate(s)

Chain link posts and fabric 6-foot high, no barbed wire

Cost - $2.92/LF × 1,100 LF = $3,212

Disposal - assume one, 40 CY capacity dumpster - Cost $1,276 for one week

disposal fee per ton - Cost - $79

haul average for all sizes - Cost - $214.50 each

Volume: steel 490 pcf × (1100 ft × 6 ft × 0.021 ft) × ton/2000 lbs = 34 tons

Cost - $79/ton × 34 tons = $2,686

References/Notes: 02-41-13.60 1755; 02-41-19.23 0840; 02-41-19.23 0950; 02-41-19.23 0920

2. TOTAL FENCE

| | |
|---|---|
| Removal | $3,212 |
| Dumpster | 1,276 |
| Transportation | 214.50 |
| Disposal | 2,686 |
| TOTAL | $7,388.50 |

(B) TOTAL CLEARING AND GRUBBING

| | |
|---|---|
| Vegetation | $30,437.50 |
| Fence | 7,388.50 |
| TOTAL | $37,826 |

(C) Dewatering

Removal of free standing water existing on top of sludge material

Volume: 48,900 gallons

Volume based on free water present at time of field survey

Sump construction including excavation and gravel

Size - 8 ft × 8 ft × 4 ft = 256 CF

Cost - $2.22/CF × 256 CF = $568.32

References/Notes: RS Means Site Work and Landscape Cost Data 2008 31-23-19.20 1600

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.002.002 | RAI | 6/10/08 | 1 | 3 / 7 |

| Project | Subject |
|---|---|
| GRENADA SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE CLOSURE COST |

References/Notes

Pump 8 hr, attended 2hr per day, including 20LF of suction hose and 100LF of discharge hose; 4-inch diaphram pump
Cost - $193/day × 10 days = $1,930 — 31-23-19.20 0650

(C) TOTAL DEWATERING

| | |
|---|---|
| Sump | $ 568.32 |
| Pumping | 1,930.00 |
| TOTAL | $ 2,498.32 |

(D) Sludge Solidification/Stabilization

The sludge solidification/stabilization will be performed by adding and mixing the appropriate volume of reagents (Portland cement and lime kiln dust) by ratio determined in the treatability study performed by Kemron Environmental Services. A 7.5% Type I Portland cement and 20% lime kiln dust blend will be used to solidify/stabilize the sludge. The Type I Portland cement and lime kiln dust will be blended beneath a visqueen barrier over excavated sumps and mixed into the sludge material using a bucket attachment on a hydraulic excavator. No extra water is anticipated to be added due to existing water content of the sludge material. Solidified/stabilized sludge will be handled and stacked during the mixing process for placement and grading to achieve the design contours.

Sludge lagoon to be devided into 4 sections for mixing - require 4 sumps to control surface water; use cost of sumps from Item (C) of $568.32/sump
Cost - 4 sumps × $568.32/sump = $2,273.28
Pumping 8hr attended 2hr per day; 4-inch diaphram pump
Cost - $193/day × 60 days assumed to solidify/stabilize sludge = $11,580 — 31-23-19.20 0650

Solidification/Stabilization
Volume of sludge material 6,524 CY or 6,077 tons
Volume of reagents: Type I Portland cement = (6077 tons × 0.015) × 0.1 = 501.4 tons
Lime kiln dust = (6077 tons × 0.20) × 0.1 = 1336.9 tons

Cost Type I Portland cement - $115/ton material + $27.5/ton delivery × 501.4 tons = $71,449.50 — WRS compass
Lime kiln dust - $40/ton material + $27.5/ton delivery × 1336.9 tons = $90,240.75 — WRS Compass

Mixing, handling, placement - $15/CY × (6524 CY sludge + 395.1 CY Type I Portland cement + 1320.4 CY lime kiln dust) = — WRS compass
$15/CY × 8239.5 CY = $123,592.50

#1590-1/10" sq.

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.002.002 | RAI | 6/11/08 | 1 | 4 / 7 |

| Project | Subject |
|---|---|
| GREENDALE SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE CLOSURE COST |

1. TOTAL MIXING

| | |
|---|---|
| Sumps and water control | $ 13,853.28 |
| Type I Portland cement | 71,449.50 |
| Lime Kiln Dust | 90,240.75 |
| Mixing, handling, placement | 123,592.50 |
| TOTAL | $ 299,136.03 |

Grading solidified/stabilized sludge to the design contours

Dozer from existing stockpile, no compaction, 150 HP, 150 foot push, clay
Cost - $ 2.28/LCY × 8,239.5 CY = $ 18,786.06

RS Means Site Work and Landscape Cost Data 2008 31-23-23.14 3240

2. TOTAL GRADING

| | |
|---|---|
| Grade solidified/stabilized sludge | $ 18,786.06 |
| TOTAL | $ 18,786.06 |

(D) TOTAL SLUDGE SOLIDIFICATION/STABILIZATION

| | |
|---|---|
| Mixing | $ 299,136.03 |
| Grading | 18,786.06 |
| TOTAL | $ 317,922.09 |

(E) Grade Berms

Grade existing berms into the Sludge Lagoon as part of the final cover system subbase

Dozer, open site, 300 HP, 150 foot push, common earth
Cost - $ 2.75/BCY × 1585 CY = $ 4,358.75

31-23-16.46 5220

(E) TOTAL GRADE BERMS
$ 4,358.75

(F) Common Borrow Soil - Subbase

Excavate, load, transport, place, grade, and compact common borrow soil to construct the subbase upon which the final cover system will be constructed.

Cost of excavation and loading: hydraulic excavator, crawler-mounted, 3-CY
Cost - $ 1.66/BCY plus 15% for loading onto trucks = $ 1.91/BCY

31-23-16.42 0300
31-23-16.42 0020

Cost of transport (hauling): excavated loose cubic yards, 12 CY dump truck, 4 mile round trip = $ 7.45/LCY

31-23-23.18 0500

Cost of grading at the dump site, dozer - $ 1.85/LCY

31-23-23.18 1600

Cost of compaction: Sheepsfoot, 12-inch lift, 4 passes - $ 0.69

31-23-23.23 5720

TOTAL COST = $ 1.91 + $ 7.45 + $ 1.85 + $ 0.69 = $ 11.90/CY × 10,570 CY = $ 125,783.0

References/Notes

#1590 - 1/10" sq.

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | P1076.002.002 | RAI | 6/11/03 | 1 | 5 / 7 |

| Project | Subject |
|---|---|
| GRENACA SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE CLOSURE COST |

References/Notes

Cost for finish grading, fine grading - $1.39/SY × 10,554.5 SY = $14,670.75 — 31-22-16.10 1100

Cost for dust control - $820/day; assume 18 days = $14,760 — 31-23-23.18 4500

(F) TOTAL COMMON BORROW SOIL - SUBBASE

| | |
|---|---|
| Excavate, load, haul, place, grade, compact | $125,783 |
| Finish grading | 14,670.75 |
| Dust control | 14,760 |
| TOTAL | $155,213.75 |

(G) Final Cover System Installation

1. Geomembrane: 60-mil textured HDPE flexible membrane liner (FML)

Area - 95,000 SF plus anchor trench

anchor trench - 10 LF × 1155 LF = 11,550 SF

Area - 95,000 SF + 11,550 SF = 106,550 SF

Cost - $0.55/SF × 106,550 SF = $58,602.50 (includes material & installation) — American Environmental Group Ltd Brecksville, OH

2. Geocomposite: 200-mil w/8 oz/sy geotextile heat-bonded to each side

Area - 95,000 SF plus anchor trench

Area - 106,550 SF

Cost - $0.45/SF × 106,550 SF = $47,947.50 (includes material & installation) — American Environmental Group Ltd Brecksville, OH

3. Protective/Vegetative Material

Cost will be similar to the subbase cost - $11.90 CY × 5278 CY = $62,808.20

$1.39/SY × 10,554.5 SY = $14,670.75

$820/day × 18 days = $14,760.00

TOTAL $92,238.95

4. Topsoil

Topsoil material will be obtained from an off-site source within a 50 mile radius of the site.

Volume: 1759.3 CY; 6-inch thick layer use 1,760 CY

Material cost - $12.00/CY × 1,760 CY = $21,120 — RS Means Site Work and Landscape Cost Data 2008

Cost of excavation and loading - $1.91/BCY × 1760 CY = $3,361.60 — 31-23-16.42 0300

Cost of hauling: 12 CY truck, 50 MPH ave, cycle 50 miles, 15 min wait ld/Uld — 31-23-16.42 0020

Cost - $12.95/LCY × 1760 CY = $22,792 — 31-23-23.20 1114

Cost of grading at dump site, dozer - $1.85/LCY × 1760 CY = $3,256

Cost of finish grading, fine grading - $1.39/SY × 10,554.5 SY = $14,670.75

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.002.002 | EAI | 6/11/08 | 1 | 6 / 7 |

| Project | Subject |
|---|---|
| GRENADA SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE CLOSURE COST |

References/Notes

Total Cost of Topsoil

| | |
|---|---|
| Material | $21,120 |
| Excavation and loading | 3,361.60 |
| Hauling | 22,792 |
| Grading | 3,256 |
| Finish grading | 14,670.75 |
| TOTAL | $65,200.35 |

(G) TOTAL FINAL COVER SYSTEM INSTALLATION

| | |
|---|---|
| Geomembrane | $58,602.50 |
| Geocomposite | 47,947.50 |
| Protective/Vegetative Material | 92,238.95 |
| Topsoil | 65,200.35 |
| TOTAL | $263,989.30 |

(H) Vegetation

Plant seed mix including lime, fertilizer, and mulch in accordance with NRCS, Mississippi - Seeding Specifications

Use hydroseeding, Fescue, tall - @ 63/MSF x (95000 SF/1000) = $5,985 — 32-92-19.14 2400

(H') TOTAL VEGETATION

| | |
|---|---|
| Hydroseeding | $5,985 |
| TOTAL | $5,985 |

(I) SECURITY ITEMS

Perimeter Fence: chain-link industrial; 3-strand barb wire, 2-inch posts at 10-foot OC set in concrete, 6-feet, 6 gauge, aluminized steel

Cost - $9.28/LF x 1488 LF = $13,808.64 — Clark Fence and Awning, Greenwood, MS

Gate: double-swing gates including posts and hardware, in concrete 6-foot, 12-foot opening

Cost - @ 1,325 — 32-31-13.20 5060

Signs: Exterior signs, letters 6-inches high, 5/8-inch deep cast aluminum

Number - 1 per 50 feet: 1000 LF / 50 LF = 36 signs

Cost - $49.50 x 36 signs = $1,782 — 10-14-19.10 0300

(I) TOTAL SECURITY ITEMS

| | |
|---|---|
| Perimeter Fence | $13,808.64 |
| Gate | 1,325 |
| Signs | 1,782 |
| TOTAL | $16,915.64 |

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.002.002 | RAT | 6/11/08 | 1 | 7 / 7 |

| Project | Subject |
|---|---|
| GREEN SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE CLOSURE COST |

References/Notes

OPINION OF PROBABLE CLOSURE COST TOTAL

| | | |
|---|---|---|
| (A) | Mobilization / Demobilization | $ 39,389.66 |
| (B) | Clearing and Grubbing | 37,826.00 |
| (C) | Demolition | 2,498.32 |
| (D) | Sludge Solidification / Stabilization | 317,922.09 |
| (E) | Grade Berms | 4,358.75 |
| (F) | Common Borrow Soil - Subbase | 155,213.75 |
| (G) | Final Cover System Installation | 263,989.30 |
| (H) | Vegetation | 5,985.00 |
| (I) | Security Items | 16,915.64 |
| | TOTAL | $ 844,098.51 |

ENGINEERING AND CERTIFICATION

| | |
|---|---|
| Surveying | $ 10,000.00 |
| CQA Oversight and Testing | 75,000.00 |
| Closure Certification Report | 25,000.00 |
| Administration @ 5% | 42,204.93 |
| TOTAL | $ 152,204.93 |

| | |
|---|---|
| SUBTOTAL | $ 996,303.44 |
| CONTINGENCY @ 15% | $ 149,445.52 |

TOTAL OPINION OF PROBABLE CLOSURE COST $1,145,748.96 use $1,145,750

# APPENDIX I

## Opinion of Probable Post-Closure Care Cost

| Table 3-2. Opinion of Probable Post-Closure Care Cost | | | | |
|---|---|---|---|---|
| **Item** | **Unit** | **Quantity** | **Unit Price** | **Total Cost** |
| Surface Water Management System | Year | 30 | $500 | $15,000 |
| Final Cover System | | | | |
| Erosion Maintenance | Year | 30 | $2,343 | $70,290 |
| Repair/Replacement | Year | 30 | $6,580 | $197,400 |
| Revegetation | Year | 30 | $1,575 | $47,250 |
| Vegetation Maintenance | Year | 30 | $600 | $18,000 |
| Total Final Cover System | | | | $332,940 |
| Inspections | Year | 60 | $125 | $7,500 |
| Site Security | | | | |
| Perimeter Fence | LF | 200 | $9.28 | $1,856 |
| Gate | Each | 1 | $1,325 | $1,325 |
| Signs | Each | 10 | $49.50 | $495 |
| Total Site Security | | | | $3,676 |
| Certification of Post-Closure Care | | | | $25,000 |
| Subtotal Opinion of Probable Post-Closure Care Cost | | | | $384,116 |
| Contingency @ 15% | | | | $57,617 |
| **OPINION OF PROBABLE POST-CLOSURE CARE** | | | | **$441,733** |
| **TOTAL PRESENT WORTH (6.0%; Present Worth Factor – 0.1741; 30-Year Period)** | | | | **$76,906** |

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.02.02 | RAI | 6/12/08 | 2 | 1 / 4 |

| Project | Subject |
|---|---|
| GRENADA SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE POST-CLOSURE CARE COST |

OBJECTIVE: Prepare the Opinion of Probable Post-Closure Care Cost for the former Sludge Lagoon

ANALYSIS: The post-closure care period will extend for 30 years following the acceptance by the U.S EPA of the Sludge Lagoon closure. The Opinion of Probable Post-Closure Care Cost will be determined for the entire 30 year period and the present worth of the cost will be determined using the Present Worth Factor over a 30 year period at 6.0 percent. The cost of the following components will be determined for the Opinion of Probable Post-Closure Care:

(A) Surface Water Management System
(B) Final Cover System
1. Erosion Maintenance
2. Repair/Replacement
3. Revegetation
4. Vegetation Maintenance
(C) Inspections
1. Biyearly to coincide w/ the Site groundwater monitoring program
(D) Site security
1. Perimeter Fence
2. Gate
3. Signs

(A) Surface Water Management System

This will involve removing potential obstruction and areas where excessive siltation may occur. Assume that this will occur once per year for 30 years. Work can be performed using hand tools and no equipment will be necessary. Use Crew A-3A: 1 truck driver, 1 pickup truck 4x4, 3/4 ton

Cost - $62.19/hr x 8 hrs = $497.52 use $500

Cost - $500/year x 30 years = $15,000

(A) TOTAL SURFACE WATER MANAGEMENT SYSTEM

$15,000

(B) Final Cover System

Erosion maintenance: assume one time per year for 30 years; furnish soil material from an onsite source to include excavation, loading, transport, place, and grade; assume 200 CY of soil material is required

Excavation and load: Cost - $1.66/CY plus 15% to load = $1.91/CY x 200 CY = $382

Transport: Cost - $7.45/CY x 200 CY = $1,490

Grading: Cost - $1.85/CY x 200 CY = $370

Vegetation: plant seed mix including fertilizer and mulch
Use hydroseeding, Tall Fescue - $63/MSF x 1.6 MSF = $100.80

References/Notes

RS Means Site Work and Landscape Cost Data 2008, Crew A-3A

31-23-16.42 0300
31-23-16.42 0020
31-23-23.18 0500
31-23-23.18 1600
32-92-19.14 2400

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 13016.002.002 | RAI | 6/12/08 | 2 | 2 / 4 |

| Project | Subject |
|---|---|
| GRENADA SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE POST-CLOSURE CARE COST |

1. Total Erosion Maintenance

| | |
|---|---|
| Excavation and load | $382 |
| Transport | 1,490 |
| Grading | 370 |
| Vegetation | 101 |
| TOTAL | $2,343 each occurance |

TOTAL - $2,343/year x 30 years = $70,290

Repair/Replacement: Maximum potential differential settlement calculations indicate a settlement of 1.25 feet. Assume one repair/replacement per year for a period of 30 years. The geosynthetic components of the final cover system will not be compromised. Assume 500 CY of soil material required.

Earthwork cost to be the same as "Erosion Maintenance" with compaction
Compaction cost plus earthwork cost - ($0.69/CY + $11.21/CY) x 500 CY = $5,950 — 31-23-23.23 5720

Vegetation cost to be the same as "Erosion Maintenance" - $63/MSF x 10 MSF = $630

2. Total Repair/Replacement

| | |
|---|---|
| Earthwork | $5,950 |
| Vegetation | 630 |
| TOTAL | $6,580 each occurance |

TOTAL - $6,580/year x 30 years = $197,400

Revegetation: assume that areas of the final cover system surface require periodic revegetation; typical surface area of 50 ft x 50 ft = 2500 SF
Cost - $63/MSF x (2500 SF/1000) = $1,575 per occurance

3. Total Revegetation

TOTAL - $1575/year x 30 years = $47,250

Vegetation Maintenance: assume grass cover mowing twice per year - once in the spring and once in the fall: 2 mowing/year x 30 years = 60
Cost - $300 per mowing event — Promo Lawn Care Grenada, MS

4. Total Vegetation Maintenance

TOTAL - $300 x 2 = $600/year x 30 years = $18,000

(B) TOTAL FINAL COVER SYSTEM

| | |
|---|---|
| 1. Erosion Maintenance | $70,290 |
| 2. Repair/Replacement | 197,400 |
| 3. Revegetation | 47,250 |
| 4. Vegetation Maintenance | 18,000 |
| TOTAL | $332,940 |

References/Notes

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.002.002 | CAI | 6/12/08 | 2 | 3 / 4 |

| Project | Subject |
|---|---|
| GRENADA SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE POST-CLOSURE CARE COST |

References/Notes

(C) INSPECTIONS

Perform inspections of the closed form - Sludge Lagoon twice per year to coincide w/ the Site groundwater monitoring program. Assume inspections can be performed in 2 hours. Use Crew A-3A

Cost - $62.19/hr × 2 hours = $124.38 Use $125 per inspection — Crew A-3A

Total - $125/inspection × 2 inspections/year × 30 years = $7,500

(C) TOTAL INSPECTIONS

$7,500

(D) Site Security

Assume at some point during the 30 year post-closure care period that sections of the perimeter fence, gate, and signs will need to be repaired and replaced.

Perimeter Fence: assume that over the 30 year post-closure care period that 200 LF of fence will be replaced

Cost - $9.28/LF × 200 LF = $1,856 — Clark Fence and Awning, Greenwood, MS

Gate: assume that the access gate will need to be replaced one time during the 30 year post-closure care period

Cost 6-foot, 12-foot wide double-swing gate - $1,325 — 32-31-13.20 5060

Signs: assume that over the 30 year post-closure care period that 10 signs will need to be replaced, Cost - $49.50 × 10 signs = $495 — 10-14-19.10 0300

(D) TOTAL SITE SECURITY

| | |
|---|---|
| 1. Perimeter Fence | $1,856 |
| 2. Gate | 1,325 |
| 3. Signs | 495 |
| TOTAL | $3,676 |

SUBTOTAL OPINION OF PROBABLE POST-CLOSURE CARE COST

| | | |
|---|---|---|
| A | SURFACE WATER MANAGEMENT SYSTEM | $15,000 |
| B | FINAL COVER SYSTEM | 332,940 |
| C | INSPECTIONS | 7,500 |
| D | SITE SECURITY | 3,676 |
| | TOTAL | $359,116 |

Certification of Post Closure Care

At the end of the 30-year post-closure care period, a Post-Closure Care Certification Report will be prepared for submittal to the U.S. EPA

Cost - $25,000

BROWN AND CALDWELL

| Date Checked | Checked By | Job Number | By | Date | Calc. No. | Sheet No. |
|---|---|---|---|---|---|---|
| | | 131016.002.002 | RAI | 6/12/08 | 2 | 4 / 4 |

| Project | Subject |
|---|---|
| GRENADA SLUDGE LAGOON CLOSURE PLAN | OPINION OF PROBABLE POST-CLOSURE CARE COST |

SUBTOTAL $359,116
25,000
$384,116

Contingency @ 15% = $57,617.4

OPINION OF PROBABLE POST-CLOSURE CARE COST TOTAL = $441,733.4

Present Worth Calculation

Determine the present worth of $984,763 at 6% interest over 30 years

$441,733.4 X 0.1741 = $76,905.79 use 76,906

References/Notes

Table D.11; "Economic Decision Analysis"; Fabrycky and Thuesen 1974.

# APPENDIX J

## Financial Assurance Mechanism

TEXTRON

Textron Inc.
40 Westminster St.
Providence, RI 02903

Tel: (401) 421-2800

2008 APR -2 A 11:56

RESTORATION & UNDERGROUND
STORAGE TANK BRANCH

March 31, 2008

2007 Annual Report was attached to original.

**VIA OVERNIGHT COURIER**

Chief, Restoration and Underground Storage Tanks Branch
RCRA Division
U.S. Environmental Protection Agency
61 Forsyth Street, S.W.
Atlanta, GA 30303-3104Executive Director

**Re: Financial Responsibility Requirements for Closure and Post Closure Care of Treatment Storage and Disposal Facilities**

Dear Chief:

Textron Inc., located in Providence, Rhode Island, is the owner and operator of a facility located in Grenada, Mississippi which is subject to regulations applicable to owners and operators of Hazardous Waste Treatment, Storage and Disposal Facilities.

In compliance with MHWMR Part 265, as respects closure and post-closure inflation adjusted cost estimates and updated financial information, respectively, Textron encloses the following:

1. A letter dated March 31, 2008 from the Chief Financial Officer of Textron Inc., as specified in the aforementioned;

2. A copy of the 2007 Annual Report of Textron Inc. containing a report by Ernst & Young on Textron's financial statements for the fiscal year ended December 29, 2007: and

3. A letter from Ernst & Young that verifies the financial information contained in the letter referred to in Paragraph 1 above.

Please do not hesitate to call me should you have any questions or concerns with respect to any of the above. My direct line is (401) 457-6023.

Sincerely,

Maureen Flaherty

Maureen Flaherty
Environmental Health & Safety Accounting Analyst

DEQLTRS Enclosures

cc: Ernst & Young (w/enclosures)

10532946

c:\finrs08\randcov.doc

**TEXTRON**

Textron Inc.
40 Westminster St.
Providence, RI 02903

Tel: (401) 421-2800

2008 APR -2 A 11:56

RESTORATION & UNDERGROUND
STORAGE TANK BRANCH

March 31, 2008

Chief, Restoration and Underground Storage Tanks Branch
RCRA Division
U.S. Environmental Protection Agency
61 Forsyth Street, S.W.
Atlanta, GA 30303-3104

**RE: Financial Assurance Requirements Demonstrating Financial Responsibility for Liability Coverage and Closure Care**

Dear Chief;

I am the Chief Financial Officer of Textron Inc., 40 Westminster Street, Providence, Rhode Island 02903. This letter is in support of the use of the financial test to demonstrate financial responsibility for liability coverage and closure and/or post-closure care as specified in Subpart H of 40 CFR Parts 264 and 265.

The firm identified above is the owner or operator or is financially responsible for the following facilities for which liability coverage for both sudden and non-sudden accidental occurrences is being demonstrated through the financial test specified in Subpart H of 40 CFR Parts 264 and 265: **Textron Inc. (Randall - RCRA) 635 Highway #332, Grenada, MS 38901; EPA #MSD007037278**

The firm identified above guarantees, through the guarantee specified in Subpart H of 40 CFR Parts 264 and 265, liability coverage for both sudden and non-sudden accidental occurrences at the following facilities owned or operated by the following: **None**

1. The firm identified above owns or operates or is financially responsible for the following facilities which are in the State of Mississippi for which financial assurance for closure and/or post-closure care is demonstrated through the financial test specified in Subpart H of 40 CFR Parts 264 and 265. The current closure and/or post-closure cost estimates covered by the test are shown for each facility. **Textron Inc. (Randall - RCRA) 635 Highway #332, Grenada, MS 38901; EPA #MSD007037278. Closure $6,386,270; Post-closure $2,529,450**

2. The firm identified above guarantees, through the corporate guarantee specified in Subpart H of 40 CFR Parts 264 and 265, the closure and post-closure care or liability coverage of the following facilities owned or operated by the guaranteed party. The current cost estimates for the closure or post-closure care so guaranteed are shown for each facility: **None**

3. In states where EPA is not administering the financial requirements of Subpart H of 40 CFR Parts 264 and 265, this firm is demonstrating financial assurance for the closure or post-closure care of the following facilities through the use of a test equivalent or substantially equivalent to the financial test specified in Subpart H of 40 CFR Parts 264 and 265. The current closure and/or post-closure cost estimates covered by such a test or guarantee are shown for each facility: **See Exhibit A**

4. The firm identified above owns or operates the following hazardous waste management facilities for which financial assurance for closure, or if a disposal facility, for post-closure care, is not demonstrated either to EPA or a State through the financial test or any other financial assurance mechanism specified in Subpart H of 40 CFR Parts 264 and 265, or equivalent or substantially equivalent State mechanism. The current closure and/or post-closure cost estimates not covered by such financial assurance are shown for each facility: **None**

5. This firm is the owner or operator of the following UIC facilities for which financial assurance for plugging and abandonment is required under Part 144 and is assured through a financial test. The current closure cost estimates as required by 40 CFR 144.62 are shown for each facility: **None**

The firm is required to file a Form 10K with the Securities and Exchange Commission (SEC) for the latest fiscal year.

The fiscal year of this firm ends on the Saturday nearest to the thirty-first day of December in each year, whether such Saturday falls in December or in January. The figures for the following items marked with an asterisk are derived from this firm's independently audited, year-end financial statements for the latest completed fiscal year ended December 29, 2007.

## ALTERNATIVE II

| | | |
|---|---|---|
| 1. | Sum of current closure and post-closure estimates (total of all cost estimates listed above) | $ 18,135,670 |
| 2. | Amounts of annual aggregate liability coverage to be demonstrated | $ 8,000,000 |
| 3. | Sum of lines 1 and 2 | $ 26,135,670 |
| 4. | Current bond rating of most recent issuance and name of rating service | A-; Standard & Poor's |
| 5. | Date of issuance of bond | November 29, 2007 |
| 6. | Date of maturity of bond | December 1, 2017 |
| *7. | Tangible net worth (if any portion of the closure or post-closure cost estimates is included in "total liabilities" on your financial statements you may add that portion to this line) | $ 694,000,000 |
| *8. | Total assets in the U.S. (required only if less than 90% of assets are located in the U.S.) | $17,799,000,000 |
| 9. | Is line 7 at least $10 million? | Yes |
| 10. | Is line 7 at least 6 times line 3? | Yes |
| *11. | Are at least 90% of assets located in the U.S.? If not, complete line 12. | No |
| 12. | Is line 8 at least 6 times line 3? | Yes |

I hereby certify that the wording of this letter is identical to the wording specified in 40 CFR Section 264.151(g), as such regulations were constituted on the date shown immediately below.

By: _____
Name: Ted R. French
Title: Executive Vice President and Chief Financial Officer
Date: March 31, 2008

## Exhibit A

| | Location | EPA# | Closure Costs | Post-closure Costs |
|---|---|---|---|---|
| Former Deere/Gastonia Plant | Little Mountain Road Gastonia, NC 28052 | NCD091249417 | $ -- | $4,184,839 |
| Textron Realty Operations (formerly Textron Defense Systems) | 2221 Niagara Falls Boulevard Wheatfield, NY 14304 | NYD002106276 | $ -- | $1,673,827 |
| Former Cessna Aircraft Facility, ARC Division | 429 Rockaway Valley Rd. Boonton, NJ 07005 | NJD002155448 | $ -- | $2,671,284 |
| Textron Inc. (formerly Randall Grenada) | Grenada Highway #332 East Route 2 Grenada, MS 38901 | MSD007037278 | $ -- | $690,000 |

| Grenada Manufacturing Facility – Corrective Measure Cost Estimates for Financial Assurance Calculations | |
|---|---|
| Site-Wide Activities* | $2,529,450 |
| Sludge Lagoon Closure | $651,900 |
| Sheet Pile Barrier | $1,190,700 |
| PRB** | $648,300 |
| Improved NAPL Recovery | $1,645,370 |
| Multi-Phase High Vacuum Extraction | $2,250,000 |
| **TOTAL*** ** | $8,915,720 |

*Comprises site-wide monitoring, including indoor air monitoring, surface water, groundwater, and sediment monitoring; implementation of deed restrictions and institutional controls; and fencing.

**Cost includes 10- and 20-year rejuvenation of PRB.

***All costs calculated based on 30 year present worth estimates using a 5% rate of interest.

# Report of Independent Registered Public Accounting Firm

To the Board of Directors
Textron Inc.

We have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States), the Consolidated Balance Sheet of Textron Inc. as of December 29, 2007 and December 30, 2006, and the related Consolidated Statements of Operations, Shareholders' Equity, and Cash Flows for each of the three years in the period ended December 29, 2007, and have issued our unqualified opinion thereon dated February 13, 2008, expect for, as discussed in Note 5 to the Consolidated Financial Statements, in 2007 Textron Inc. adopted Financial Accounting Standard Board ("FASB") Staff Position No. 13-2, "Accounting for a Change or Projected Change in the Timing of Cash Flows Relating to Income Taxes Generated by a Leverage Lease Transaction," as discussed in Note 13 to the Consolidated Financial Statements, in 2007 Textron Inc. adopted FASB Interpretation No. 48, "Accounting for Uncertainty in Income Taxes an Interpretation of FASB Statement No. 109," and as discussed in Note 1 to the Consolidated Financial Statements, in 2006 Textron Inc. adopted Statement of Financial Accounting Standards No. 158, "Employers' Accounting for Defined Benefit Pension and Other Postretirement Plans - An amendment of FASB Statement Nos. 87, 88, 106, and 132(R)."

Mr. Ted R. French's letter dated March 31, 2008, in support of the use of the financial test, as specified in Subpart H of 40 CFR Parts 264 and 265, to demonstrate financial responsibility for liability coverage and closure and/or post-closure care of the Company's hazardous waste facilities, for the locations listed in the letter, is addressed to the Chief, Restoration and Underground Storage Tanks Branch, RCRA Division, of the U.S. Environmental Protection Agency.

In connection with our audit and in accordance with Subpart H of 40 CFR Parts 264 and 265, we compared the dollar amounts in the section entitled "Alternative II", line items 7, and 8, of the March 31, 2008 letter mentioned above, to the amounts in the audited consolidated financial statements described in the introductory paragraph of this letter included in the Company's annual report to shareholders for the fiscal year ended December 29, 2007, to the extent such amounts are included in or can be derived from such statements and found them to be in agreement.

This report is intended solely for your information and use, and for the use of the Chief, RCRA Programs Branch, Waste Management Division, of the U.S. Environmental Protection Agency, Region 4, and is not intended to be and should not be used by anyone other than these specified parties.

Ernst + Young LLP

March 31, 2008

# REFERENCES


Brown and Caldwell, 2003. *Corrective Measures Study, Grenada Manufacturing, LLC, Grenada, Mississippi, EPA ID No. MSD 007 037 278*, Brown and Caldwell, August 2003.

Brown and Caldwell, 2006. *Corrective Measures Pre-Design Activities Work Plan, Grenada Manufacturing, LLC, Grenada, Mississippi*, Brown and Caldwell, July 2006.

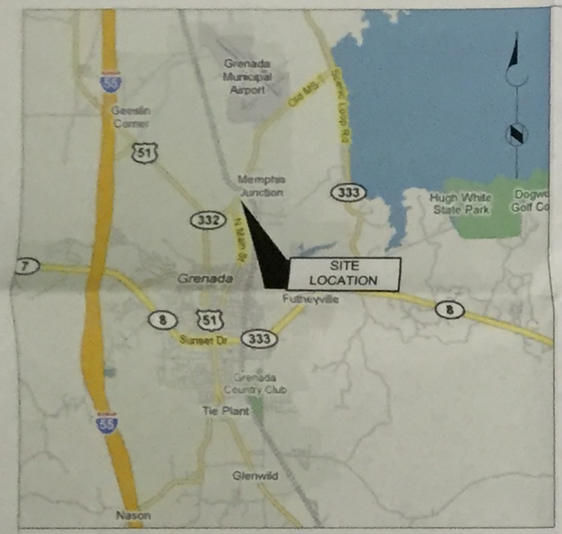
Brown and Caldwell, 2008. *Corrective Measures Pre-Design Investigation Results for the Grenada Manufacturing Facility Site, Grenada, Mississippi*, Brown and Caldwell, February 21, 2008.

Code of Federal Regulations, Title 40. *Part 264 – Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Subchapter 1 – Solid Wastes, Chapter 1 – Environmental Protection Agency (Parts 239-299), Title 40 – Protection of Environment*, as amended.

Mississippi Commission on Environmental Quality, April 28, 2005. *Regulation SW-2: Nonhazardous Solid Waste Management Regulations & Criteria.*

NRCS, Mississippi, 2000. *Seeding Specifications*, NRCS Grenada Field Office, January 2000.

U.S. EPA, 2005. *HSWA Portion of the RCRA Permit*, U.S. EPA December 23, 2005.




SOURCE: GOOGLE MAPS

LOCATION MAP

# SOLID WASTE MANAGEMENT UNIT 4 - SLUDGE LAGOON CLOSURE AND POST-CLOSURE CARE PLAN

## GRENADA MANUFACTURING, LLC

GRENADA, MISSISSIPPI

JULY 2008

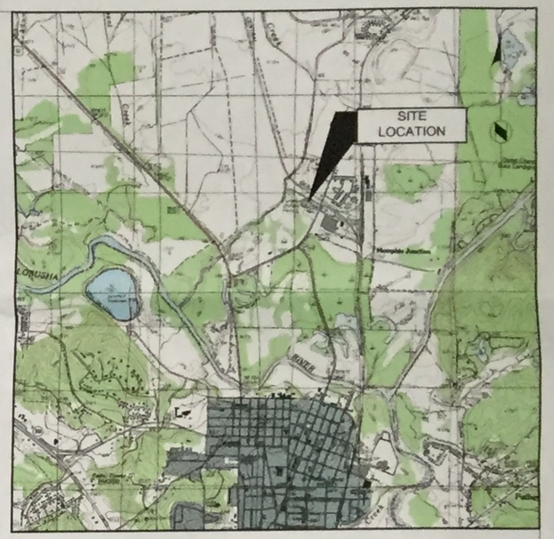
PREPARED FOR

ArvinMeritor

TROY, MICHIGAN

PREPARED BY

BROWN AND CALDWELL



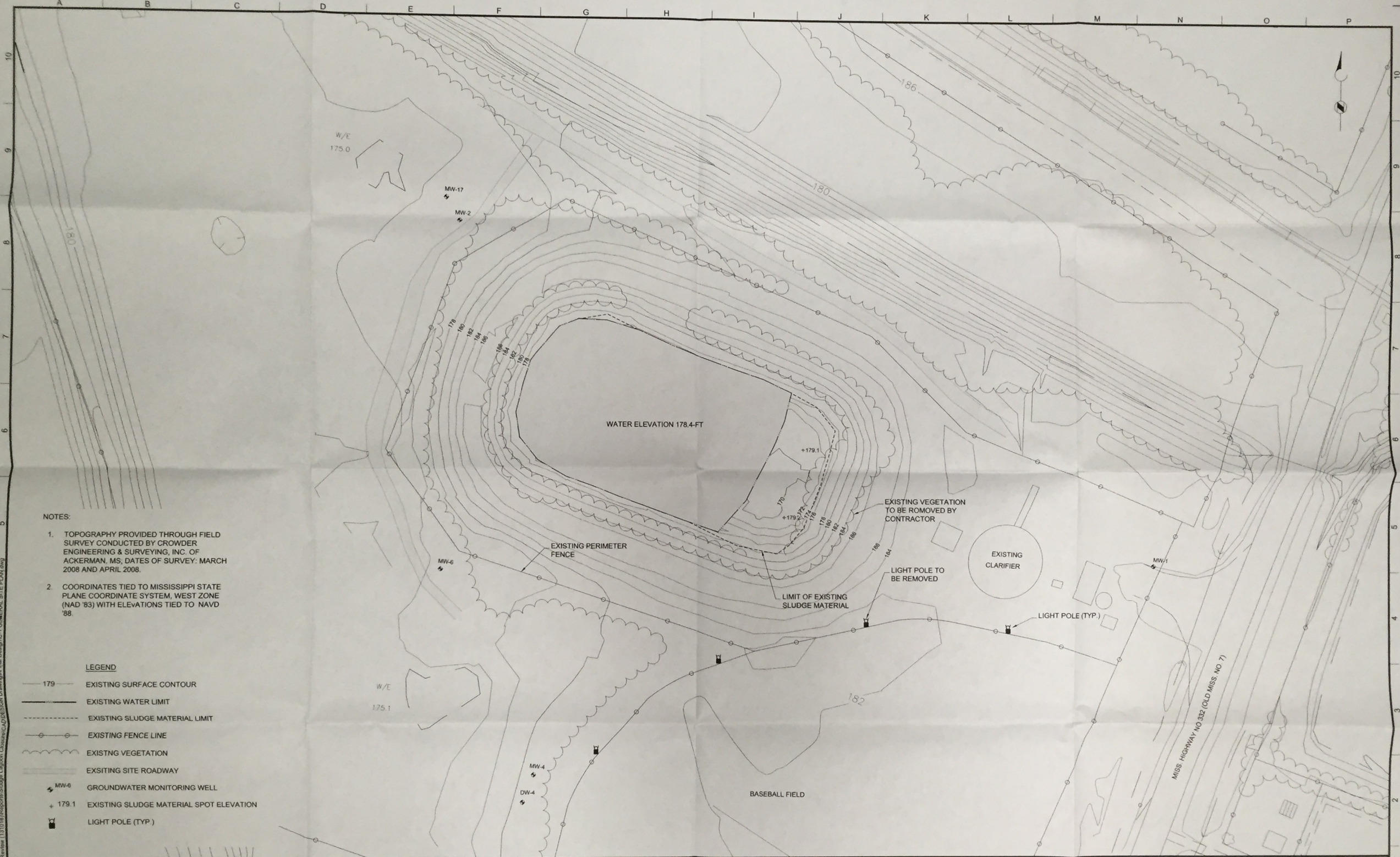

SOURCE: GRENADA QUADRANGLE, MISSISSIPPI, 7.5-MINUTE SERIES
PROVISIONAL EDITION 1983
SCALE: 1" = 2500'

VICINITY MAP

BROWN AND CALDWELL
4700 LAKEHURST COURT, SUITE 100
DUBLIN, OHIO

## LIST OF DRAWINGS


| DRAWING | TITLE |
|---|---|
| | COVER SHEET |
| C-1 | GENERAL SITE PLAN |
| C-2 | SLUDGE MATERIAL PLAN AND SECTIONS |
| C-3 | STABILIZED SLUDGE PLAN AND SECTIONS |
| C-4 | SUBBASE GRADING PLAN AND SECTIONS |
| C-5 | FINAL GRADING PLAN AND SECTIONS |
| C-6 | STORM WATER MANAGEMENT PLAN |
| C-7 | DETAILS |




NOTES:

1. TOPOGRAPHY PROVIDED THROUGH FIELD SURVEY CONDUCTED BY CROWDER ENGINEERING & SURVEYING, INC. OF ACKERMAN, MS, DATES OF SURVEY: MARCH 2008 AND APRIL 2008.
2. COORDINATES TIED TO MISSISSIPPI STATE PLANE COORDINATE SYSTEM, WEST ZONE (NAD '83) WITH ELEVATIONS TIED TO NAVD '88.

LEGEND

- 179 — EXISTING SURFACE CONTOUR
- EXISTING WATER LIMIT
- EXISTING SLUDGE MATERIAL LIMIT
- EXISTING FENCE LINE
- EXISTNG VEGETATION
- EXSITING SITE ROADWAY
- MW-6 — GROUNDWATER MONITORING WELL
- 179.1 — EXISTING SLUDGE MATERIAL SPOT ELEVATION
- LIGHT POLE (TYP.)

BROWN AND CALDWELL
COLUMBUS, OHIO

SUBMITTED: _____ DATE: _____
PROJECT MANAGER
APPROVED: _____ DATE: _____
BROWN AND CALDWELL

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED: EGM
DRAWN: EGM
CHECKED: RAI
CHECKED:
APPROVED: RAI

EXTERNAL REFERENCES: cover.dwg; Pre-Construction BlueMap02.dwg

IMAGE REFERENCES: FILE0000.tif; Lagoon Borings.tif

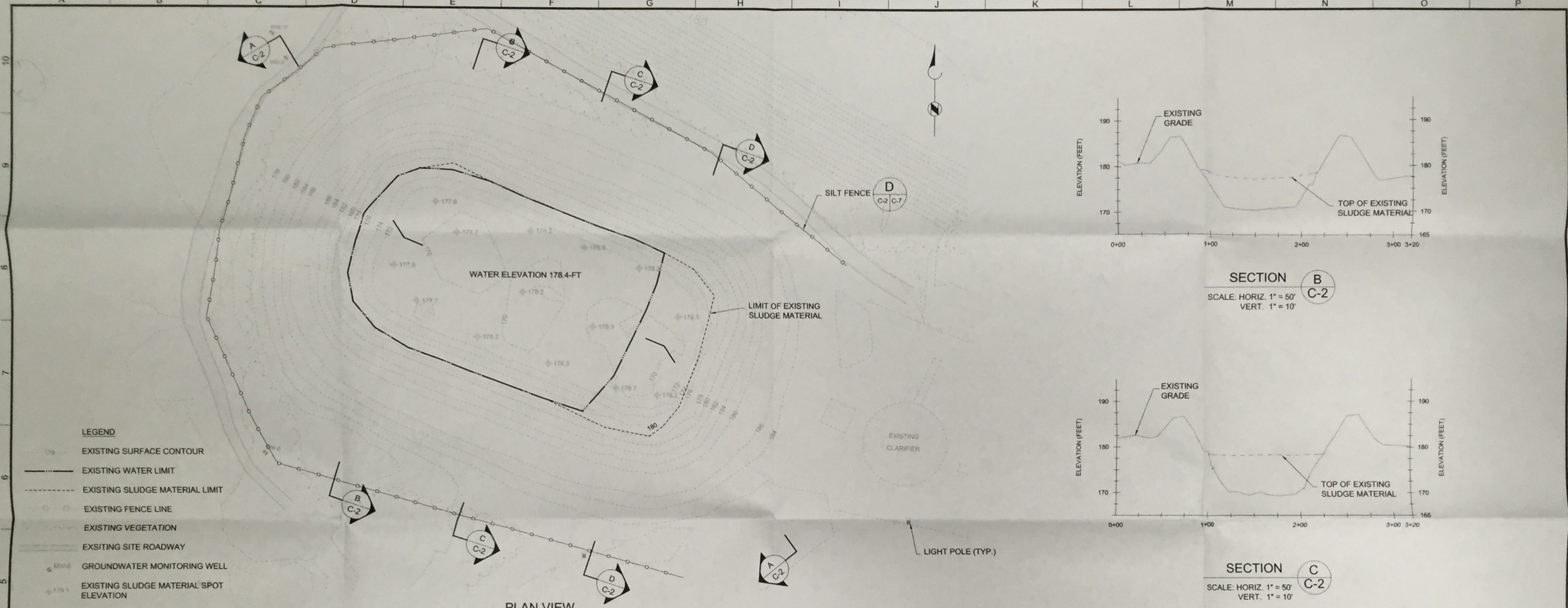
| REVISIONS | | | | | |
|---|---|---|---|---|---|
| ZONE | REV. | DESCRIPTION | BY | DATE | APP |

0 30 60
SCALE IN FEET

ArvinMeritor
SOLID WASTE MANAGEMENT UNIT 4
SLUDGE LAGOON CLOSURE AND
POST-CLOSURE CARE PLAN
GENERAL SITE PLAN

FILENAME: GENERAL_SITE_PLAN
BC PROJECT NUMBER: 131016
CLIENT PROJECT NUMBER:
DRAWING NUMBER: C-1
SHEET NUMBER: 2 OF 8

Jul 10, 2008 - 9:28am emcpeek
P:\ArvinMeritor\Grenada\Technical Review (131016)\Reports\Sludge Lagoon Closure\CAD\DESIGN Drawings\Final Design\C-1 GENERAL SITE PLAN.dwg
5/13/08




PLAN VIEW
SCALE: 1" = 30'



SECTION B C-2
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'



SECTION C C-2
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'



SECTION A C-2
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'



SECTION D C-2
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'

BROWN AND CALDWELL
COLUMBUS, OHIO

SUBMITTED: _____ PROJECT MANAGER DATE: _____
APPROVED: _____ BROWN AND CALDWELL DATE: _____

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED: EGM
DRAWN: EGM
CHECKED: RAI
CHECKED:
APPROVED: RAI

EXTERNAL REFERENCES
cover.dwg
PostDemolationBaseMap004.dwg

IMAGE REFERENCES
FILE0000.tif
Lagoon Borings.tif

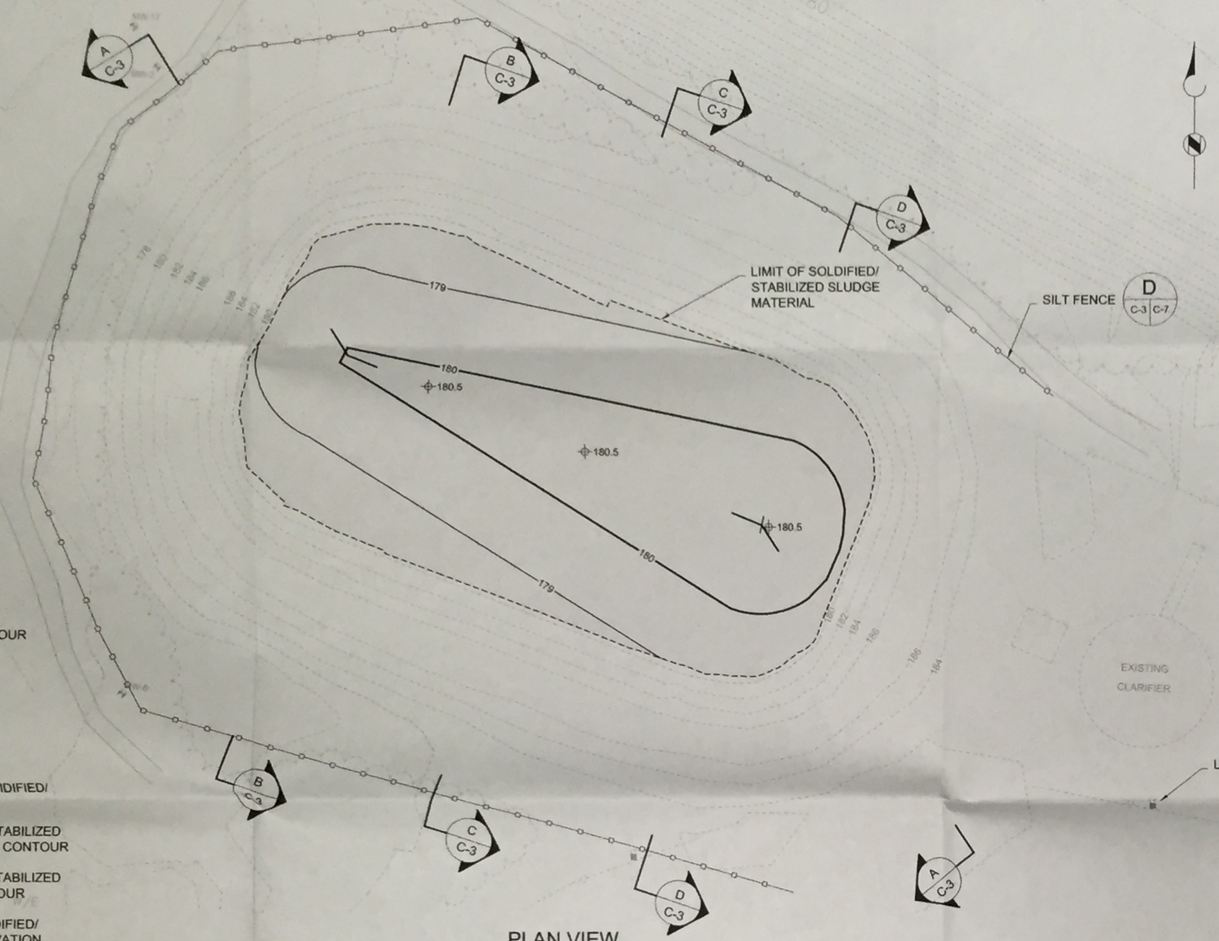
REVISIONS

| ZONE | REV | DESCRIPTION | BY | DATE | APP |
|---|---|---|---|---|---|
| | | | | | |

ArvinMeritor
SOLID WASTE MANAGEMENT UNIT 4
SLUDGE LAGOON CLOSURE AND
POST-CLOSURE CARE PLAN
SLUDGE MATERIAL PLAN AND SECTIONS

FILENAME: GENERAL_SITE_PLAN
BC PROJECT NUMBER: 131016
CLIENT PROJECT NUMBER:
DRAWING NUMBER: C-2
SHEET NUMBER: 3 OF 6

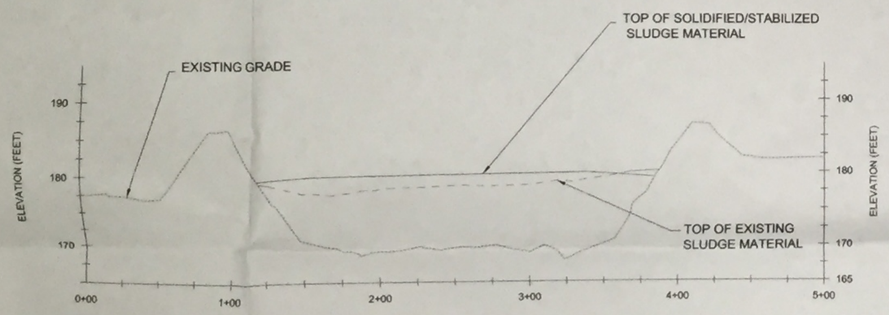
Jul 10, 2008 - 9:30am
P:\ArvinMeritor\Grenada\Technical Review (131016)\Reports\Sludge Lagoon Closure\CAD\DESIGN Drawings\Final Design\Plan_Drawings_016.dwg
emcpeek
5/13/08



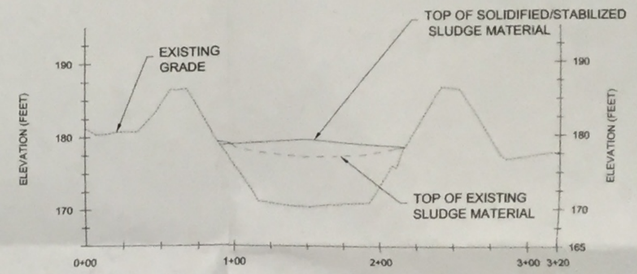

PLAN VIEW
SCALE: 1" = 30'

LEGEND

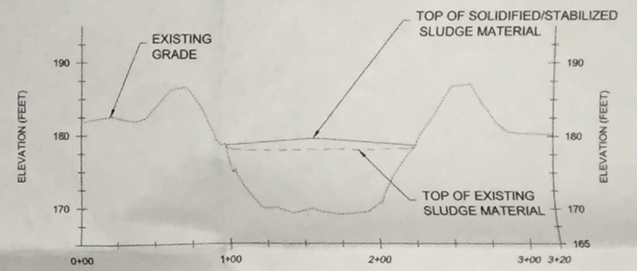
- EXISTING SURFACE CONTOUR
- EXISTING FENCE LINE
- EXISTNG VEGETATION
- EXSITING SITE ROADWAY
- PROPOSED SILT FENCE
- PROPOSED LIMIT OF SOLIDIFIED/ STABILIZED SLUDGE
- 180 PROPOSED SOLIDIFIED/STABILIZED SLUDGE MATERIAL INDEX CONTOUR
- 179 PROPOSED SOLIDIFIED/STABILIZED SLUDGE MATERIAL CONTOUR
- 180.0 PROPOSED TOP OF SOLIDIFIED/ STABILIZED SLUDGE ELEVATION
- MW-6 GROUNDWATER MONITORING WELL
- LIGHT POLE (TYP.)



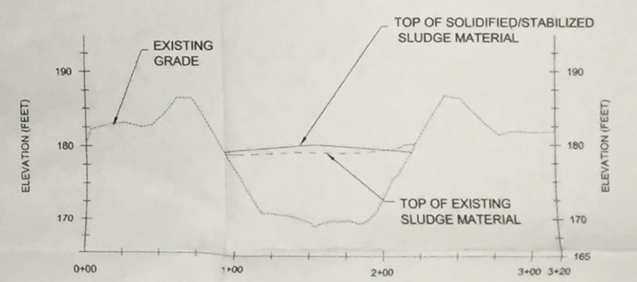

SECTION A C-3
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION B C-3
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION C C-3
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION D C-3
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'

BROWN AND CALDWELL
COLUMBUS, OHIO

SUBMITTED: _____ PROJECT MANAGER DATE: _____
APPROVED: _____ BROWN AND CALDWELL DATE: _____

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED: EGM
DRAWN: EGM
CHECKED: RAI
CHECKED:
APPROVED: RAI

EXTERNAL REFERENCES: xbase.dwg; Post-Remediation-BaseMap004.dwg

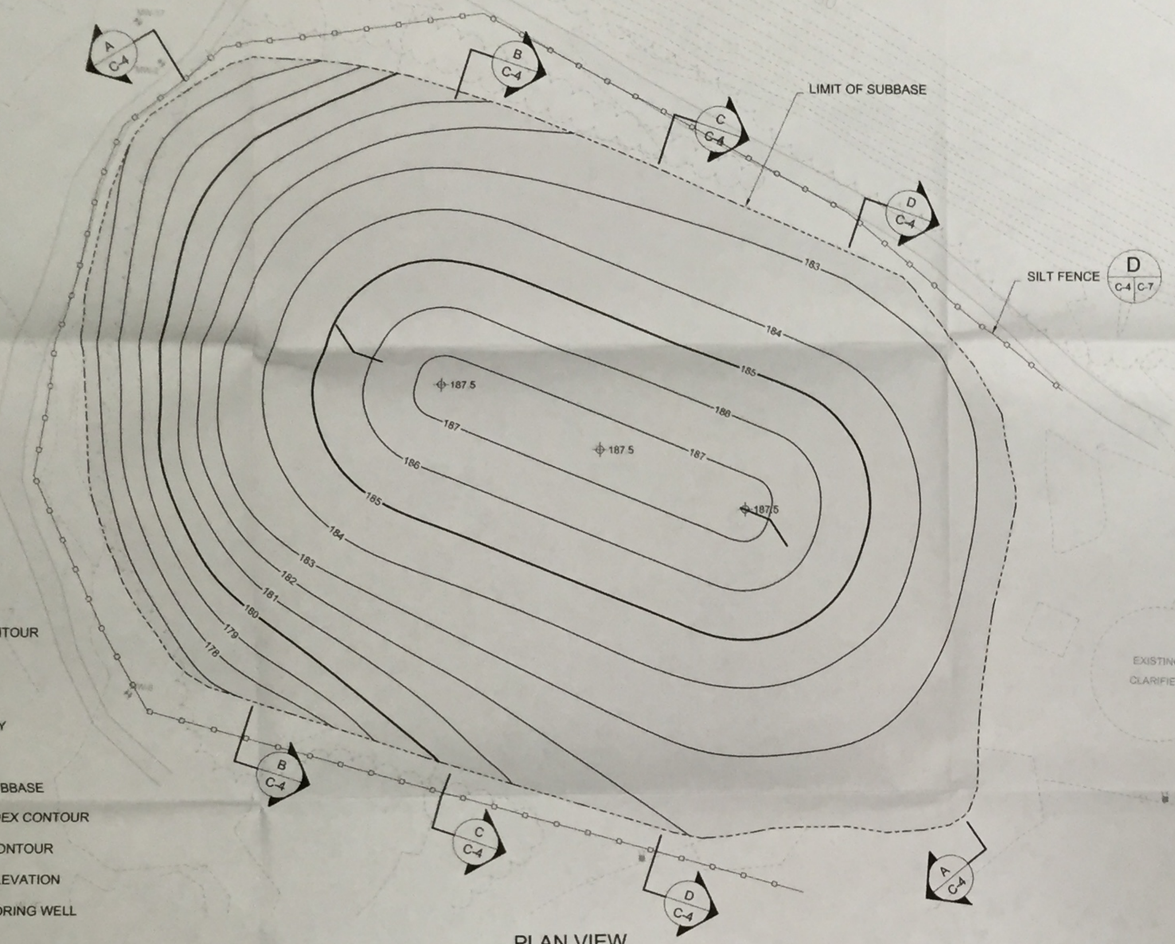
IMAGE REFERENCES: FILE0000.tif; Lagoon Borings.tif

| REVISIONS | | | | | |
|---|---|---|---|---|---|
| ZONE | REV. | DESCRIPTION | BY | DATE | APP. |

ArvinMeritor
SOLID WASTE MANAGEMENT UNIT 4
SLUDGE LAGOON CLOSURE AND
POST-CLOSURE CARE PLAN
STABILIZED SLUDGE PLAN AND SECTIONS

FILENAME: GENERAL_SITE_PLAN
BC PROJECT NUMBER: 131016
CLIENT PROJECT NUMBER:
DRAWING NUMBER: C-3
SHEET NUMBER: 4 OF 8

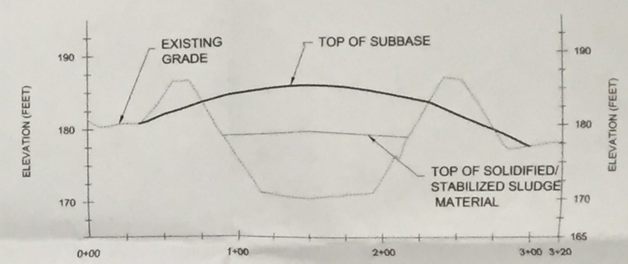
emcpeek
Jul 10, 2008, 0:31am
p:\A-collected\Columbus\Technical Review (131016)\Reports\Sludge Lagoon Closure\CADD\DESIGN Drawings\Final Design\Plan Drawings_016.dwg
5/13/08



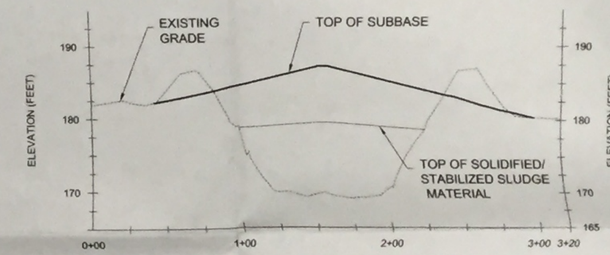

PLAN VIEW
SCALE: 1" = 30'

LEGEND

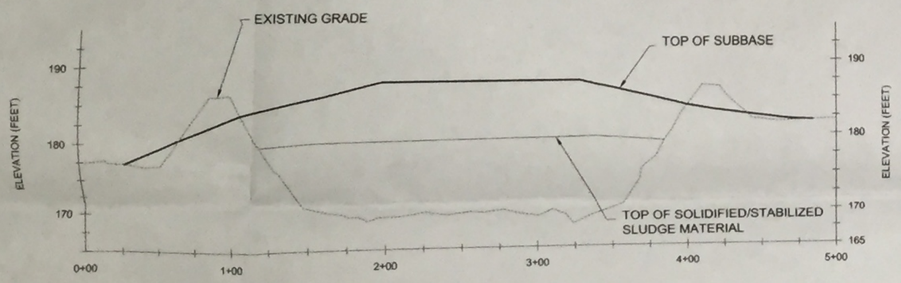
- EXISTING SURFACE CONTOUR
- EXISTING FENCE LINE
- EXISTNG VEGETATION
- EXSITING SITE ROADWAY
- PROPOSED SILT FENCE
- PROPOSED LIMIT OF SUBBASE
- 180 PROPOSED SUBASE INDEX CONTOUR
- 179 PROPOSED SUBBASE CONTOUR
- 187.5 PROPOSED SUBBASE ELEVATION
- MW-6 GROUNDWATER MONITORING WELL
- LIGHT POLE (TYP.)



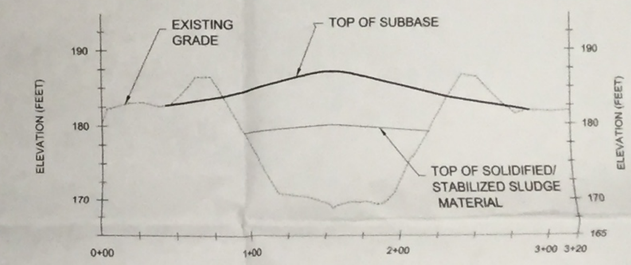

SECTION B / C-4
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION C / C-4
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION A / C-4
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION D / C-4
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'

BROWN AND CALDWELL
COLUMBUS, OHIO

SUBMITTED: _____ PROJECT MANAGER DATE: _____
APPROVED: _____ BROWN AND CALDWELL DATE: _____

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" SCALE ACCORDINGLY)

DESIGNED: EGM
DRAWN: EGM
CHECKED: RAI
CHECKED:
APPROVED: RAI

EXTERNAL REFERENCES: xbar.dwg; Post_Vegetation-BaseMap004.dwg

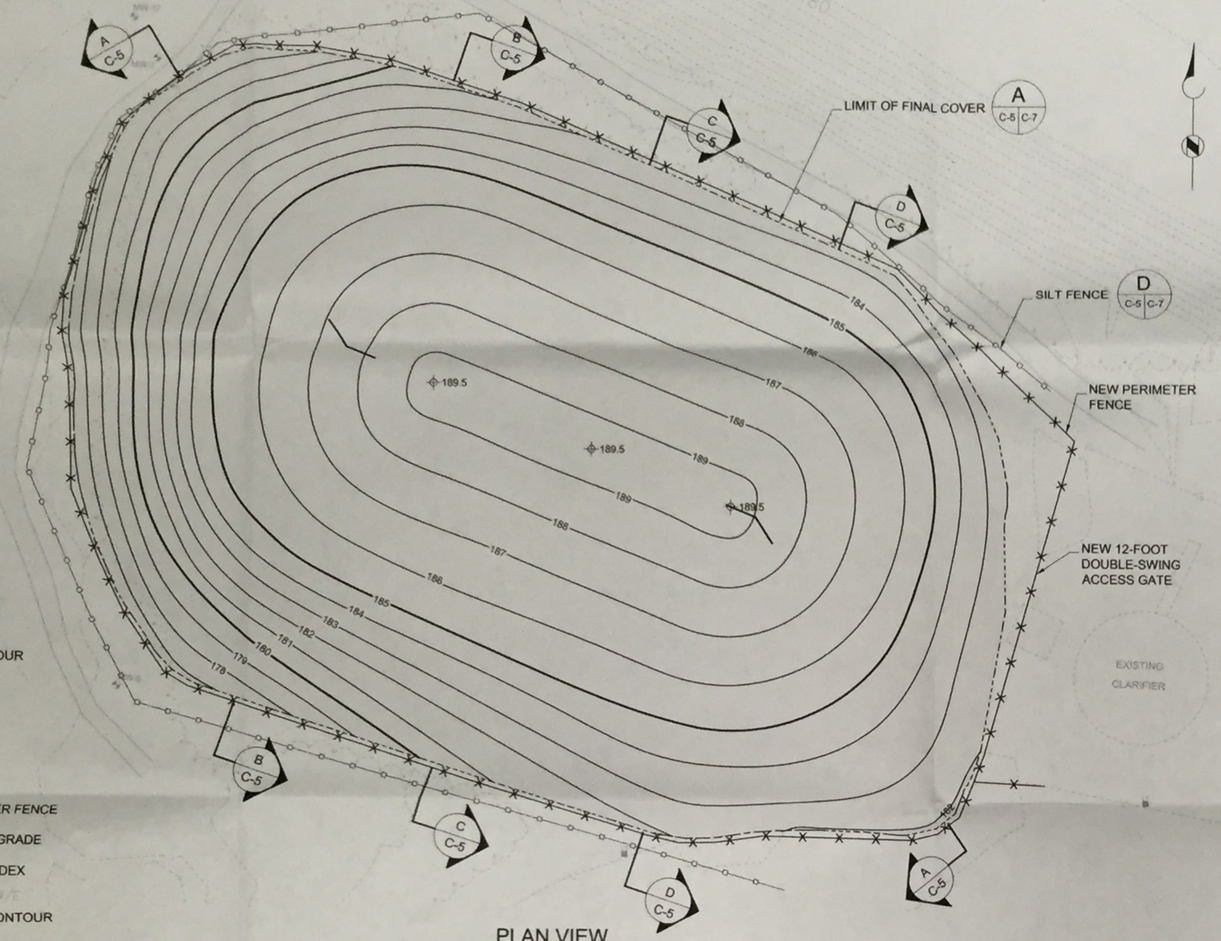
IMAGE REFERENCES: FILE0000.tif; Lagoon Borings.tif

| REVISIONS | | | | | |
|---|---|---|---|---|---|
| ZONE | REV. | DESCRIPTION | BY | DATE | APP. |
| | | | | | |

ArvinMeritor
SOLID WASTE MANAGEMENT UNIT 4
SLUDGE LAGOON CLOSURE AND
POST-CLOSURE CARE PLAN
SUBBASE GRADING PLAN AND SECTIONS

FILENAME: GENERAL_SITE_PLAN
BC PROJECT NUMBER: 131016
CLIENT PROJECT NUMBER:
DRAWING NUMBER: C-4
SHEET NUMBER: 5 OF 8

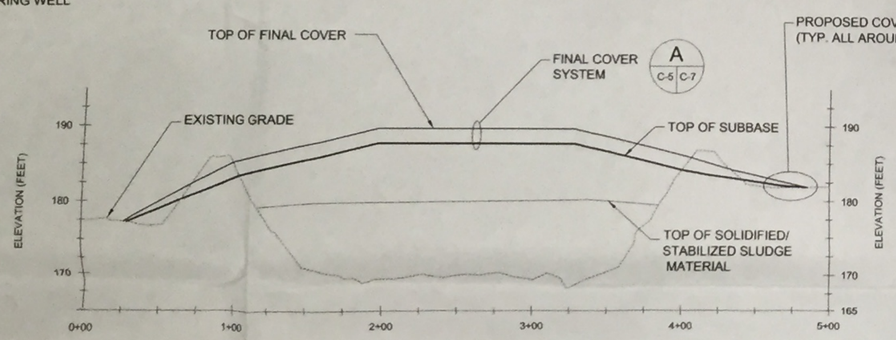
Jul 10, 2008 9:33am emcgeek
P:\Arvin Meritor\Operations\Technical Review (131016)\Reports\Sludge Lagoon Closure\CAD\BROWN Drawings\Pilot Design\Plan Drawings_016.dwg
5/13/08



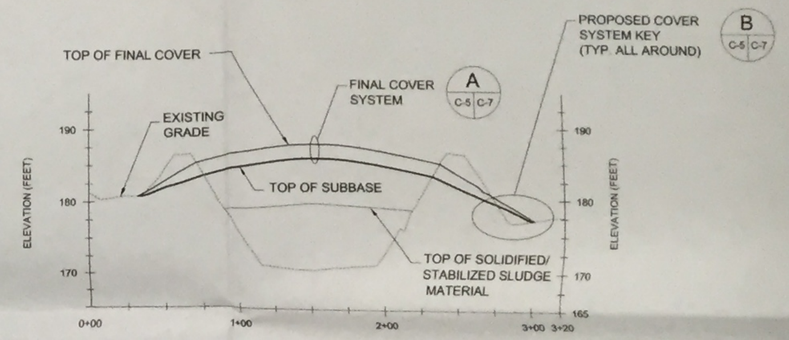

PLAN VIEW
SCALE: 1" = 30'

LEGEND

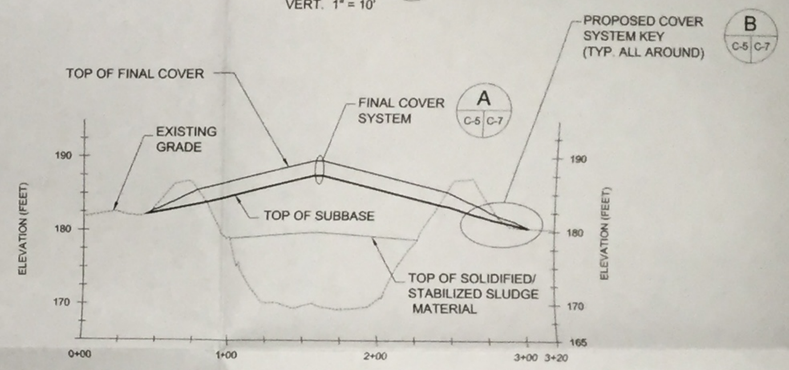
- EXISTING SURFACE CONTOUR
- EXISTING FENCE LINE
- EXISTNG VEGETATION
- EXSITING SITE ROADWAY
- PROPOSED SILT FENCE
- *PROPOSED NEW PERIMETER FENCE*
- PROPOSED LIMIT OF FINAL GRADE
- 185 PROPOSED FINAL GRADE INDEX CONTOUR
- 183 PROPOSED FINAL GRADE CONTOUR
- 189.5 PROPOSED FINAL GRADE ELEVATION
- MW-8 GROUNDWATER MONITORING WELL
- LIGHT POLE (TYP.)



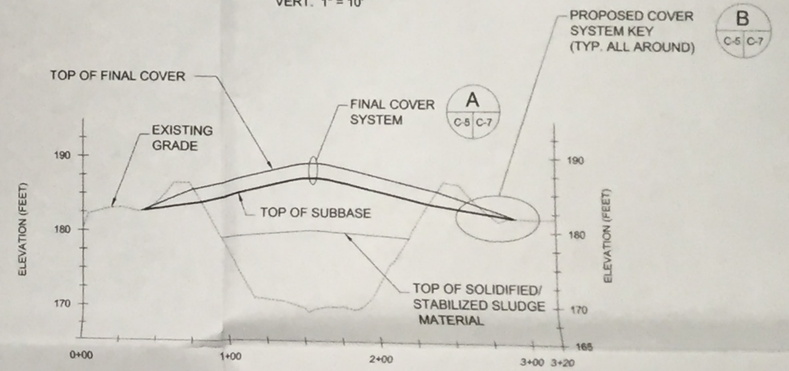

SECTION A C-5
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION B C-5
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION C C-5
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'




SECTION D C-5
SCALE: HORIZ. 1" = 50'
VERT. 1" = 10'

BROWN AND CALDWELL
COLUMBUS, OHIO

SUBMITTED: _____ DATE: _____
PROJECT MANAGER
APPROVED: _____ DATE: _____
BROWN AND CALDWELL

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" SCALE ACCORDINGLY)
DESIGNED: EGM
DRAWN: EGM
CHECKED: RAI
CHECKED:
APPROVED: RAI

EXTERNAL REFERENCES: stmp.dwg; Fmt$demrefdom$LayoMac004.dwg
IMAGE REFERENCES: FILE0000.tif; Lagoon Borings.tif

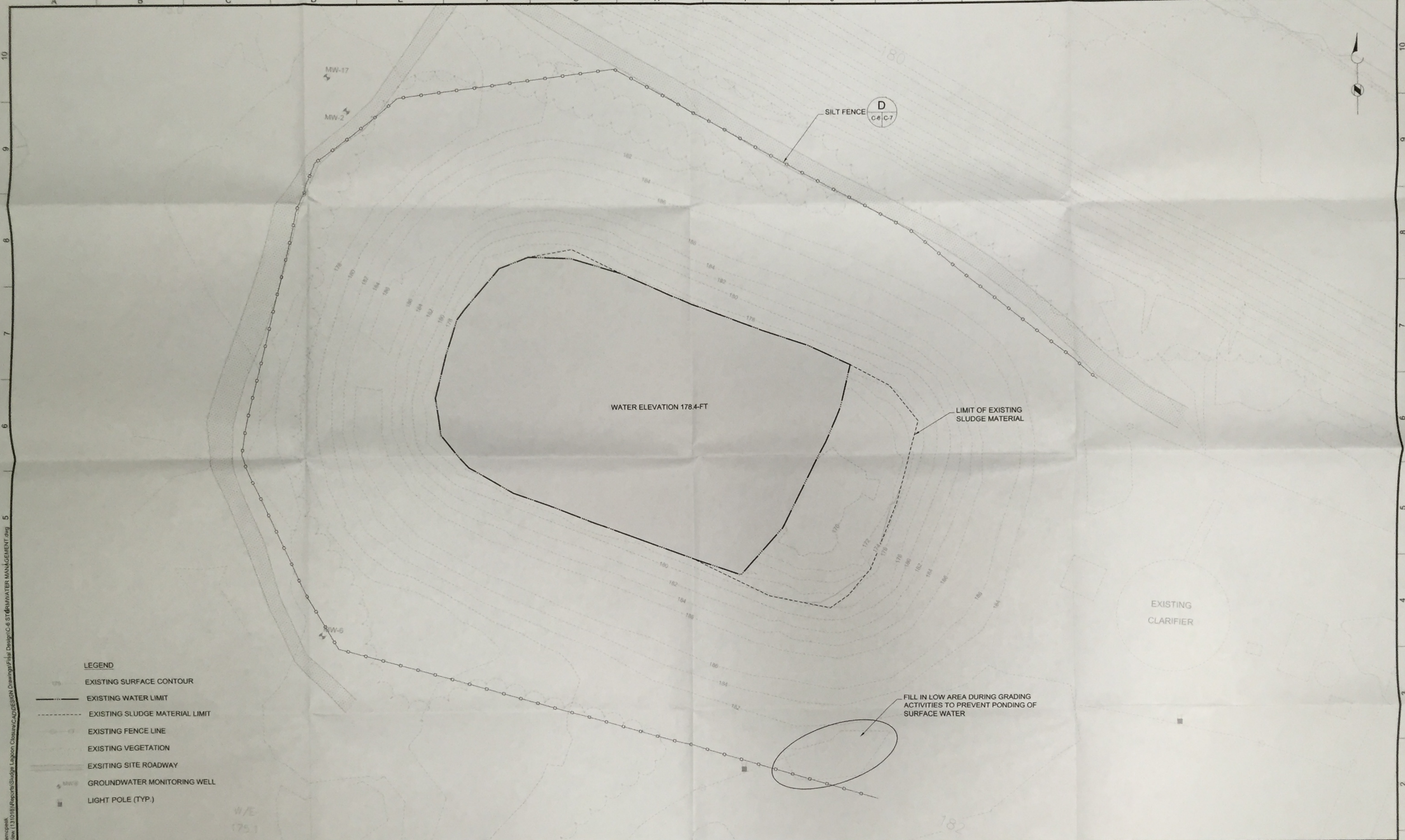
REVISIONS

| ZONE | REV. | DESCRIPTION | BY | DATE | APP. |
|---|---|---|---|---|---|
| | | | | | |

ArvinMeritor
SOLID WASTE MANAGEMENT UNIT 4
SLUDGE LAGOON CLOSURE AND
POST-CLOSURE CARE PLAN
FINAL GRADING PLAN AND SECTIONS

FILENAME: GENERAL_SITE_PLAN
BC PROJECT NUMBER: 131016
CLIENT PROJECT NUMBER:
DRAWING NUMBER: C-5
SHEET NUMBER: 6 OF 8

Jul 10, 2008 9:28am
P:\Arvin/Meritor/Grenada/Technical Review (131016)/Reports\Sludge Lagoon Closure\CADDESIGN Drawings\Final Design\Plan Drawings_018.dwg
emcpeek
5/13/08




BROWN AND CALDWELL
COLUMBUS, OHIO

SUBMITTED: _____ PROJECT MANAGER DATE: _____
APPROVED: _____ BROWN AND CALDWELL DATE: _____

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)
DESIGNED: EGM
DRAWN: EGM
CHECKED: RAI
CHECKED:
APPROVED: RAI

EXTERNAL REFERENCES
cover.dwg
PostDemolationBaseMap004.dwg

IMAGE REFERENCES
FILE0000.tif
Lagoon Borings.tif

REVISIONS

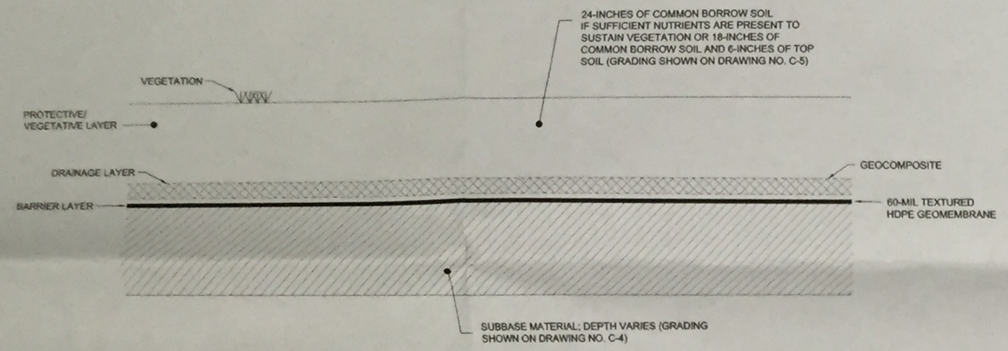
| ZONE | REV. | DESCRIPTION | BY | DATE | APP |
|---|---|---|---|---|---|
| | | | | | |

0 20 80
SCALE IN FEET

ArvinMeritor
SOLID WASTE MANAGEMENT UNIT 4
SLUDGE LAGOON CLOSURE AND
POST-CLOSURE CARE PLAN
STORM WATER MANAGEMENT PLAN

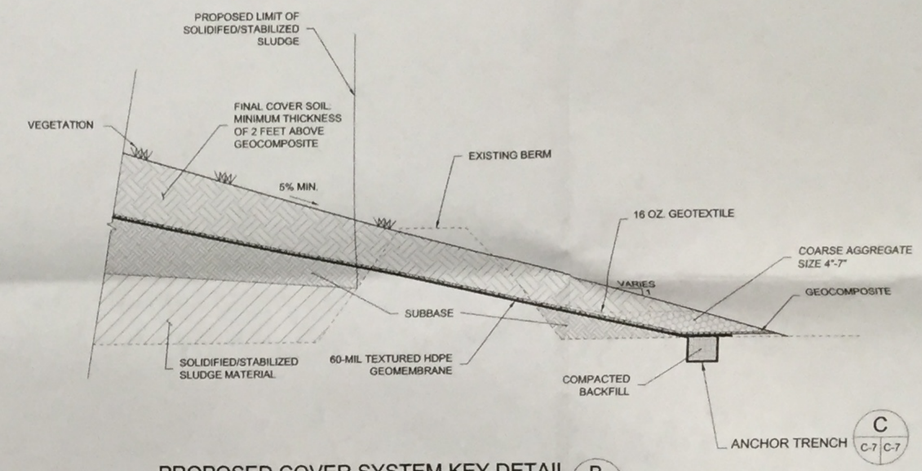
FILENAME
GENERAL_SITE_PLAN
BC PROJECT NUMBER
131016
CLIENT PROJECT NUMBER
DRAWING NUMBER
C-6
SHEET NUMBER
7 OF 8

Jul 10, 2008 - 9:27am
P:\Arvin\Meritor\Granada\Technical Review (131016)\Reports\Sludge Lagoon Closure\CAD\DESIGN Drawings\Final Design\C-6 STORMWATER MANAGEMENT.dwg
emcpeek
5/13/08



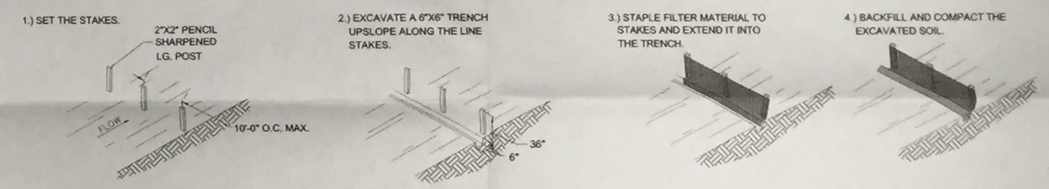

## PROPOSED COVER SYSTEM (A / C-7)

N.T.S.




## PROPOSED COVER SYSTEM KEY DETAIL (B / C-7)

N.T.S.




## CONSTRUCTION OF TEMPORARY SILT FENCE

NTS

(WIRE SUPPORTED SILT FENCE IS SNOWN. SELF SUPPORTING SILT FENCE WILL BE CONSTRUCTED ACCORDING TO MANUFACTURERS SPECIFICATIONS)

SILT FENCE. THIS SEDIMENT BARRIER UTILIZES STANDARD STRENGTH SYNTHETIC FILTER FABRICS. IT IS DESIGNED FOR SITUATIONS IN WHICH ONLY SHEET OR OVERLAND FLOWS ARE EXPECTED. THE HEIGHT OF A SILT FENCE SHALL NOT EXCEED 36 INCHES (HIGHER FENCES MAY IMPOUND VOLUMES OF WATER SUFFICIENT TO CAUSE FAILURE TO THE STRUCTURE).

THE FILTER FABRIC SHALL BE PURCHASED IN A CONTINUOUS ROLL CUT TO THE LENGTH OF THE BARRIER TO AVOID THE USE OF JOINTS. WHEN JOINTS ARE NECESSARY FILTER CLOTH SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST WITH A MINIMUM 6-INCH OVERLAP AND SECURELY SEALED.

WHEN STANDARD STRENGTH FILTER FABRIC IS USED A WIRE MESH SUPPORT FENCE SHALL BE FASTENED SECURELY TO THE UPSLOPE SIDE OF THE POSTS USING HEAVY DUTY WIRE STAPLES AT LEAST 1 INCH LONG. TIE WIRES OR HOG RINGS. THE WIRE SHALL EXTEND INTO THE TRENCH A MINIMUM OF 2 INCHES AND SHALL NOT EXTEND MORE THAN 36 INCHES ABOVE THE ORIGINAL GROUND SURFACE.

POSTS SHALL BE SPACED A MAXIMUM OF 10 FEET APART AT THE BARRIER LOCATON AND DRIVEN SECURELY INTO THE GROUND (MINIMUM OF 12 INCHES).

A TRENCH SHALL BE EXCAVATED APPROXIMATELY 6 INCHES WIDE AND 6 INCHES DEEP ALONG THE LINE OF POSTS AND UPSLOPE FROM THE BARRIER. THE STANDARD STRENGTH FILTER FABRIC SHALL BE STAPLED OR WIRED TO THE FENCE AND 8 INCHES OF THE FABRIC SHALL BE EXTENDED INTO THE TRENCH. THE FABRIC SHALL NOT EXTEND MORE THAN 36 INCHES ABOVE THE ORIGINAL GROUND SURFACE. FILTER FABRIC SHALL NOT BE STAPLED TO EXISTING TREES.

SILT FENCES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFUL PURPOSE BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED.

### MAINTENANCE

SILT FENCES AND FILTER BARRIERS SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.

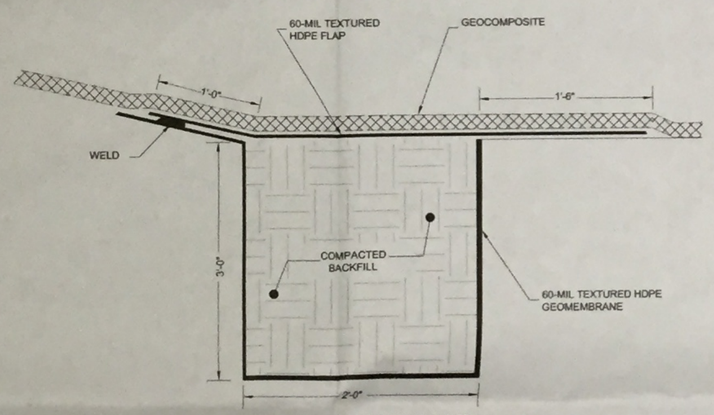
SHOULD THE FABRIC ON A SILT FENCE OR FILTER BARRIER DECOMPOSE OR BECOME INEFFECTIVE PRIOR TO THE END OF THE EXPECTED USABLE LIFE AND THE BARRIER IS STILL NECESSARY, THE FABRIC SHALL BE REPLACED PROMPTLY.

*SEDIMENT DEPOSITS SHALL BE REMOVED AFTER EACH STORM EVENT. THEY MUST BE REMOVED WHEN DEPOSITS REACH APPROXIMATELY ONE HALF OF THE* HEIGHT OF THE BARRIER.

ANY SEDIMENT DEPOSITS REMAINING IN PLACE AFTER THE SILT FENCE OR FILTER BARRIER IS NO LONGER REQUIRED SHALL BE DRESSED TO CONFORM WITH THE EXISTING GRADE AND SHALL BE PREPARED AND SEEDED.

## SILT FENCE DETAIL (D / C-7)

N.T.S.




*NOTE: CORNERS OF EXCAVTION TO BE ROUNDED*

## ANCHOR TRENCH DETAIL (C / C-7)

N.T.S.

BROWN AND CALDWELL
COLUMBUS, OHIO

SUBMITTED: _____ DATE: _____ (PROJECT MANAGER)
APPROVED: _____ DATE: _____ (BROWN AND CALDWELL)

LINE IS 2 INCHES AT FULL SIZE (IF NOT 2" - SCALE ACCORDINGLY)
DESIGNED: EGM
DRAWN: EGM
CHECKED: RAI
CHECKED:
APPROVED: RAI

EXTERNAL REFERENCES: cover.dwg
IMAGE REFERENCES: FILE0000.tif, Lagoon Borings.tif

REVISIONS

| ZONE | REV. | DESCRIPTION | BY | DATE | APP. |
|---|---|---|---|---|---|
| | | | | | |

0 30 60
SCALE IN FEET

ArvinMeritor
SOLID WASTE MANAGEMENT UNIT 4
SLUDGE LAGOON CLOSURE AND
POST-CLOSURE CARE PLAN
DETAILS

FILENAME: GENERAL_SITE_PLAN
BC PROJECT NUMBER: 131016
CLIENT PROJECT NUMBER:
DRAWING NUMBER: C-7
SHEET NUMBER: 8 OF 8

Jul 10, 2008 - 9:22am ericpeek
P:\ArvinMeritor\Granite\Technical Review (131016)\Reports\Sludge Lagoon Closure\CAD\DESIGN\Drawings\Final Design\DETAIL8.dwg
5/13/08