Sarasota County
Solid Waste Operations

Central County Solid Waste Disposal Complex
Class I Landfill Phase I Closure

Permit Application

April 2010

HDR

Prepared by:
HDR Engineering, Inc.
2621 Cattlemen Road, Suite 106
Sarasota, Florida 34232-6212
(941)342-2700

HDR Project No. 0096-125174-002

April 30, 2010

Ms. Susan J. Pelz, P.E.
Florida Department of Environmental Protection
Southwest District
13051 North Telecom Parkway
Temple Terrace, Florida 33637-0926

Subject: Sarasota County Solid Waste Operations
Central County Solid Waste Disposal Complex – Class I Landfill
Phase I Closure Construction Permit Application

Dear Ms. Pelz:

On behalf of Sarasota County, HDR Engineering, Inc. is pleased to submit four permit applications and full-size drawing sets, signed and sealed by a Professional Engineer, licensed in the state of Florida for the partial closure construction of Phase I of the Class I Landfill at the Central County Solid Waste Disposal Complex.

Also, enclosed with this application is a check in the amount of $7,500 made payable to the Florida Department of Environmental Protection in accordance with the fee schedule for a Class I Landfill closure application listed in Rule 62-701.315 (3) (a).

Please contact me with any questions at (813) 262-2776 or (813) 270-8058 with any questions.

Sincerely,
HDR ENGINEERING, INC.

Richard Siemering
Solid Waste Section Manager

Thomas Yanoschak, P.E.
Senior Project Manager

Enclosures

cc: Spencer Anderson, P.E. – Sarasota County
Jack Gibson, Sarasota County
Gary Bennett, Sarasota County
Lois Rose, Sarasota County

5426 Bay Center Drive
Suite 400
Tampa, FL 33609-3444

Phone: (813) 282-2300
Fax: (813) 282-2430
www.hdrinc.com

HDR ENGINEERING, INC

8404 Indian Hills Drive
Omaha, Nebraska
68114-4049

93-455/929

usbank.

Havre, MT 59604-8002

0995778

Date 04/16/2010

Pay Amount $7,500.00**

SEVEN THOUSAND FIVE HUNDRED AND XX / 100 DOLLAR

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FLORIDA DEPT OF ENVIRONMENTAL PROTECTION
SOUTHWEST DISTRICT OFFICE
13051 N TELECOM PKWY
TEMPLE TERRACE, FL 33637-0926

Richard R. Bell

Chad Hartnett

Check Date: 04/16/2010 **Check No.** 0995778

Invoice Number	Invoice Date	Voucher ID	Comment	Paid Amount
CLASS 1 LANDFILL 2010-	04/12/2010	01405087	TAMPA CK TO RENEE HADALA	7,500.00

FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION

APR 30 2010

SOUTHWEST DISTRICT
TAMPA

Vendor Number	Name				
0000110198	FLORIDA DEPT OF ENVIRONMENTAL PROTECTION				
Check Number	**Date**		**Total Amount**	**Discounts Taken**	**Total Paid Amount**
0995778	04/16/2010		$7,500.00	$0.00	$7,500.00

'01

Sarasota County
Solid Waste Operations

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April 2010

Prepared by
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FDEP APPLICATION TO CONSTRUCT, OPERATE, MODIFY, OR CLOSE A SOLID WASTE MANAGEMENT FACILITY

LIST OF ATTACHMENTS

APPENDICES

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

PART A
PERMIT APPLICATION FORM

The completed FDEP Application form for a Closure Construction Permit is attached.

The following documents are incorporated by reference into this permit application:

Reference 1: FDEP Permit No.: 130542-007-S0/01

A. Complex Class I Landfill Phase II Expansion Construction/Operation Permit Application (two 3-ring binder volumes and plan set) dated February 2007 (received February 20, 2007), as revised, replaced or amended (replacement pages inserted into original) dated and received June 22, 2007, dated September 21, 2007 (received September 27, 2007), dated January 11, 2008 (received January 16, 2008, dated March 18, 2008 (received March 19, 2008), dated April 24, 2008 (received April 25, 2008), and dated June 5, 2008 (received June 6, 2008). This information includes, but is not limited to:

   1) *Operations Plan, dated March 2008 (Appendix A) ;*

   2) *Water Quality Monitoring Plan, Appendix C; and*

   3) *Plan Set titled, Phase II Class I Landfill Expansion Central*
   4) *County Solid Waste Disposal Complex (34 Sheets) dated March 2008 (received March 19, 2008) including Sheets G-02, G-05, C-04, C-05A through C-12 and C-14 through C-21 received January 16, 2008 (inserted into March 2008 plan set) ;*

   5) *Document entitled "Ground Water Monitoring Plan Addendum," prepared by SCS Engineers, dated June 28, 2002, with revisions dated July 24, 2002 [Section 2 -Leachate Sampling Parameters] and September 16, 2002 [Appendix A], received June 28, 2002, July 29, 2002, and September 20, 2002; including revisions to Section 4 [Ground Water Sampling and Parameters], prepared by PBS&J dated February 22, 2007, received February 26, 2007 (copy inserted into Water Quality Monitoring Plan, Appendix C.)*

B. Plan Sheets titled, Sarasota County Phase I Class I Operations Drawings -Central County Solid vJaste Disposal Complex ... (24" x 36" Sheets 1 through 9, 13C through 13R, and 14 through 17) dated January 2008, signed and sealed January 7, 2008 (received January 9, 2008)

C. Document entitled "Ground Water Monitoring Plan Addendum," prepared by SCS Engineers, dated June 28, 2002, with revisions dated July 24, 2002 [Section 2 - Leachate Sampling Parameters] and September 16, 2002 [Appendix A], received June 28, 2002, July 29, 2002, and September 20, 2002; including revisions to Section 4 [Ground Water Sampling and Parameters], prepared by PBS&J dated February 22, 2007, received February 26, 2007.

Reference 2: FDEP Permit No. 130542-011-SC\MM

A. Complex Class I Landfill Phase II Expansion Construction/Operation Permit Application Minor Modification dated April 2009 (received April 23, 2009) *Water Quality Monitoring Plan Addendum Revised April 2009.*

Reference 3: FDEP Permit No.: 130542-009-SC/08

A. Central County Solid Waste Disposal Complex Class I Landfill Phase I Gas Collection and Control System Construction and Operation Permit Application (3-ring binder & plan set) dated December 29, 2008 (received December 30, 2008), as revised, replaced or amended (information collated into originals*) dated March 13, 2009 (received March 26, 2009) and dated April 20, 2009 (received April 22, 2009). This information includes, but is not limited to:

   1) Section 2 – Engineering Report;

   2) Section 4 – Specifications; and

   3) Plan Sheets titled, Permit Drawings for Central County Solid Waste Disposal Complex, Sarasota County Phase I Gas Collection and Control System (17 Sheets) signed and sealed April 20, 2009 (received April 22, 2009).

Florida Department of Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

DEP Form #: 62-701.900(1), F.A.C.
Form Title: Application to Construct, Operate, Modify, or Close a Solid Waste Management Facility
Effective Date: January 6, 2010
Incorporated in Rule: 62-701.330(3), F.A.C.

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

APPLICATION TO CONSTRUCT, OPERATE, MODIFY, OR CLOSE A SOLID WASTE MANAGEMENT FACILITY

APPLICATION INSTRUCTIONS AND FORMS

INSTRUCTIONS TO APPLY FOR A SOLID WASTE MANAGEMENT FACILITY PERMIT

I. General

Solid Waste Management Facilities shall be permitted pursuant to Section 403.707, Florida Statutes,(FS) and in accordance with Florida Administrative Code (FAC) Chapter 62-701. A minimum of four copies of the application shall be submitted to the Department's District Office having jurisdiction over the facility. The appropriate fee in accordance with Rule 62-701.315, FAC, shall be submitted with the application by check made payable to the Department of Environmental Protection (DEP).

Complete appropriate sections for the type of facility for which application is made. Entries shall be typed or printed in ink. All blanks shall be filled in or marked "not applicable" or "no substantial change". Information provided in support of the application shall be marked "submitted" and the location of this information in the application package indicated. The application shall include all information, drawings, and reports necessary to evaluate the facility. Information required to complete the application is listed on the attached pages of this form.

II. Application Parts Required for Construction and Operation Permits

A. Landfills and Ash Monofills - Submit Parts A through S
B. Asbestos Monofills - Submit Parts A,B,C,D,E,F,I,K,M, O through S
C. Industrial Solid Waste Disposal Facilities - Submit Parts A through S

NOTE: Portions of some Parts may not be applicable.

NOTE: For facilities that have been satisfactorily constructed in accordance with their construction permit, the information required for A, B and C type facilities does not have to be resubmitted for an operation permit if the information has not substantially changed during the construction period. The appropriate portion of the form should be marked "no substantial change".

III. Application Parts Required for Closure Permits

A. Landfills and Ash Monofills - Submit Parts A,B,L, N through S
B. Asbestos Monofills - Submit Parts A,B,M, O through S
C. Industrial Solid Waste Disposal Facilities - Submit Parts A,B, L through S

NOTE: Portions of some Parts may not be applicable.

IV. Permit Renewals

The above information shall be submitted at time of permit renewal in support of the new permit. However, facility information that was submitted to the Department to support the expiring permit, and which is still valid, does not need to be re-submitted for permit renewal. Portions of the application not re-submitted shall be marked "no substantial change" on the application form.

V. Application Codes

S	-	Submitted
LOCATION	-	Physical location of information in application
N/A	-	Not Applicable
N/C	-	No Substantial Change

VI. LISTING OF APPLICATION PARTS

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
APPLICATION FOR A PERMIT TO CONSTRUCT, OPERATE, MODIFY OR CLOSE A SOLID WASTE MANAGEMENT FACILITY

Please Type or Print

PART A. GENERAL INFORMATION

1. Type of disposal facility (check all that apply):

☑ Class I Landfill ☐ Ash Monofill
☐ Class III Landfill ☐ Asbestos Monofill
☐ Industrial Solid Waste
☐ Other Describe:

NOTE: Waste Processing Facilities should apply on Form 62-701.900(4), FAC;
Land Clearing Disposal Facilities should notify on Form 62-701.900(3), FAC;
Compost Facilities should apply on Form 62-701.900(10), FAC; and
C&D Disposal Facilities should apply on Form 62-701.900(6), FAC

2. Type of application:
   - ☐ Construction
   - ☐ Operation
   - ☐ Construction/Operation
   - ☑ Closure
   - ☐ Long-term Care Only

3. Classification of application:

☑ New ☐ Substantial Modification
☐ Renewal ☐ Intermediate Modification
☐ Minor Modification

4. Facility name: Central County Solid Waste Disposal Complex

5. DEP ID number: SWD-58-51614 County: Sarasota

6. Facility location (main entrance):
North end of Knights Trail Road.

7. Location coordinates:

Section: 1-4, 9-16 Township: 38S Range: 19E

Latitude: 27° 12' 11" Longitude: 82° 23' 16"

Datum: NAD 83 Coordinate Method: AutoCADD

Collected by: HDR Company/Affiliation: HDR

8. Applicant name (operating authority): Sarasota County Solid Waste Operations

Mailing address: 4000 Knights Trail Road | Nokomis | FL | 34275
Street or P.O. Box | City | State | Zip

Contact person: Lois Rose Telephone: (941) 650-0722

Title: Manager, Solid Waste

lerose@scgov.net
E-Mail address (if available)

9. Authorized agent/Consultant: HDR Engineering, Inc.

Mailing address: 2621 Cattlemen Road, Suite 106 | Sarasota | FL | 34232-6212
Street or P.O. Box | City | State | Zip

Contact person: Richard A. Siemering Telephone: (941) 342-2700

Title: Senior Project Manager

richard.siemering@hdrinc.com
E-Mail address (if available)

10. Landowner (if different than applicant): same as applicant

Mailing address: same as applicant
Street or P.O. Box | City | State | Zip

Contact person: same as applicant Telephone: ( ) same as applicant

same as applicant
E-Mail address (if available)

11. Cities, towns and areas to be served:
Sarasota County, FL

12. Population to be served:

Current: 482,000 Five-Year Projection: 531,000

13. Date site will be ready to be inspected for completion: Estimated August 2011

14. Expected life of the facility: ______ years N/A

15. Estimated costs:

Total Construction: $ 0 Closing Costs: $ 11,740,465

16. Anticipated construction starting and completion dates:

From: January 2011 To: June 2011

17. Expected volume or weight of waste to be received: N/A

______ yds^3/day ______ tons/day ______ gallons/day

PART B. DISPOSAL FACILITY GENERAL INFORMATION

1. Provide brief description of disposal facility design and operations planned under this application:
This application is for the closure of Phase I (approximately 55 acres) of the Central County Solid Disposal Complex Class I Landfill.

2. Facility site supervisor: Gary Bennett

   Title: General Manager Solid Waste Operation Telephone: (941) 650-2079

   gbennett@scgov.net
   E-Mail address (if available)

3. Disposal area: Total 109 acres; Used 55 acres; Available 54 acres.

4. Weighing scales used: ☑ Yes ☐ No

5. Security to prevent unauthorized use: ☑ Yes ☐ No

6. Charge for waste received: ________ $/yds^3 57.56 $/ton

7. Surrounding land use, zoning:

   ☐ Residential ☐ Industrial
   ☐ Agricultural ☐ None
   ☐ Commercial ☑ Other Describe:
   government use and open use conservation

8. Types of waste received:

   ☑ Household ☑ C & D debris
   ☑ Commercial ☑ Shredded/cut tires
   ☐ Incinerator/WTE ash ☑ Yard trash
   ☑ Treated biomedical ☐ Septic tank
   ☑ Water treatment sludge ☑ Industrial

☐ Air treatment sludge
☑ Agricultural
☑ Asbestos
☑ Industrial sludge
☑ Domestic sludge
☐ Other Describe:

9. Salvaging permitted: ☐ Yes ☑ No

10. Attendant: ☑ Yes ☐ No Trained operator: ☑ Yes ☐ No

11. Trained spotters: ☑ Yes ☐ No Number of spotters used: 1

12. Site located in: ☐ Floodplain ☐ Wetlands ☑ Other:
Uplands

13. Days of operation: Monday through Saturday

14. Hours of operation: 8:00AM to 5:00PM

Days Working Face covered: Monday through Saturday

16. Elevation of water table: 20.5 ft. Datum Used: NGVD 1929

17. Number of monitoring wells: 10

18. Number of surface monitoring points: 2

19. Gas controls used: ☑ Yes ☐ No Type controls: ☑ Active ☐ Passive

Gas flaring: ☑ Yes ☐ No Gas recovery: ☑ Yes ☐ No

20. Landfill unit liner type:

☐ Natural soils
☐ Single clay liner
☐ Single geomembrane
☑ Single composite
☐ Slurry wall
☐ Double geomembrane
☐ Geomembrane & composite
☐ Double composite
☐ None
☐ Other Describe:

A single composite liner for Phase I Landfill.

21. Leachate collection method:

- ☑ Collection pipes
- ☑ Sand layer
- ☑ Geonets
- ☐ Gravel layer
- ☐ Well points
- ☐ Interceptor trench
- ☐ Perimeter ditch
- ☐ None
- ☐ Other Describe:

22. Leachate storage method:

- ☑ Tanks
- ☐ Surface impoundments
- ☐ Other Describe:

23. Leachate treatment method:

- ☐ Oxidation
- ☐ Chemical treatment
- ☐ Secondary
- ☐ Settling
- ☐ Advanced
- ☐ None
- ☑ Other

Off-site treatment.

24. Leachate disposal method:

- ☐ Recirculated
- ☑ Pumped to WWTP
- ☐ Transported to WWTP
- ☐ Discharged to surface water/wetland
- ☐ Injection well
- ☐ Percolation ponds
- ☐ Evaporation
- ☐ Spray Irrigation
- ☐ Other

25. For leachate discharged to surface waters:

Name and Class of receiving water:
N/A

26. Storm Water:

Collected: ☑ Yes ☐ No

Type of treatment:
Retention Ponds

Name and Class of receiving water:
Cow Pen Slough, Class III

27. Environmental Resources Permit (ERP) number or status:

FDEP 58-0272622-001

PART C. **PROHIBITIONS** (62-701.300, FAC)

S	LOCATION	N/A	N/C	
☐		☑	☐	1. Provide documentation that each of the siting criteria will be satisfied for the facility; (62-701.300(2), FAC)
☐		☑	☐	2. If the facility qualifies for any of the exemptions contained in Rules 62-701.300(12) through (18), FAC, then document this qualification(s).
☐		☑	☐	3. Provide documentation that the facility will be in compliance with the burning restrictions; (62-701.300(3), FAC)
☐		☑	☐	4. Provide documentation that the facility will be in compliance with the hazardous waste restrictions; (62-701.300(4), FAC)
☐		☑	☐	5. Provide documentation that the facility will be in compliance with the PCB disposal restrictions; (62-701.300(5), FAC)
☐		☑	☐	6. Provide documentation that the facility will be in compliance with the biomedical waste restrictions; (62-701.300(6), FAC)
☐		☑	☐	7. Provide documentation that the facility will be in compliance with the Class I surface water restrictions; (62-701.300(7), FAC)
☐		☑	☐	8. Provide documentation that the facility will be in compliance with the special waste for landfills restrictions; (62-701.300(8), FAC)
☐		☑	☐	9. Provide documentation that the facility will be in compliance with the liquid restrictions; (62-701.300(10), FAC)
☐		☑	☐	10. Provide documentation that the facility will be in compliance with the used oil and oily waste restrictions; (62-701.300(11), FAC)

PART D. **SOLID WASTE MANAGEMENT FACILITY PERMIT REQUIREMENTS, GENERAL** (62-701.320, FAC)

S	LOCATION	N/A	N/C	
☑	Application	☐	☐	1. Four copies, at minimum, of the completed application form, all supporting data and reports; (62-701.320(5)(a),FAC)

S	LOCATION	N/A	N/C	PART D CONTINUED
●	Application Signature Page	☐	☐	2. Engineering and/or professional certification (signature, date and seal) provided on the applications and all engineering plans, reports and supporting information for the application; (62-701.320(6),FAC)
☑	Attached with Application	☐	☐	3. A letter of transmittal to the Department; (62-701.320(7)(a),FAC)
☑	Application Signature Page	☐	☐	4. A completed application form dated and signed by the applicant; (62-701.320(7)(b),FAC)
☑	Attached with Application	☐	☐	5. Permit fee specified in Rule 62-701.315, FAC in check or money order, payable to the Department; (62-701.320(7)(c),FAC)
☑	Attached with Application	☐	☐	6. An engineering report addressing the requirements of this rule and with the following format: a cover sheet, text printed on 8 1/2 inch by 11 inch consecutively numbered pages, a table of contents or index, the body of the report and all appendices including an operation plan, contingency plan, illustrative charts and graphs, records or logs of tests and investigations, engineering calculations; (62-701.320(7)(d),FAC)
☑	Part O	☐	☐	7.Operation Plan and Closure Plan; (62-701.320(7)(e)1,FAC)
●		☑	☐	8. Contingency Plan; (62-701.320(7)(e)2,FAC)
☑	Appendix A	☐	☐	9. Plans or drawings for the solid waste management facilities in appropriate format (including sheet size restrictions, cover sheet, legends, north arrow, horizontal and vertical scales, elevations referenced to NGVD 1929) showing; (62-701.320(7)(f),FAC)
☑	Appendix A Drawing 00G-01	☐	☐	a. A regional map or plan with the project location in relation to major roadways and population centers;
☐	Reference 1	☐	☑	b. A vicinity map or aerial photograph no more than 1 year old showing the facility site and relevant surface features located within 1000 feet of the facility;
☐	Reference 1	☐	☑	c. A site plan showing all property boundaries certified by a Florida Licensed Professional Surveyor and Mapper; and
☑	Appenidx A Drawings	☐	☐	d. Other necessary details to support the engineering report, including referencing elevations to a consistent, nationally recognized datum and identifying the method used for collecting latitude and longitude data.

S	LOCATION	N/A	N/C	PART D CONTINUED
☐	Part D.10	☐	☑	10. Documentation that the applicant either owns the property or has legal authority from the property owner to use the site; (62-701.320(7)(g),FAC)
☐		☑	☐	11. For facilities owned or operated by a county, provide a description of how, if any, the facilities covered in this application will contribute to the county's achievement of the waste reduction and recycling goals contained in Section 403.706,FS; (62-701.320(7)(h),FAC)
☑	Part D.12	☐	☐	12. Provide a history and description of any enforcement actions taken by the Department against the applicant for violations of applicable statutes, rules, orders or permit conditions relating to the operation of any solid waste management facility in this state; (62-701.320(7)(i),FAC)
☐		☑	☐	13. Proof of publication in a newspaper of general circulation of notice of application for a permit to construct or substantially modify a solid waste management facility; (62-702.320(8),FAC)
☐		☑	☐	14. Provide a description of how the requirements for airport safety will be achieved including proof of required notices if applicable. If exempt, explain how the exemption applies; (62-701.320(13),FAC)
☐		☑	☐	15. Explain how the operator and spotter training requirements and special criteria will be satisfied for the facility; (62-701.320(15), FAC)

PART E. LANDFILL PERMIT REQUIREMENTS (62-701.330, FAC)

S	LOCATION	N/A	N/C	
☐		☑	☐	1. Regional map or aerial photograph no more than 5 years old showing all airports that are located within five miles of the proposed landfill; (62-701.330(3)(a),FAC)
☐		☑	☐	2. Plot plan with a scale not greater than 200 feet to the inch showing; (62-701.330(3)(b),FAC)
☐		☑	☐	a. Dimensions;
☐		☑	☐	b. Locations of proposed and existing water quality monitoring wells;
☐		☑	☐	c. Locations of soil borings;

S	LOCATION	N/A	N/C	PART E CONTINUED
		☑	☐	d. Proposed plan of trenching or disposal areas;
☐		☑	☐	e. Cross sections showing original elevations and proposed final contours which shall be included either on the plot plan or on separate sheets;
☐		☑	☐	f. Any previously filled waste disposal areas;
☐		☑	☐	g. Fencing or other measures to restrict access.
☐		☑	☐	3. Topographic maps with a scale not greater than 200 feet to the inch with 5-foot contour intervals showing; (62-701.330(3)(c),FAC):
☐		☑	☐	a. Proposed fill areas;
☐		☑	☐	b. Borrow areas;
☐		☑	☐	c. Access roads;
		☑	☐	d. Grades required for proper drainage;
☐		☑	☐	e. Cross sections of lifts;
☐		☑	☐	f. Special drainage devices if necessary;
☐		☑	☐	g. Fencing;
☐		☑	☐	h. Equipment facilities.
☐		☑	☐	4. A report on the landfill describing the following; (62-701.330(3)(d),FAC)
☐		☑	☐	a. The current and projected population and area to be served by the proposed site;
☐		☑	☐	b. The anticipated type, annual quantity, and source of solid waste, expressed in tons;
		☑	☐	c. Planned active life of the facility, the final design height of the facility and the maximum height of the facility during its operation;

S	LOCATION	N/A	N/C	PART E CONTINUED
☐	______	☑	☐	d. The source and type of cover material used for the landfill.
☐	______	☑	☐	5. Provide evidence that an approved laboratory shall conduct water quality monitoring for the facility in accordance with Chapter 62-160,FAC; (62-701.330(3)(g),FAC)
☐	______	☑	☐	6. Provide a statement of how the applicant will demonstrate financial responsibility for the closing and long-term care of the landfill; (62-701.330(3)(h),FAC)

PART F. GENERAL CRITERIA FOR LANDFILLS (62-701.340,FAC)

S	LOCATION	N/A	N/C	
☐	______	☑	☐	1. Describe (and show on a Federal Insurance Administration flood map, if available) how the landfill or solid waste disposal unit shall not be located in the 100-year floodplain where it will restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain unless compensating storage is provided, or result in a washout of solid waste; (62-701.340(3)(b),FAC)
☐	______	☑	☐	2. Describe how the minimum horizontal separation between waste deposits in the landfill and the landfill property boundary shall be 100 feet, measured from the toe of the proposed final cover slope; (62-701.340(3)(c),FAC)

PART G. LANDFILL CONSTRUCTION REQUIREMENTS (62-701.400,FAC)

S	LOCATION	N/A	N/C	
☐	______	☑	☐	1. Describe how the landfill shall be designed so that solid waste disposal units will be constructed and closed at planned intervals throughout the design period of the landfill and shall be designed to achieve a minimum factor of safety of 1.5 using peak strength values to prevent failures of side slopes and deep-seated failures; (62-701.400(2),FAC)
☐	______	☑	☐	2. Landfill liner requirements; (62-701.400(3),FAC)
☐	______	☑	☐	a. General construction requirements; (62-701.400(3)(a),FAC):
☐	______	☑	☐	(1) Provide test information and documentation to ensure the liner will be constructed of materials that have approp[illegible] physical, chemical, and mechanical properties to prev[illegible] failure;

S	LOCATION	N/A	N/C	PART G CONTINUED
		☑	☐	(2) Document foundation is adequate to prevent liner failure;
☐		☑	☐	(3) Constructed so bottom liner will not be adversely impacted by fluctuations of the ground water;
☐		☑	☐	(4) Designed to resist hydrostatic uplift if bottom liner located below seasonal high ground water table;
☐		☑	☐	(5) Installed to cover all surrounding earth which could come into contact with the waste or leachate.
☐		☑	☐	b. Composite liners; (62-701.400(3)(b),FAC)
☐		☑	☐	(1) Upper geomembrane thickness and properties;
☐		☑	☐	(2) Design leachate head for primary LCRS including leachate recirculation if appropriate;
☐		☑	☐	(3) Design thickness in accordance with Table A and number of lifts planned for lower soil component.
☐		☑	☐	c. Double liners; (62-701.400(3)(c),FAC)
☐		☑	☐	(1) Upper and lower geomembrane thicknesses and properties;
☐		☑	☐	(2) Design leachate head for primary LCRS to limit the head to one foot above the liner;
☐		☑	☐	(3) Lower geomembrane sub-base design;
☐		☑	☐	(4) Leak detection and secondary leachate collection system minimum design criteria ($k \geq 10$ cm/sec, head on lower liner ≤ 1 inch, head not to exceed thickness of drainage layer);
☐		☑	☐	d. Standards for geosynthetic components; (62-701.400(3)(d),FAC)

S	LOCATION	N/A	N/C	PART G CONTINUED
☐		☑	☐	(1) Factory and field seam test methods to ensure all geomembrane seams achieve the minimum specifications;
☐		☑	☐	(2) Geomembranes to be used shall pass a continuous spark test by the manufacturer;
☐		☑	☐	(3) Design of 24-inch-thick protective layer above upper geomembrane liner;
☐		☑	☐	(4) Describe operational plans to protect the liner and leachate collection system when placing the first layer of waste above 24-inch-thick protective layer.
☐		☑	☐	(5) HDPE geomembranes, if used, meet the specifications in GRI GM13 and LLDPE geomembranes, if used, meet the specifications in GRI GM17;
☐		☑	☐	(6) PVC geomembranes, if used, meet the specifications in PGI 1104;
☐		☑	☐	(7) Interface shear strength testing results of the actual components which will be used in the liner system;
☐		☑	☐	(8) Transmissivity testing results of geonets if they are used in the liner system;
☐		☑	☐	(9) Hydraulic conductivity testing results of geosynthetic clay liners if they are used in the liner system;
☐		☑	☐	e. Geosynthetic specification requirements; (62-701.400(3)(e),FAC)
☐		☑	☐	(1) Definition and qualifications of the designer, manufacturer, installer, QA consultant and laboratory, and QA program;
☐		☑	☐	(2) Material specifications for geomembranes, geocomposites, geotextiles, geogrids, and geonets;

S	LOCATION	N/A	N/C	PART G CONTINUED
		☑	☐	(3) Manufacturing and fabrication specifications including geomembrane raw material and roll QA, fabrication personnel qualifications, seaming equipment and procedures, overlaps, trial seams, destructive and nondestructive seam testing, seam testing location, frequency, procedure, sample size and geomembrane repairs;
☐		☑	☐	(4) Geomembrane installation specifications including earthwork, conformance testing, geomembrane placement, installation personnel qualifications, field seaming and testing, overlapping and repairs, materials in contact with geomembrane and procedures for lining system acceptance;
☐		☑	☐	(5) Geotextile and geogrid specifications including handling and placement, conformance testing, seams and overlaps, repair, and placement of soil materials and any overlying materials;
☐		☑	☐	(6) Geonet and geocomposite specifications including handling and placement, conformance testing, stacking and joining, repair, and placement of soil materials and any overlying materials;
☐		☑	☐	(7) Geosynthetic clay liner specifications including handling and placement, conformance testing, seams and overlaps, repair, and placement of soil material and any overlying materials;
☐		☑	☐	f. Standards for soil liner components (62-710.400(3)(f),FAC):
☐		☑	☐	(1) Description of construction procedures including overexcavation and backfilling to preclude structural inconsistencies and procedures for placing and compacting soil component in layers;
☐		☑	☐	(2) Demonstration of compatibility of the soil component with actual or simulated leachate in accordance with EPA Test Method 9100 or an equivalent test method;
☐		☑	☐	(3) Procedures for testing in-situ soils to demonstrate they meet the specifications for soil liners;

S	LOCATION	N/A	N/C	PART G CONTINUED
☐		☑	☐	(4) Specifications for soil component of liner including at a minimum:
☐		☑	☐	(a) Allowable particle size distribution, Atterberg limits, shrinkage limit;
☐		☑	☐	(b) Placement moisture and dry density criteria;
☐		☑	☐	(c) Maximum laboratory-determined saturated hydraulic conductivity using simulated leachate;
☐		☑	☐	(d) Minimum thickness of soil liner;
☐		☑	☐	(e) Lift thickness;
☐		☑	☐	(f) Surface preparation (scarification);
☐		☑	☐	(g) Type and percentage of clay mineral within the soil component;
☐		☑	☐	(5) Procedures for constructing and using a field test section to document the desired saturated hydraulic conductivity and thickness can be achieved in the field.
☐		☑	☐	g. If a Class III landfill is to be constructed with a bottom liner system, provide a description of how the minimum requirements for the liner will be achieved.
☐		☑	☐	3. Leachate collection and removal system (LCRS); (62-701.400(4),FAC)
☐		☑	☐	a. The primary and secondary LCRS requirements; (62-701.400(4)(a),FAC)
☐		☑	☐	(1) Constructed of materials chemically resistant to the waste and leachate;
☐		☑	☐	(2) Have sufficient mechanical properties to prevent collapse under pressure;

S	LOCATION	N/A	N/C	PART G CONTINUED
	____________	☑	☐	(3) Have granular material or synthetic geotextile to prevent clogging;
☐	____________	☑	☐	(4) Have method for testing and cleaning clogged pipes or contingent designs for rerouting leachate around failed areas;
☐	____________	☑	☐	b. Other LCRS requirements; (62-701.400(4)(b) and (c),FAC)
☐	____________	☑	☐	(1) Bottom 12 inches having hydraulic conductivity ≥ 1 x 10^{-3} cm/sec;
☐	____________	☑	☐	(2) Total thickness of 24 inches of material chemically resistant to the waste and leachate;
☐	____________	☑	☐	(3) Bottom slope design to accommodate for predicted settlement and still meet minimum slope requirements;
☐	____________	☑	☐	(4) Demonstration that synthetic drainage material, if used, is equivalent or better than granular material in chemical compatibility, flow under load and protection of geomembrane liner.
☐	____________	☑	☐	4. Leachate recirculation; (62-701.400(5),FAC)
☐	____________	☑	☐	a. Describe general procedures for recirculating leachate;
☐	____________	☑	☐	b. Describe procedures for controlling leachate runoff and minimizing mixing of leachate runoff with storm water;
☐	____________	☑	☐	c. Describe procedures for preventing perched water conditions and gas buildup;
☐	____________	☑	☐	d. Describe alternate methods for leachate management when it cannot be recirculated due to weather or runoff conditions, surface seeps, wind-blown spray, or elevated levels of leachate head on the liner;
☐	____________	☑	☐	e. Describe methods of gas management in accordance with Rule 62-701.530, FAC;

S	LOCATION	N/A	N/C	PART G CONTINUED
☐		☑	☐	f. If leachate irrigation is proposed, describe treatment methods and standards for leachate treatment prior to irrigation over final cover and provide documentation that irrigation does not contribute significantly to leachate generation.
☐		☑	☐	5.Leachate storage tanks and leachate surface impoundments; (62-701.400(6),FAC)
☐		☑	☐	a. Surface impoundment requirements; (62-701.400(6)(b),FAC)
☐		☑	☐	(1) Documentation that the design of the bottom liner will not be adversely impacted by fluctuations of the ground water;
☐		☑	☐	(2) Designed in segments to allow for inspection and repair as needed without interruption of service;
☐		☑	☐	(3) General design requirements;
☐		☑	☐	(a) Double liner system consisting of an upper and lower 60-mil minimum thickness geomembrane;
☐		☑	☐	(b) Leak detection and collection system with hydraulic conductivity ≥ 1 cm/sec;
☐		☑	☐	(c) Lower geomembrane placed on subbase ≥ 6 inches thick with $k \leq 1 \quad 10^{-5}$ cm/sec or on an approved geosynthetic clay liner with $k \leq 1 \quad 10^{-7}$ cm/sec;
☐		☑	☐	(d) Design calculation to predict potential leakage through the upper liner;
☐		☑	☐	(e) Daily inspection requirements and notification and corrective action requirements if leakage rates exceed that predicted by design calculations;
☐		☑	☐	(4) Description of procedures to prevent uplift, if applicable;
☐		☑	☐	(5) Design calculations to demonstrate minimum two feet of freeboard will be maintained;
☐		☑	☐	(6) Procedures for controlling vectors and off-site odors.

S	LOCATION	N/A	N/C	PART G CONTINUED
☐	______	☑	☐	b. Above-ground leachate storage tanks; (62-701.400(6)(c),FAC)
☐	______	☑	☐	(1) Describe tank materials of construction and ensure foundation is sufficient to support tank;
☐	______	☑	☐	(2) Describe procedures for cathodic protection if needed for the tank;
☐	______	☑	☐	(3) Describe exterior painting and interior lining of the tank to protect it from the weather and the leachate stored;
☐	______	☑	☐	(4) Describe secondary containment design to ensure adequate capacity will be provided and compatibility of materials of construction;
☐	______	☑	☐	(5) Describe design to remove and dispose of stormwater from the secondary containment system;
☐	______	☑	☐	(6) Describe an overfill prevention system such as level sensors, gauges, alarms and shutoff controls to prevent overfilling;
☐	______	☑	☐	(7) Inspections, corrective action and reporting requirements;
☐	______	☑	☐	(a) Overfill prevention system weekly;
☐	______	☑	☐	(b) Exposed tank exteriors weekly;
☐	______	☑	☐	(c) Tank interiors when tank is drained or at least every three years;
☐	______	☑	☐	(d) Procedures for immediate corrective action if failures detected;
☐	______	☑	☐	(e) Inspection reports available for department review.
☐	______	☑	☐	c. Underground leachate storage tanks; (62-701.400(6)(d),FAC)

S	LOCATION	N/A	N/C	PART G CONTINUED
☐	______	☑	☐	(1) Describe materials of construction;
☐	______	☑	☐	(2) A double-walled tank design system to be used with the following requirements;
☐	______	☑	☐	(a) Interstitial space monitoring at least weekly;
☐	______	☑	☐	(b) Corrosion protection provided for primary tank interior and external surface of outer shell;
☐	______	☑	☐	(c) Interior tank coatings compatible with stored leachate;
☐	______	☑	☐	(d) Cathodic protection inspected weekly and repaired as needed;
☐	______	☑	☐	(3) Describe an overfill prevention system such as level sensors, gauges, alarms and shutoff controls to prevent overfilling and provide for weekly inspections;
☐	______	☑	☐	(4) Inspection reports available for department review.
☐	______	☑	☐	d.Schedule provided for routine maintenance of LCRS; (62-701.400(6)(e),FAC)
☐	______	☑	☐	6.Liner systems construction quality assurance (CQA); (62-701.400(7),FAC)
☐	______	☑	☐	a. Provide CQA Plan including:
☐	______	☑	☐	(1) Specifications and construction requirements for liner system;
☐	______	☑	☐	(2) Detailed description of quality control testing procedures and frequencies;
☐	______	☑	☐	(3) Identification of supervising professional engineer;
☐	______	☑	☐	(4) Identify responsibility and authority of all appropriate organizations and key personnel involved in the construction project;

S	LOCATION	N/A	N/C	PART G CONTINUED
☐	________	☑	☐	(5) State qualifications of CQA professional engineer and support personnel;
☐	________	☑	☐	(6) Description of CQA reporting forms and documents;
☐	________	☑	☐	b. An independent laboratory experienced in the testing of geosynthetics to perform required testing;
☐	________	☑	☐	7. Soil Liner CQA (62-701.400(8)FAC)
☐	________	☑	☐	a. Documentation that an adequate borrow source has been located with test results or description of the field exploration and laboratory testing program to define a suitable borrow source;
☐	________	☑	☐	b. Description of field test section construction and test methods to be implemented prior to liner installation;
☐	________	☑	☐	c. Description of field test methods including rejection criteria and corrective measures to insure proper liner installation.
☐	________	☑	☐	8. Surface water management systems; (62-701.400(9),FAC)
☐	________	☑	☐	a. Provide a copy of a Department permit for stormwater control or documentation that no such permit is required;
☐	________	☑	☐	b. Design of surface water management system to isolate surface water from waste filled areas and to control stormwater run-off;
☐	________	☑	☐	c. Details of stormwater control design including retention ponds, detention ponds, and drainage ways;
☐	________	☑	☐	9. Gas control systems; (62-701.400(10),FAC)
☐	________	☑	☐	a. Provide documentation that if the landfill is receiving degradable wastes, it will have a gas control system complying with the requirements of Rule 62-701.530, FAC;
☐	________	☑	☐	10. For landfills designed in ground water, provide documentation that the landfill will provide a degree of protection equivalent to landfills designed with bottom liners not in contact with ground water; (62-701.400(11),FAC)

PART H. HYDROGEOLOGICAL INVESTIGATION REQUIREMENTS (62-701.410(1), FAC)

S	LOCATION	N/A	N/C	
☐		☑	☐	1. Submit a hydrogeological investigation and site report including at least the following information:
☐		☑	☐	a. Regional and site specific geology and hydrogeology;
☐		☑	☐	b. Direction and rate of ground water and surface water flow including seasonal variations;
☐		☑	☐	c. Background quality of ground water and surface water;
☐		☑	☐	d. Any on-site hydraulic connections between aquifers;
☐		☑	☐	e. Site stratigraphy and aquifer characteristics for confining layers, semi-confining layers, and all aquifers below the landfill site that may be affected by the landfill;
☐		☑	☐	f. Description of topography, soil types and surface water drainage systems;
☐		☑	☐	g. Inventory of all public and private water wells within a one-mile radius of the landfill including, where available, well top of casing and bottom elevations, name of owner, age and usage of each well, stratigraphic unit screened, well construction technique and static water level;
☐		☑	☐	h. Identify and locate any existing contaminated areas on the site;
☐		☑	☐	i. Include a map showing the locations of all potable wells within 500 feet of the waste storage and disposal areas;
☐		☑	☐	2. Report signed, sealed and dated by PE and/or PG.

PART I. GEOTECHNICAL INVESTIGATION REQUIREMENTS (62-701.410(2),FAC)

S	LOCATION	N/A	N/C	
☐	______	☑	☐	1. Submit a geotechnical site investigation report defining the engineering properties of the site including at least the following:
☐	______	☑	☐	a. Description of subsurface conditions including soil stratigraphy and ground water table conditions;
☐	______	☑	☐	b. Investigate for the presence of muck, previously filled areas, soft ground, lineaments and sink holes;
☐	______	☑	☐	c. Estimates of average and maximum high water table across the site;
☐	______	☑	☐	d. Foundation analysis including:
☐	______	☑	☐	(1) Foundation bearing capacity analysis;
☐	______	☑	☐	(2) Total and differential subgrade settlement analysis;
☐	______	☑	☐	(3) Slope stability analysis;
☐	______	☑	☐	e. Description of methods used in the investigation and includes soil boring logs, laboratory results, analytical calculations, cross sections, interpretations and conclusions;
☐	______	☑	☐	f. An evaluation of fault areas, seismic impact zones, and unstable areas as described in 40 CFR 258.13, 40 CFR 258.14 and 40 CFR 258.15.
☐	______	☑	☐	2. Report signed, sealed and dated by PE and/or PG.

PART J. VERTICAL EXPANSION OF LANDFILLS (62-701.430,FAC)

S	LOCATION	N/A	N/C	
☐	______	☑	☐	1. Describe how the vertical expansion shall not cause or contribute to leachate leakage from the existing landfill, shall not cause objectionable odors, or adversely affect the closure design of the existing landfill;
☐	______	☑	☐	2. Describe how the vertical expansion over unlined landfills will meet the requirements of Rule 62-701.400, FAC with the exceptions of Rule 62-701.430(1)(c),FAC;
☐	______	☑	☐	3. Provide foundation and settlement analysis for the vertical expansion;
☐	______	☑	☐	4. Provide total settlement calculations demonstrating that the final elevations of the lining system, that gravity drainage, and that no other component of the design will be adversely affected;
☐	______	☑	☐	5. Minimum stability safety factor of 1.5 for the lining system component interface stability and deep stability;
☐	______	☑	☐	6. Provide documentation to show the surface water management system will not be adversely affected by the vertical expansion;
☐	______	☑	☐	7. Provide gas control designs to prevent accumulation of gas under the new liner for the vertical expansion.

PART K. LANDFILL OPERATION REQUIREMENTS (62-701.500,FAC)

S	LOCATION	N/A	N/C	
☐		☑	☐	1. Provide documentation that landfill will have at least one trained operator during operation and at least one trained spotter at each working face; (62-701.500(1),FAC)
☐		☑	☐	2. Provide a landfill operation plan including procedures for: (62-701.500(2), FAC)
☐		☑	☐	a. Designating responsible operating and maintenance personnel;
☐		☑	☐	b. Emergency preparedness and response, as required in subsection 62-701.320(16), FAC;
☐		☑	☐	c. Controlling types of waste received at the landfill;
☐		☑	☐	d. Weighing incoming waste;
☐		☑	☐	e. Vehicle traffic control and unloading;
☐		☑	☐	f. Method and sequence of filling waste;
☐		☑	☐	g. Waste compaction and application of cover;
☐		☑	☐	h. Operations of gas, leachate, and stormwater controls;
☐		☑	☐	i. Water quality monitoring.
☐		☑	☐	j. Maintaining and cleaning the leachate collection system;
☐		☑	☐	3. Provide a description of the landfill operation record to be used at the landfill; details as to location of where various operational records will be kept (i.e. FDEP permit, engineering drawings, water quality records, etc.) (62-701.500(3),FAC)
☐		☑	☐	4. Describe the waste records that will be compiled monthly and provided to the Department annually; (62-701.500(4),FAC)
		☑	☐	5. Describe methods of access control; (62-701.500(5),FAC)

S	LOCATION	N/A	N/C	PART K CONTINUED
☐		☑	☐	6. Describe load checking program to be implemented at the landfill to discourage disposal of unauthorized wastes at the landfill; (62-701.500(6),FAC)
☐		☑	☐	7. Describe procedures for spreading and compacting waste at the landfill that include: (62-701.500(7),FAC)
☐		☑	☐	a. Waste layer thickness and compaction frequencies;
☐		☑	☐	b. Special considerations for first layer of waste placed above liner and leachate collection system;
☐		☑	☐	c. Slopes of cell working face and side grades above land surface, planned lift depths during operation;
☐		☑	☐	d. Maximum width of working face;
☐		☑	☐	e. Description of type of initial cover to be used at the facility that controls:
☐		☑	☐	(1) Vector breeding/animal attraction
☐		☑	☐	(2) Fires
☐		☑	☐	(3) Odors
☐		☑	☐	(4) Blowing litter
☐		☑	☐	(5) Moisture infiltration
☐		☑	☐	f. Procedures for applying initial cover including minimum cover frequencies;
☐		☑	☐	g. Procedures for applying intermediate cover;
☐		☑	☐	h. Time frames for applying final cover;
☐		☑	☐	i. Procedures for controlling scavenging and salvaging.

S	LOCATION	N/A	N/C	PART K CONTINUED
●		☑	☐	j. Description of litter policing methods;
☐		☑	☐	k. Erosion control procedures.
☐		☑	☐	8. Describe operational procedures for leachate management including; (62-701.500(8),FAC)
☐		☑	☐	a. Leachate level monitoring, sampling, analysis and data results submitted to the Department;
☐		☑	☐	b. Operation and maintenance of leachate collection and removal system, and treatment as required;
☐		☑	☐	c. Procedures for managing leachate if it becomes regulated as a hazardous waste;
☐		☑	☐	d. Identification of treatment or disposal facilities that may be used for off-site discharge and treatment of leachate;
●		☑	☐	e. Contingency plan for managing leachate during emergencies or equipment problems;
☐		☑	☐	f. Procedures for recording quantities of leachate generated in gal/day and including this in the operating record;
☐		☑	☐	g. Procedures for comparing precipitation experienced at the landfill with leachate generation rates and including this information in the operating record;
☐		☑	☐	h. Procedures for water pressure cleaning or video inspecting leachate collection systems.
☐		☑	☐	9. Describe how the landfill receiving degradable wastes shall implement a gas management system meeting the requirements of Rule 62-701.530, FAC; (62-701.500(9),FAC)
☐		☑	☐	10. Describe procedures for operating and maintaining the landfill stormwater management system to comply with the requirements of Rule 62-701.400(9); (62-701.500(10),FAC)

S	LOCATION	N/A	N/C	PART K CONTINUED
☐		☑	☐	11. Equipment and operation feature requirements; (62-701.500(11),F
☐		☑	☐	a. Sufficient equipment for excavating, spreading, compacting and covering waste;
☐		☑	☐	b. Reserve equipment or arrangements to obtain additional equipment within 24 hours of breakdown;
☐		☑	☐	c. Communications equipment;
☐		☑	☐	d. Dust control methods;
☐		☑	☐	e. Fire protection capabilities and procedures for notifying local fire department authorities in emergencies;
☐		☑	☐	f. Litter control devices;
☐		☑	☐	g. Signs indicating operating authority, traffic flow, hours of operation, disposal restrictions.
☐		☑	☐	12. Provide a description of all-weather access road, inside perimeter road and other roads necessary for access which shall be provided at the landfill; (62-701.500(12),FAC)
☐		☑	☐	13. Additional record keeping and reporting requirements; (62-701.500(13),FAC)
☐		☑	☐	a. Records used for developing permit applications and supplemental information maintained for the design period of the landfill;
☐		☑	☐	b. Monitoring information, calibration and maintenance records, copies of reports required by permit maintained for at least 10 years;
☐		☑	☐	c. Maintain annual estimates of the remaining life of constructed landfills and of other permitted areas not yet constructed and submit this estimate annually to the Department;
☐		☑	☐	d. Procedures for archiving and retrieving records which are n than five year old.

PART L. **WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS** (62-701.510, FAC)

S	LOCATION	N/A	N/C	
☐	Part L	☐	☑	1. Water quality and leachate monitoring plan shall be submitted describing the proposed ground water, surface water and leachate monitoring systems and shall meet at least the following requirements;
☐	Part L	☐	☑	a. Based on the information obtained in the hydrogeological investigation and signed, dated and sealed by the PG or PE who prepared it; (62-701.510(2)(a),FAC)
☐	Part L	☐	☑	b. All sampling and analysis preformed in accordance with Chapter 62-160, FAC; (62-701.510(2)(b),FAC)
☐	Part L	☐	☑	c. Ground water monitoring requirements; (62-701.510(3),FAC)
☐	Part L	☐	☑	(1) Detection wells located downgradient from and within 50 feet of disposal units;
☐	Part L	☐	☑	(2) Downgradient compliance wells as required;
☐	Part L	☐	☑	(3) Background wells screened in all aquifers below the landfill that may be affected by the landfill;
☐	Part L	☐	☑	(4) Location information for each monitoring well;
☐	Part L	☐	☑	(5) Well spacing no greater than 500 feet apart for downgradient wells and no greater than 1500 feet apart for upgradient wells unless site specific conditions justify alternate well spacings;
☐	Part L	☐	☑	(6) Well screen locations properly selected;
☐	Part L	☐	☑	(7) Monitoring wells constructed to provide representative ground water samples;
☐	Part L	☐	☑	(8) Procedures for properly abandoning monitoring wells;
☐		☑	☐	(9) Detailed description of detection sensors if proposed.
☐	Part L	☐	☑	d. Surface water monitoring requirements; (62-701.510(4),FAC)

S	LOCATION	N/A	N/C	PART L CONTINUED
☐	Section L	☐	☑	(1) Location of and justification for all proposed surface water monitoring points;
☐	Section L	☐	☑	(2) Each monitoring location to be marked and its position determined by a registered Florida land surveyor;
☐	Section L	☐	☑	e. Leachate sampling locations proposed; (62-701.510(5),FAC)
☐	Section L	☐	☑	f. Initial and routine sampling frequency and requirements; (62-701.510(6),FAC)
☐	Section L	☐	☑	(1) Initial background ground water and surface water sampling and analysis requirements;
☐	Section L	☐	☑	(2) Routine leachate sampling and analysis requirements;
☐	Section L	☐	☑	(3) Routine monitoring well sampling and analysis requirements;
☐	Section L	☐	☑	(4) Routine surface water sampling and analysis requirements.
☐	Section L	☐	☑	g. Describe procedures for implementing evaluation monitoring, prevention measures and corrective action as required; (62-701.510(7),FAC)
☐	Section L	☐	☑	h. Water quality monitoring report requirements;(62-701.510(9),FAC)
☐	Section L	☐	☑	(1) Semi-annual report requirements (see paragraphs 62 701.510(6)(c),(d)and (e) for sampling frequencies);
☑	Section L.h. (2)	☐	☐	(2) Documentation that the water quality data shall be provided to the Department in an electronic format consistent with requirements for importing into Department databases, unless an alternate form of submittal is specified in the permit.
☑	Section L.h. (3)	☐	☐	(3) Two and one-half year report requirements, or every fi[illegible] years if in long-term care, signed, dated and sealed by [illegible] or PE.

PART M. **SPECIAL WASTE HANDLING REQUIREMENTS** (62-701.520, FAC)

S	LOCATION	N/A	N/C	
☐		☑	☐	1. Describe procedures for managing motor vehicles; (62-701.520(1),FAC)
☐		☑	☐	2. Describe procedures for landfilling shredded waste; (62-701.520(2),FAC)
☐		☑	☐	3. Describe procedures for asbestos waste disposal; (62-701.520(3),FAC)
☐		☑	☐	4. Describe procedures for disposal or management of contaminated soil; (62-701.520(4), FAC)
☐		☑	☐	5. Describe procedures for disposal of biological wastes; (62-701.520(5), FAC)

PART N. **GAS MANAGEMENT SYSTEM REQUIREMENTS** (62-701.530,FAC)

S	LOCATION	N/A	N/C	
☐	Part N.1	☐	☑	1. Provide the design for a gas management system that will (62-701.530(1), FAC):
☐	Part N.1	☐	☑	a. Be designed to prevent concentrations of combustible gases from exceeding 25% the LEL in structures and 100% the LEL at the property boundary;
☐	Part N.1	☐	☑	b. Be designed for site-specific conditions;
☐	Part N.1	☐	☑	c. Be designed to reduce gas pressure in the interior of the landfill;
☐	Part N.1	☐	☑	d. Be designed to not interfere with the liner, leachate control system or final cover.
☐	Part N.2	☐	☑	2. Provide documentation that will describe locations, construction details and procedures for monitoring gas at ambient monitoring points and with soil monitoring probes; (62-701.530(2), FAC):
☐	Part N.3	☐	☑	3. Provide documentation describing how the gas remediation plan and odor remediation plan will be implemented; (62-701.530(3), FAC):
	Part N.4	☐	☑	4. Landfill gas recovery facilities; (62-701.530(5), FAC):

S	LOCATION	N/A	N/C	PART N CONTINUED
☐	Part N.4	☐	☑	a. Information required in Rules 62-701.320(7) and 62-701.330(3), FAC supplied;
☐	Part N.4	☐	☑	b. Information required in Rule 62-701.600(4), FAC supplied where relevant and practical;
☐	Part N.4	☐	☑	c. Estimate of current and expected gas generation rates and description of condensate disposal methods provided;
☐	Part N.4	☐	☑	d. Description of procedures for condensate sampling, analyzing and data reporting provided;
☐	Part N.4	☐	☑	e. Closure plan provided describing methods to control gas after recovery facility ceases operation and any other requirements contained in Rule 62-701.400(10), FAC;
☐	Part N.4	☐	☑	f. Performance bond provided to cover closure costs if not already included in other landfill closure costs.

PART O. LANDFILL FINAL CLOSURE REQUIREMENTS (62-701.600,FAC)

S	LOCATION	N/A	N/C	
☑	Part O.1	☐	☐	1. Closure permit requirements; (62-701.600(2),FAC)
☑	Part O.1.a	☐	☐	a. Application submitted to Department at least 90 days prior to final receipt of wastes;
☑	Part O.1.b	☐	☐	b. Closure plan shall include the following:
☑	Part O.2	☐	☐	(1) Closure design plan;
☑	Part O.3	☐	☐	(2) Closure operation plan;
☑	Part Q	☐	☐	(3) Plan for long-term care;
☑	Part R	☐	☐	(4) A demonstration that proof of financial responsibility for long-term care will be provided.

S	LOCATION	N/A	N/C	PART O CONTINUED
☑	Part O.2	☐	☐	2. Closure design plan including the following requirements: (62-701.600(3),FAC)
☑	Part O.2.a	☐	☐	a. Plan sheet showing phases of site closing;
☑	Part O.2.b	☐	☐	b. Drawings showing existing topography and proposed final grades;
☑	Part O.2.c	☐	☐	c. Provisions to close units when they reach approved design dimensions;
☑	Part O.2.d	☐	☐	d. Final elevations before settlement;
☑	Part O.2.e	☐	☐	e. Side slope design including benches, terraces, down slope drainage ways, energy dissipaters and discussion of expected precipitation effects;
☑	Part O.2.f	☐	☐	f. Final cover installation plans including:
	Part O.2.f. (1)	☐	☐	(1) CQA plan for installing and testing final cover;
☑	Part O.2.f. (2)	☐	☐	(2) Schedule for installing final cover after final receipt of waste;
☑	Part O.2.f. (3)	☐	☐	(3) Description of drought-resistant species to be used in the vegetative cover;
☑	Part O.2.f. (4)	☐	☐	(4) Top gradient design to maximize runoff and minimize erosion;
☑	Part O.2.f. (5)	☐	☐	(5) Provisions for cover material to be used for final cover maintenance.
☑	Part O.2.g.	☐	☐	g. Final cover design requirements:
☑	Part O.2.g. (1)	☐	☐	(1) Protective soil layer design;
	Part O.2.g. (2)	☐	☐	(2) Barrier soil layer design;

S	LOCATION	N/A	N/C	PART O CONTINUED
☑	Part O.2.g. (3)	☐	☐	(3) Erosion control vegetation;
☑	Part O.2.g. (4)	☐	☐	(4) Geomembrane barrier layer design;
☑	Part O.2.g. (5)	☐	☐	(5) Geosynthetic clay liner design if used;
☑	Part O.2.g. (6)	☐	☐	(6) Stability analysis of the cover system and the disposed waste.
☑	Part Q.2.h	☐	☐	h. Proposed method of stormwater control;
☑	Part Q.2.i	☐	☐	i. Proposed method of access control;
☑	Part O.2.j. and Part N.1	☐	☐	j. Description of the proposed or existing gas management system which complies with Rule 62-701.530, FAC.
☑	Part O.3	☐	☐	3. Closure operation plan shall include:(62-701.600(4),FAC)
☑	Part O.3.a.	☐	☐	a. Detailed description of actions which will be taken to close the landfill;
☑	Part O.3.b.	☐	☐	b. Time schedule for completion of closing and long-term care;
☑	Part O.3.c.	☐	☐	c. Describe proposed method for demonstrating financial assurance for long-term care;
☑	Part O.3.d.	☐	☐	d. Operation of the water quality monitoring plan required in Rule 62-701.510, FAC.
☑	Part O.3.e.	☐	☐	e. Development and implementation of gas management system required in Rule 62-701.530, FAC.
☑	Part O.4	☐	☐	4. Certification of closure construction completion including: (62-701.600(6),FAC)
☐	Part O.4.a.	☑	☐	a. Survey monuments; (62-701.600(6)(a),FAC)
☑	Part O.4.b.	☐	☐	b. Final survey report; (62-701.600(6)(b),FAC)

S	LOCATION	N/A	N/C	PART O CONTINUED
☑	Part O.5	☐	☐	5. Declaration to the public; (62-701.600(7),FAC)
☑	Part O.6	☐	☐	6. Official date of closing; (62-701.600(8),FAC)
☑	Part O.7	☐	☐	7. Justification for and detailed description of procedures to be followed for temporary closure of the landfill, if desired; (62-701.600(9),FAC)

PART P. OTHER CLOSURE PROCEDURES (62-701.610,FAC)

S	LOCATION	N/A	N/C	
☑	Part P.1	☐	☐	1. Describe how the requirements for use of closed solid waste disposal areas will be achieved;(62-701.610(1),FAC)
☑	Part P.2	☐	☐	2. Describe how the requirements for relocation of wastes will be achieved; (62-701.610(2), FAC)

PART Q. LONG-TERM CARE (62-701.620,FAC)

S	LOCATION	N/A	N/C	
☑	Part Q.1	☐	☐	1. Maintaining the gas collection and monitoring system; (62-701.620(5), FAC)
☐	Part Q.2	☑	☐	2. Stabilization report requirements; (62-701.620(6),FAC)
☑	Part Q.3	☐	☐	3. Right of access;(62-701.620(7),FAC)
☑	Part Q.4	☐	☐	4. Requirements for replacement of monitoring devices; (62-701.620(8),FAC)
☑	Part Q.5	☐	☐	5. Completion of long-term care signed and sealed by professional engineer (62-701.620(9), FAC).

PART R. FINANCIAL ASSURANCE (62-701.630,FAC)

S	LOCATION	N/A	N/C	
☑	Part R.1	☐	☐	1. Provide cost estimates for closing, long-term care, and corrective action costs estimated by a PE for a third party performing the work, on a per unit basis, with the source of estimates indicated; (62-701.630(3)&(7), FAC).
☑	Part R.2	☐	☐	2. Describe procedures for providing annual cost adjustments to the Department based on inflation and changes in the closing, long-term care, and corrective action plans; (62-701.630(4)&(8), FAC).
☑	Part R.3	☐	☐	3. Describe funding mechanisms for providing proof of financial assurance and include appropriate financial assurance forms; (62-701.630(5),(6),&(9), FAC).
☐		☑	☐	4. Provide documentation and the appropriate forms for delaying submitting proof of financial assurance for solid waste disposal units that qualify; (62-701.630(2)(c), FAC).

PART S. CERTIFICATION BY APPLICANT AND ENGINEER OR PUBLIC OFFICER

Applicant:

The undersigned applicant or authorized representative of Sarasota County ________ is aware that statements made in this form and attached information are an application for a Landfill Closure Permit from the Florida Department of Environmental Protection and certifies that the information in this application is true, correct and complete to the best of his/her knowledge and belief. Further, the undersigned agrees to comply with the provisions of Chapter 403, Florida Statutes, and all rules and regulations of the Department. It is understood that the Permit is not transferable, and the Department will be notified prior to the sale or legal transfer of the permitted facility.

Lois E. Rose
Signature of Applicant or Agent

4000 Knights Trail Road
Mailing Address

Lois Rose, Manager, Solid Waste
Name and Title (please type)

Nokomis, Florida 34275
City, State, Zip Code

lerose@scgov.net
E-Mail address (if available)

(941) 650-0722
Telephone Number

Date: 4/30/10

Attach letter of authorization if agent is not a governmental official, owner, or corporate officer.

Professional Engineer registered in Florida (or Public Officer if authorized under Sections 403.707 and 403.7075, Florida Statutes):

This is to certify that the engineering features of this solid waste management facility have been designed/examined by me and found to conform to engineering principles applicable to such facilities. In my professional judgment, this facility, when properly maintained and operated, will comply with all applicable statutes of the State of Florida and rules of the Department. It is agreed that the undersigned will provide the applicant with a set of instructions of proper maintenance and operation of the facility.

Thomas M. Yanoschak
Signature

3733 National Drive, Suite 207
Mailing Address

Thomas M. Yanoschak, P.E., Proj. Eng.
Name and Title (please type)

Raleigh, North Carolina
City, State, Zip Code

thomas.yanoschak@hdrinc.com
E-Mail address (if available)

FL PE #44200 HDR CA#4213
Florida Registration Number
(please affix seal)

(919) 783-1118
Telephone Number

Date: 4/30/10

THOMAS M. YANOSCHAK
LICENSE
No. 44200
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

4/30/10

PART B
DISPOSAL FACILITY GENERAL INFORMATION

General information about the Central County Solid Waste Disposal Complex (CCSWDC) Class I landfill is described on pages 4 through 8 under Tab FDEP Permit Application, Section A.

Evidence that the landfill is located on a property recorded as a disposal site was provided as part of the permit application in Reference 1. This information has not changed.

PART D
PERMIT REQUIREMENTS

D.10 PROPERTY OWNERSHIP

Please refer to the documents submitted/referenced as part of Reference 1 listed in Part A. There have been no changes to this information.

D.12 ENFORCEMENT ACTION HISTORY

The following enforcement actions have occurred since submittal of the Phase II Construction/Operations Permit Application (Reference 1):

Executed Consent Order OGC Case No. 08-1728 dated October 8, 2008.

PART L
WATER QUALITY AND LEACHATE MONITORING REQUIREMENTS

An addendum to the CCSWDC Water Quality Monitoring Plan (WQMP) was submitted as part of Reference 2 that expanded the previously permitted monitoring system to include the Phase II expansion area. No changes to the amended water quality and leachate monitoring requirements are anticipated for the Phase I closure.

L.2.h.(2) Electronic Data Submittal

Electronic water quality data will be submitted to the Department in a format consistent with importing into the Department database or as specified in the permit.

L.2.h.(3) Summary Reports

A technical report, signed and sealed by a professional geologist or engineer, shall be submitted to the Department every two and one-half years during the active life of the facility, and every five years during the long-term care period. The report shall summarize and interpret the water quality and leachate monitoring results and water level measurements collected during the past two and one-half years.

Since Phase I and Phase II share a common water quality monitoring system, we respectfully request that the summary reports for Phase I and Phase II be kept on the same schedule for submittal in order to maintain consistency and to reduce number of reviews and documents for the Department..

PART N
GAS MANAGEMENT SYSTEM

N.1 GAS MANAGEMENT SYSTEM DESIGN

Tier II testing at the CCSWDC landfill indicates that the facility will not be generating more than 50 Mg of Non-Methane Organic Compounds (NMOC) until 2009. By 2010, a gas collection and control system design plan must be submitted to FDEP for approval, and within 18 months of this submittal date, a gas collection and control system must be constructed and operational.

An active gas management system currently is being constructed within Phase I under FDEP permit number 130542-009-SC/08 Reference 3 listed in Part A. The lower tier wells and associated piping will be complete by June 2010. The remaining wells and associated piping will be constructed as part of the Phase I closure. In the interim, gas will be managed within Phase I using operational practices described in the most current Operations Plan.

Sarasota County is currently exploring the beneficial use of landfill gas. If a feasible alternative is identified, a separate permit application for gas reuse will be submitted to FDEP.

N.2 MONITORING REQUIREMENTS

A landfill gas monitoring program is currently implemented at CCSWDC. This plan was expanded to include Phase II within the Water Quality Monitoring Plan Addendum which was included with Reference 2.

N.3 REMEDIATION PLANS

No changes to the implementation of landfill gas remediation plans are proposed for this closure construction permit application.

N.4 LANDFILL GAS RECOVERY FACILITIES

Detailed design information for the Phase I landfill gas management system was submitted with the gas management system permit application FDEP permit number 130542-009-SC/08 Reference 3 listed in Part A. The gas system will meet the following requirements:

- Prevent the concentration of combustible gases from exceeding 25 percent of the lower explosive limit (LEL) in structures on or off-site, excluding gas control or recovery components;
- Prevent the concentration of combustible gases from exceeding the LEL at or beyond the landfill property boundary;
- Be designed for site-specific conditions;
- Be designed to reduce gas pressure in the interior of the landfill by collecting the gases to prevent them from moving laterally;
- Collect gas from at least the uppermost two-thirds of the filled waste; and,

- Be designed to not interfere with or cause failure of the liner, leachate control systems, or final cover.

No changes to the gas management system provided in the 130542-009-SC/08 application (Reference 3) are proposed as part of this application.

PART O
LANDFILL FINAL CLOSURE REQUIREMENTS

O.1 CLOSURE PERMIT REQUIREMENTS

O.1.a Closure Construction Permit Application

This submittal serves as a request for a closure construction permit application for Phase I of the CCSWDC Class I landfill and is being submitted to FDEP at least 90 days before the date when wastes will no longer be accepted within Phase I.

O.1.b Closure Plan

The Closure and Long Term Care Plan for Phase I of the CCSWDC Class I landfill is provided in Appendix B.

O.2 CLOSURE DESIGN PLAN

The Closure Design Plan consists of the Closure Design Drawings included within Appendix A and a report on closing procedures that apply to the final closing of Phase I and installation of temporary final cover included in the Closure and Long Term Care Plan (Appendix B). The references provided below indicate where the requested information is provided within the Closure Design Drawings and Closure and Long Term Care Plan.

O.2.a Phases of Site Closing

Closure of all of Phase I will occur after Phase II is operational, which is estimated to begin in January 2011 assuming current disposal rates and in-place waste densities are maintained. The west and south sides of Phase I will eventually have additional waste placed against them when Phases II and III are constructed, respectively. Placement of final cover will therefore be limited to the top slope, and to the north and east sides of Phase I where no future lateral expansions are planned. A temporary final cover will be constructed on the south slope of Phase I. The temporary final cover would remain in place until Phase III is operational. Additional information is provided in Section 2.4.1 of the Closure and Long Term Care Plan.

O.4.b Existing Topography and Final Grades

This information is provided within the Closure Design Drawings provided in Appendix A.

O.2.c Provisions for Staged Closure

Final closure and installation of temporary final cover within Phase I will occur as a single construction project. Future phases at the CCSWDC will be closed as design capacities are reached.

O.2.d Final Elevations Before Settlement

The proposed final elevations before settlement for Phase I are provided on Sheet C-05 of the Closure Design Drawings.

O.2.e Side Slope Design

The side slope design for Phase I is shown on Sheet C-05 of the Closure Design Drawings. Geotechnical Investigation Report and Water Quality Monitoring Plan requirements related to the Phase I closure are addressed within Section 2.3.2 and 2.3.3 respectively of the Closure and Long Term Care Plan provided in Appendix B. Final cover stability is addressed in Attachment O.1 of this Engineering Report.

A discussion of the side slope design is provided in Section 2.4.5 of the Closure and Long Term Care Plan. Final cover drainage calculations demonstrating the adequacy of the side slope design are provided in Attachment O.2 of this Engineering Report.

O.2.f Final Cover Installation Plans

Phase I final cover installation plans are provided within the Closure Design Drawings in Appendix A.

O.2.f (1) CQA Plan

The Construction Quality Assurance (CQA) Plan for the Phase I Closure is provided in Appendix C.

O.2.f (2) Schedule

Please refer to Appendix B Section 2.4.7.

O.2.f (3) Vegetative Cover

Please refer to Appendix B Section 2.4.7

O.2.f (4) Top Gradient Design

Please refer to Appendix B Section 2.4.7

O.2.f (5) Final Cover Maintenance

Please refer to Appendix B Section 2.4.7

O.2.g Final Cover Design Requirements

The Phase I final cover and temporary final cover design is provided on Sheet C-12 of the Closure Design Drawings. A description of the final cover and temporary final cover design is provided within Section 2.4.6 of the Closure and Long Term Care Plan (Appendix B). Specifications for the materials to be used for final cover and temporary final cover construction are included in the Technical Specifications provided in Appendix D. Temporary Final Cover Calculations demonstrating the feasibility of the exposed geomembrane cover are provided in Attachment O.3 of this Engineering Report.

O.2.g (1) Protective Soil Layer Design

Please refer to Appendix B Section 2.4.6

O.2.g (2) Barrier Soil Layer Design

A barrier soil design is not applicable to the Phase I closure.

O.2.g (3) Erosion Control Vegetation

Please refer to Appendix B Section 2.4.6

O.2.g (4) Geomembrane Barrier Layer Design

Please refer to Appendix B Section 2.4.6

O.2.g (5) Geosynthetic Clay Liner Design (if used)

A geosynthetic clay liner design is not applicable to the Phase I closure.

O.2.g (6) Cover System Stability Analysis

Final cover stability is addressed in Attachment O.1 of this Engineering Report.

Please refer to Appendix B Section 2.4.6 for additional information.

O.2.h Stormwater Control

Stormwater control for the Phase I closure is addressed in Section 2.4.8 of the Closure and Long Term Care Plan. Drainage calculations for the Phase I closure are provided within Attachment O.2 of this Engineering Report.

O.2.i Access Control

Access control for the CCSWDC site is addressed in Section 2.4.9 of the Closure and Long Term Care Plan.

O.2.j Gas Management System

As previously discussed, a separate permit application for a gas management system within Phase I was submitted and approved by the FDEP in July 2009. Please refer to Apppendix B Section 2.3.5.

O.3 CLOSURE OPERATION PLAN

The information required for the Closure Operation Plan is provided in Section 2.5 of the Closure and Long Term Care Plan.

O.3.a Actions to Close Landfill

Please refer to Appendix B Section 2.5.1.

O.3.b Time Schedule

This closure construction application is being prepared for the final closure of Phase I of the CCSWDC Class I landfill with the exception of the installation of the temporary final cover on the south slope of Phase I where construction of a future phase is anticipated. A permit application was submitted and approved for the Phase II expansion (Reference 1) of the Class I landfill which will be contiguous to the west slope of Phase I. It is anticipated that Phase II will be in operation at the time of Phase I closure.

For additional information please refer to Appendix B Section 2.5.2.

O.3.c Financial Responsibility

Please refer to Appendix B Section 2.5.4 and Part R.

O.3.d Operation of the Water Quality Monitoring Plan

Please refer to Part L of this application.

O.3.e Gas Management System

Please refer to Appendix Section 2.3.5.

O.4 CERTIFICATION OF CLOSURE CONSTRUCTION COMPLETION

After closure construction has been completed, the Engineer or Record will certify to the Department on Form 62-701.900(2) that the closure and is complete and that it was done in accordance with the plans submitted to the Department except where minor deviations were necessary.. All deviations will be described in detail and the reasons therefore enumerated.

O.3.a Survey Monuments

The final elevation of the Phase I Closure will be greater than 20 feet above the natural land surface, therefore this requirements is not applicable. Additional information is provided in Appendix B Section 3.1.

O.3.b Final Survey Report

The final elevation of the Phase I Closure will be greater than 20 feet above the natural land surface, therefore, a final survey will be performed after closure is complete by an engineer or a Florida Licensed Professional Surveyor and Mapper to verify that final contours and elevations of the facility are in accordance with the plans as approved by the permit. The survey will be submitted with the certification of construction completion report and may be performed using aerial mapping techniques with equivalent accuracy and a minimum of 5 foot contours.

Additional information is provided in Appendix B Section 3.2.

O.5 DECLARATION TO THE PUBLIC

After closure construction has been completed, the Engineer or Record will certify to the Department on Form 62-701.900(2) that the closure and is complete and that it was done in accordance with the plans submitted to the Department except where minor deviations were necessary. All deviations will be described in detail and the reasons therefore enumerated.

Additional information is provided in Appendix B Section 3.4.

O.6 OFFICIAL DATE OF CLOSING

Please refer to Appendix B Section 3.5.

O.7 TEMPORARY FINAL COVER – SOUTH SIDE SLOPE

A temporary final cover using a geosynthetic material (TPO) will be constructed on the south slope of Phase I. The temporary final cover would remain in place until Phase III is operational.

Exposed Geomembrane Cover Bedding Layer

The exposed geomembrane cover (EGC) is installed on a bedding layer comprised of the intermediate cover. The surface will be inspected for suitability of membrane placement. The bedding layer soil will have a maximum particle size of 1/2 inch, as required by the geomembrane manufacturer. The soils will be compacted to 90 percent of Standard Proctor maximum dry density to ensure a firm foundation for gemembrane placement.

Geomembrane Selection and Installation

The specific geomembrane requirements were developed considering the following criteria:

- Resistance to degradation due to exposure to direct sunlight;
- Strength to handle wind uplift and potential landfill gas pressure forces;
- Durability to withstand walking or low ground pressure vehicles, hail, birds and falling debris; and
- Compatibility with laminated solar panels.

The selected geomembrane material will be a scrim reinforced 60-mil Thermoplastic Polyolefin (TPO). A polyolefin is a class of polymer made by polymerizing relatively simple olefins, including ethyl, propylene, butenes, isoprenes, and pentenes. TPOs are highly resistant to tears, impacts, and punctures with flexibility to accommodate any settlement beneath the geomembrane. TPO has long been used in outdoor roofing applications because of its durability and its long-term resistance to degradation by solar UV radiation. The suitability for the exposed outdoor application is supported by the manufacturers warranty on the material performance. Additional information and detail regarding selection of the TPO as the EGC for the Central County Landfill is provided in Attachment O.4. A list of minimum material properties to guide performance measurement is provided as part of the Construction Quality Assurance Plan. Finally, as discussed in the pre-application meeting with the Department, the TPO material has been approved by the Northeast District FDEP for use as an interim cover material at the Steelfield Road Landfill in Bay County. The permit for the Steelfield Road Landfill issued by the Northeast District authorizing the use of the TPO is provided for the Department's reference in Attachment O.4.

The TPO geomembrane will be installed over the bedding layer. The top of the bedding layer will be graded and rolled smooth prior to installation of the TPO geomembrane and will be free of rocks, stones, sticks, roots, sharp objects, and debris. The surface will provide a firm foundation for the TPO geomembrane. The TPO geomembrane layer will be constructed as multiple individual panels welded together. The majority of the welds will be formed by using a hot wedge welder which fuses the two overlapping sheets together. All field seams will be made utilizing hot wedge welding techniques in accordance with industry standards. However, when hot wedge welding is not feasible, hot air welding is allowed per Manufacturer recommendations. Air lance testing, per ASTM D4437, will be used for non-destructive seam testing of hot air seams and wedge welds without the air channel.

The site has an active landfill gas collection system. The headers and laterals to the landfill gas system are currently buried and will remain beneath the TPO geomembrane. Landfill gas wells which extend through the geomembrane surface will be fitted using well boots manufactured with the TPO geomembrane material. The well boots will be welded to the primary TPO geomembrane in accordance with the welding procedures for the primary geomembrane.

PART P
CLOSURE PROCEDURES

Closure procedures for Phase I of the CCSWDC Class I Landfill are included in the Closure and Long Term Care Plan located in Appendix B. The following requested information is provided within the referenced sections of the Closure and Long Term Care Plan.

P.1 USE OF CLOSED LANDFILL AREAS

The use of closed landfill areas is discussed in Section 3.6 of the Closure and Long Term Care Plan provided in Appendix B.

P.2 RELOCATION OF WASTE

The relocation of waste after closure of Phase I is addressed in Section 3.7 of the Closure and Long Term Care Plan provided in Appendix B.

PART Q
LONG TERM CARE REQUIREMENTS

The long term care requirements for Phase I of the CCSWDC Class I Landfill are included in the Closure and Long Term Care Plan located in Appendix B. The following requested information is provided within the referenced sections of the Closure and Long Term Care Plan.

Q.1 GAS MONITORING

Landfill gas monitoring with respect to long term care is addressed in Section 4.7.2 of the Closure and Long Term Care Plan.

Q.2 STABILIZATION REPORT

Since only a portion of Phase I is receiving final cover and the adjacent Phase II landfill is active, Phase I will not enter the long-term care period in accordance with the official date of closing requirements (Rule 62-701.600(8), F.A.C.), therefore, the stabilization report will be required until the facility enters the long-term care period.

The final cover will be maintained during this time in accordance with Section 4.0 of the Closure and Long Term Care Plan provided in Appendix B.

Q.2 RIGHT OF ACCESS

Post closure rights of access are discussed in Section 4.0 of the Closure and Long Term Care Plan provided in Appendix B.

Q.4 REPLACEMENT OF MONITORING DEVICES

The replacement of monitoring devices is discussed in Section 4.7 of the Closure and Long Term Care Plan provided in Appendix B.

Q.5 COMPLETION OF LONG TERM CARE

Upon completion of the long-term care period, Sarasota County will certify to the FDEP that the long-term care was completed in accordance with the closure plan as permitted. The certification will be signed and sealed by a professional engineer.

PART R
FINANCIAL RESPONSIBILITY REQUIREMENTS

R.1 COST ESTIMATES

A full financial assurance cost estimate for closing and long-term care of Phase I and Phase II of the CCSWDC Class I Landfill was last submitted to the Department dated August 29, 2008. This cost estimate has been adjusted annually using the Department-approved inflation factor in 2009 and 2010. The most current FDEP approval letter dated March 22, 2010, for the Phase I and Phase II closure and long-term care cost estimate is provided in Attachment R.1. As discussed in Section R.3 below, the County has maintained sufficient proof of financial assurance for the closure activities for Phase I described in this permit application.

Upon completion of construction and final certification by the Department of the closure activities described in this application, the County will submit an updated financial assurance cost estimate form for Phase I and Phase II to reflect, at a minimum, the following:

- Reduce the closure quantities for the portions of Phase I that have received final cover.
- Reduce the active gas collection quantities to reflect the gas collection system components installed.
- Increase the cost estimate to include the removal of the TPO geomembrane installed on the south slope of Phase I as temporary final cover.

R.2 ANNUAL COST ADJUSTMENTS

Sarasota County will provide FDEP with annual cost adjustments for closure and long-term care of the CCSWDC Class I Landfill in the form of inflation factor adjustments or by recalculation in the event of changes to the closure or long-term care plan in accordance with FAC 62-701.630(4). If corrective actions are required in the future, these will be adjusted in accordance with FAC 62-701.630(8). Once the Phase I closure construction is complete, Sarasota County may elect to remove the Phase I acreage from the annual closure cost estimates.

R.3 FUNDING MECHANISM

Sarasota County currently demonstrates that sufficient funds exist for closure and long-term care costs for Phases I and II of the CCSWDC Class I Landfill using a financial test. The County submits proof of financial assurance annually to the Department. The most current approval letter from the Department for the County's financial assurance mechanism is provided in Attachment R.2. It is anticipated that the financial test will continue to be used through the remaining life of the landfill.

ATTACHMENT O.1
FINAL COVER STABILITY ANALYSIS

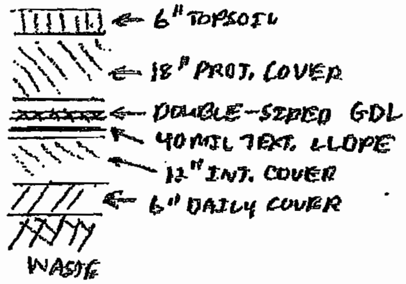
HDR | ONE COMPANY *Many Solutions*

Project: CCSWDC		Computed: Tmy	Date: 10/16/08
Subject: Phase I Closure Permit		Checked: DTD	Date: 1/21/10
Task: Veneer Slope Stability		Page: 1	of: 5
Job #: 88765		No:	

PURPOSE: Evaluate veneer stability of proposed final cover system for Phase I of CCSWDC Class I landfill.

ASSUMPTIONS: ① Max. sideslope = 3:1

② Final Cover design:



③ GDL is size such that hydrostatic and seepage forces do not develop within the final cover soils.

PROCEDURE:

Select frictional properties of geosynthetic interfaces:

① Protective Cover / GDL

From Att. A, $\phi_{peak} = 27^\circ$ (conservatively neglect cohesion)

② GDL / Text. LLDPE

From Att. B, $\phi_{peak} = 26^\circ$ (conservatively neglect cohesion)

③ Text. LLDPE / Granular Soil

From Att. C, $\phi_{peak} = 26^\circ$ (conservatively neglect cohesion)

Project:		Computed:	Date:
Subject:		Checked:	Date:
Task:		Page: 2	of: 5
Job #:		No:	

HDR | ONE COMPANY *Many Solutions*

Use methodology in "Geotechnical Aspects of Landfill Design and Construction", X. Qian et al., Prentice Hall, 2002. (See Att. D for formulas & definitions)

Case 1 – Cover Soil (Gravitational) Forces

$$FS = \frac{-b \pm (b^2 - 4ac)^{0.5}}{2a}$$

Where: (1) $a = (W_A - N_A \cdot \cos\beta) \cdot \cos\beta$

β = slope angle = $\tan^{-1}(\frac{1}{3}) = 18.43°$

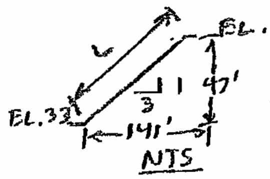
$W_A = \gamma h^2 (L/h - 1/\sin\beta - \tan\beta/2)$

γ = unit wt of cover soil

From Att. E, typical γ for mildly compacted sand ≈ 115 lb/ft³ (wet wt).

h = thickness of cover soil = 2 ft

L = length of slope measured along geomembrane



$L_{max} = \sqrt{47^2 + 141^2}$
$= 149$ ft

$\therefore W_A = 115(2)^2(149/2 - 1/\sin 18.43° - \tan\frac{18.43°}{2})$
$= \underline{32,740 \text{ lbs}}$ = wt. of active wedge

$N_A = W_A \cos\beta = 32,740 \text{ lbs} (\cos 18.43°) = \underline{31,061 \text{ lbs}}$

$\therefore a = (W_A - N_A \cdot \cos\beta)\cos\beta$
$= (32,740 - 31,061 \cos 18.43°)\cos 18.43°$
$= \underline{3104}$ ✓

(2.) $b = -[(W_A - N_A \cos\beta) \cdot \sin\beta \cdot \tan\phi + (N_A \cdot \tan\delta + C_a)\sin\beta \cdot \cos\beta + (c + W_p \cdot \tan\phi) \cdot \sin\beta]$

ϕ = friction angle of cover soil ≈ 33° for moderately compacted sand (See Att. F)

δ = min. interface friction angle between soil and geosynthetics = 26°.

$W_p = \frac{\gamma h^2}{\sin 2\beta} = \frac{115(2)^2}{\sin 2(18.43°)} = \underline{767\ lb}$

$C_a = c_a\ (L - h/\sin\beta)$ where c_a = adhesion between soil and geomembrane = 0 (conservative assumption)

$\therefore\ C_a = 0$

C = Cohesive force along the failure plane of the passive wedge = 0 (Assume non-cohesive soil)

$\therefore\ b = -[(32{,}740 - 31{,}061 \cos 18.43°) \sin 18.43° \cdot \tan 33°$
$+ (31{,}061 \tan 26° + 0) \sin 18.43° \cdot \cos 18.43°$
$+ (0 + 767 \tan 33°) \sin 18.43°]$
$= -[672 + 4544 + 157] = \underline{-5373}$

③ $c = (N_A \cdot \tan\delta + C_a) \sin^2\beta \cdot \tan\phi$

$\therefore\ c = (31{,}061 \tan 26° + 0) \sin^2 18.43° \tan 33°$
$= \underline{983}$ ✓

$\therefore\ FS = \frac{-(-5373) \pm (-5373^2 - 4(3104)(983))^{0.5}}{2(3104)}$

$FS = \frac{5373 \pm 4082}{6208} = \boxed{1.52}$ or $\cancel{0.21}$ Not Realistic   OK

Case 2 – Cover Soil W/ Equipment Loading and Accelleration

Assume low ground pressure dozer will be used with max contact pressure of 10 psi. Assume track configuration of CAT D6. Assume cover placed from bottom of slope up.

$$FS = \frac{-b \pm (b^2 - 4ac)^{0.5}}{2a}$$

Where: ① $a = [(W_A + W_e) \sin\beta + F_e] \cos\beta$

$W_A = 32{,}740\ lbs$

W_e = equivalent equipment force per unit width at geosynthetic interface.

$We = q\,w\,I$ where: q = dozer contact pressure = 10 psi = 1,440 psf
w = length of equipment track = 104 in = 8.67 ft (See Att. G)
I = influence factor (See Fig. 13.7, Att. D)
b = width of equipment track = 30 in = 2.5 ft
$b/h = 2.5/2 = 1.25$
$I = 0.95$

$\therefore We = 1{,}440\ \text{lb/ft}^2\ (8.67\text{ft})(0.95) = \underline{11{,}861\ \text{lb/ft}}$

Fe = dynamic force per unit width parallel to slope at geosynthetic interface,
$Fe = W_e\ (a/g)$ where:
a = acceleration of const. equipment

Assume dozer placing final cover achieves max. speed of 20 km/hr within 3 seconds. From Fig. 13.9 of Att. D, corresponding accelleration is 0.20g

$\therefore Fe = 11{,}861\ \text{lb/ft}\left(\frac{0.20g}{g}\right) \approx \underline{2{,}372\ \text{lb/ft}}$

$\therefore q = [(32{,}740 + 11{,}861)\sin 18.43° + 2{,}372]\cos 18.43°$
$= \underline{15{,}628}$

(b) $b = -\{[(N_A + N_e)\cdot\tan\delta + C_a]\cdot\cos\beta + [(W_A + W_e)\sin\beta + F_e]\cdot\sin\beta\cdot\tan\phi + (C + W_p\cdot\tan\phi)\}$

where: N_A = 31,061 lbs
N_e = eff. equip. force normal to failure plane of active wedge
$= W_e\cdot\cos\beta = 11{,}861\ \text{lb/ft}\ (\cos 18.43°) = \underline{11{,}253}\ \text{lb/ft}$
$\delta = 26°$
$C_a = 0$
W_A = 32,740 lbs
W_e = 11,861 lbs/ft
F_e = 2,372 lb/ft
$\phi = 33°$
$C = 0$
W_p = 767 lb

$$\therefore\ b = -\{[(31{,}061 + 11{,}253)\tan 26^\circ + 0]\cos 18.43^\circ$$
$$+ [(32{,}740 + 11{,}861)\sin 18.43^\circ + 2{,}372]\sin 18.43^\circ \tan 33^\circ$$
$$+ (0 + 767\tan 33^\circ)\}$$
$$= -\{19{,}579 + 3{,}382 + 498\} = \underline{\underline{-23{,}459}}$$

③. $c = [(N_A + N_e)\tan\delta + C_a]\sin\beta \cdot \tan\phi$

$$= [(31{,}061 + 11{,}253)\tan 26^\circ + 0]\sin 18.43^\circ \tan 33^\circ$$
$$= \underline{\underline{4237}}$$

$$\therefore\ FS = \frac{-(-23{,}459) \pm \left(-23{,}459^2 - 4(15{,}628)(4237)\right)^{0.5}}{2(15{,}628)}$$

$$= \frac{23{,}459 \pm 16{,}896}{31{,}256} = \boxed{1.29} \text{ or } \cancel{0.21}$$

Not realistic

Ok

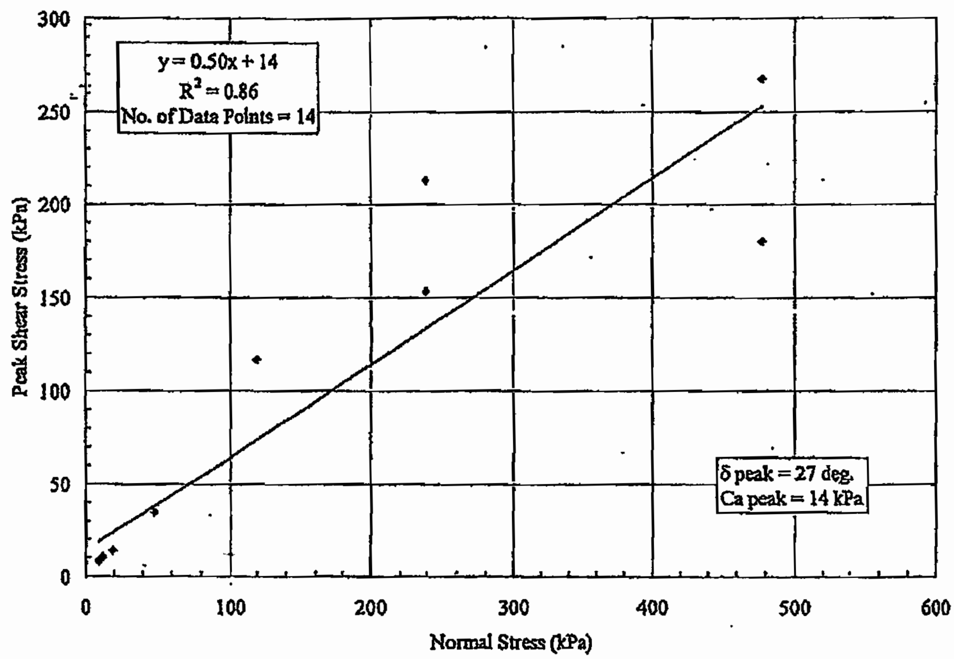
CONCLUSIONS:

Factor of safety of 1.52 for the long-term stability of the final cover system due to gravitational forces (Case 1) is sufficient.

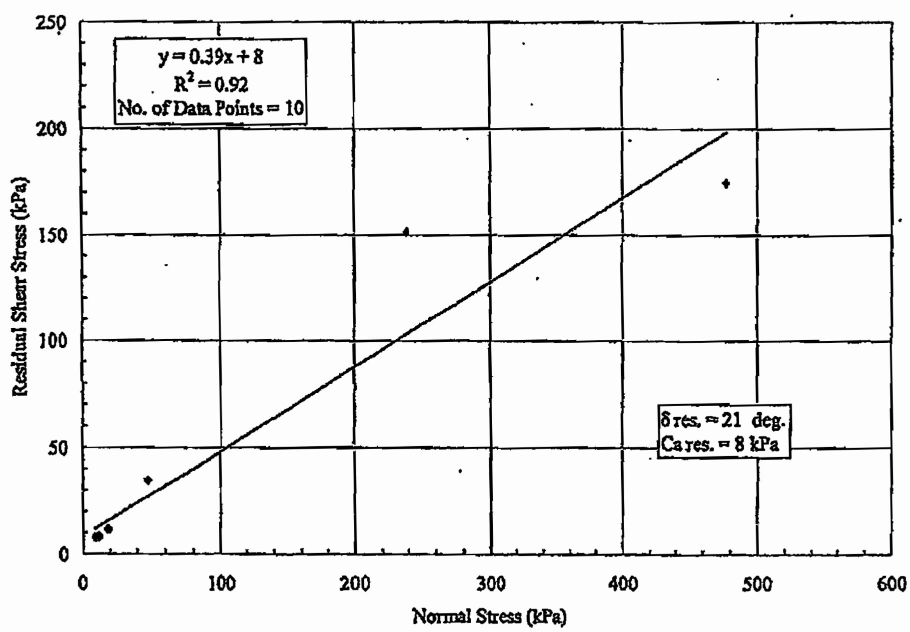
Factor of safety of 1.29 temporary equipment loading during construction (Case 2) is sufficient.

Therefore proposed final cover design is adequately stable.

ATTACHMENT A

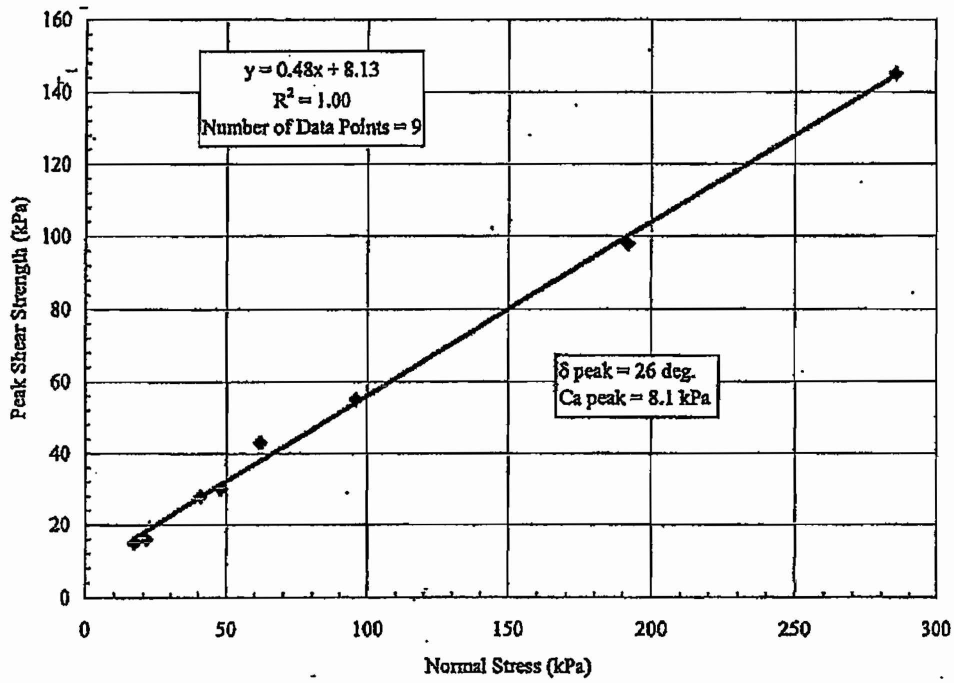


Appendix Figure 13a - Peak Shear Strength; Drainage Geocomposite against Granular Soil.

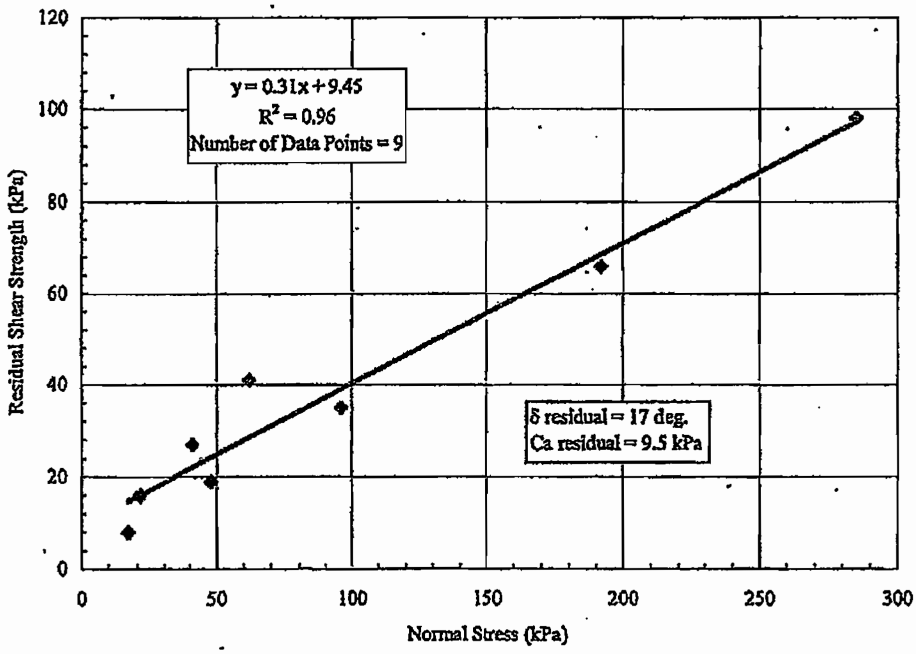


Appendix Figure 13b - Residual Shear Strength; Drainage Geocomposite against Granular Soil.

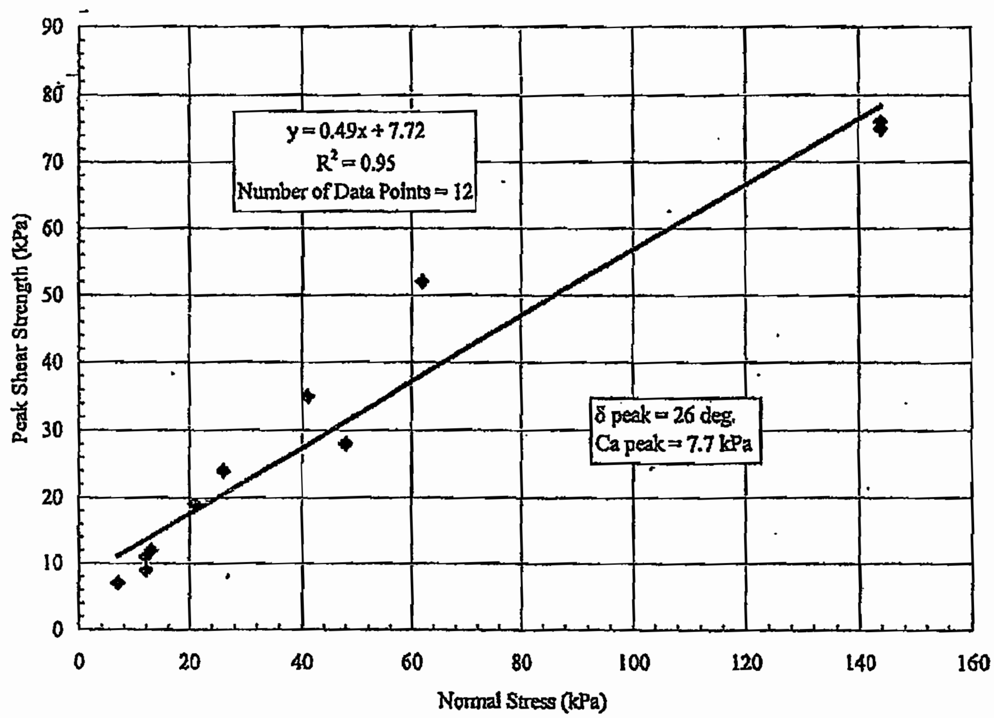
ATTACHMENT B



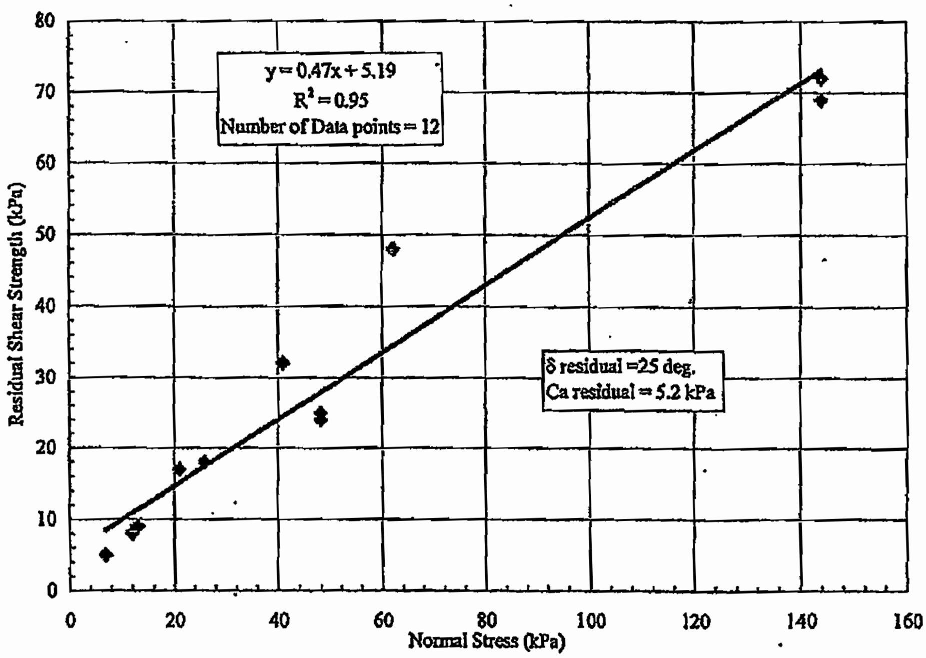
Appendix Figure 4e -Peak Shear Strength; Textured LLDPE against NW-NP Geotextile. .



Appendix Figure 4f - Residual Shear Strength; Textured LLDPE against NW-NP Geotextile.



Appendix Figure 4a -Peak Shear Strength; Textured LLDPE against Granular Soil.



Appendix Figure 4b - Residual Shear Strength; Textured LLDPE against Granular Soil.

ATTACHMENT D

13.4 VENEER SLOPE STABILITY ANALYSES

This section treats the standard veneer slope stability problem [as shown in Figure 13.1(a) and (b)] and then superimposes upon it a number of situations, all which tend to destabilize slopes. Included are gravitational, construction equipment, seepage and seismic forces, respectively. Each will be illustrated by a design graph and a numeric example.

13.4.1 Cover Soil (Gravitational) Forces

Figure 13.3 illustrates the common situation of a finite-length, uniformly-thick cover soil placed over a liner material at a slope angle β. It includes a passive wedge at the toe and has a tension crack on the crest. The analysis that follows is from Koerner and Soong (1998), but it is similar to Koerner and Hwu (1991). Comparable analyses are also available from Giroud and Beech (1989), McKelvey and Deutsch (1991), and others.

The symbols used in Figure 13.3 are defined a follows:

W_A = total weight of the active wedge
W_P = total weight of the passive wedge
N_A = effective force normal to the failure plane of the active wedge
N_P = effective force normal to the failure plane of the passive wedge
γ = unit weight of the cover soil
h = thickness of the cover soil
L = length of slope measured along the geomembrane
β = soil slope angle beneath the geomembrane

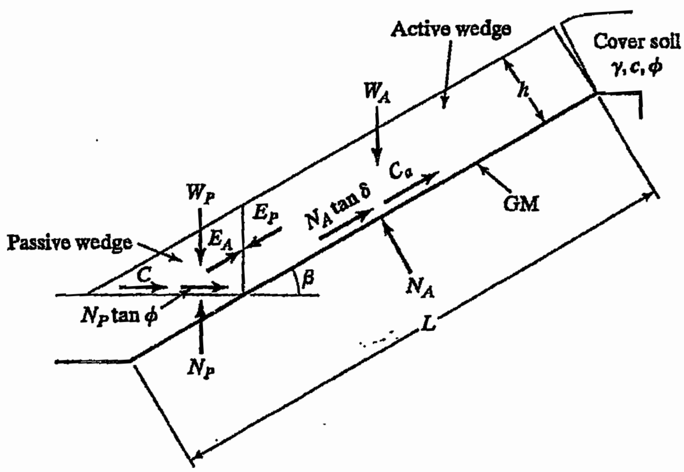


FIGURE 13.3 Limit Equilibrium Forces Involved in a Finite Length Slope Analysis for a Uniformly Thick Cover Soil

ϕ = friction angle of the cover soil
δ = interface friction angle between cover soil and geomembrane
C_a = adhesive force between cover soil of the active wedge and the geomembrane
c_a = adhesion between cover soil of the active wedge and the geomembrane
C = cohesive force along the failure plane of the passive wedge
c = cohesion of the cover soil
E_A = interwedge force acting on the active wedge from the passive wedge
E_p = interwedge force acting on the passive wedge from the active wedge
FS = factor of safety against cover soil sliding on the geomembrane.

The expression for determining the factor of safety can be derived as follows. Considering the active wedge, the forces acting on it are

$$W_A = \gamma \cdot h^2 \cdot (L/h - 1/\sin\beta - \tan\beta/2)$$
$$N_A = W_A \cdot \cos\beta$$
$$C_a = c_a \cdot (L - h/\sin\beta)$$

By balancing the forces in the vertical direction, the following formulation results:

$$E_A \cdot \sin\beta = W_A - N_A \cdot \cos\beta - \frac{N_A \cdot \tan\delta + C_a}{FS}$$

Hence, the interwedge force acting on the active wedge is

$$E_A = \frac{(FS)(W_A - N_A \cdot \cos\beta) - (N_A \cdot \tan\delta + C_a) \cdot \sin\beta}{\sin\beta \cdot (FS)} \qquad (13.7)$$

The passive wedge can be considered in a similar manner:

$$W_P = \frac{\gamma \cdot h^2}{\sin 2\beta}$$
$$N_P = W_P + E_P \cdot \sin\beta$$
$$C = \frac{c \cdot h}{\sin\beta} \qquad (13.8)$$

By balancing the forces in the horizontal direction, the following formulation results:

$$E_P \cdot \cos\beta = \frac{C + N_P \cdot \tan\phi}{FS}$$

Hence, the interwedge force acting on the passive wedge is

$$E_P = \frac{C + W_P \cdot \tan\phi}{\cos\beta \cdot (FS) - \sin\beta \cdot \tan\phi}$$

By setting $E_A = E_P$, the resulting equation can be arranged in the form of the quadratic equation $ax^2 + bx + c = 0$, which in this case, using *FS*-values, results in

$$a \cdot FS^2 + b \cdot FS + c = 0$$

The resulting *FS*-value is then obtained from the conventional solution of the quadratic equation, which gives

$$FS = \frac{-b \pm (b^2 - 4 \cdot a \cdot c)^{0.5}}{2 \cdot a} \tag{13.9}$$

where
$$a = (W_A - N_A \cdot \cos\beta) \cdot \cos\beta$$
$$b = -[(W_A - N_A \cdot \cos\beta) \cdot \sin\beta \cdot \tan\phi + (N_A \cdot \tan\delta + C_a) \cdot \sin\beta \cdot \cos\beta + (C + W_P \cdot \tan\phi) \cdot \sin\beta]$$
$$c = (N_A \cdot \tan\delta + C_a) \cdot \sin^2\beta \cdot \tan\phi$$

When the calculated *FS*-value falls below 1.0, sliding of the cover soil on the geomembrane is to be anticipated. Thus, a value of greater than 1.0 must be targeted as being the minimum factor of safety. How much greater than 1.0 the *FS*-value should be, is a design and/or regulatory issue. Recommendations for minimum allowable *FS*-values under different conditions are available in Koerner and Soong (1998). In order to better illustrate the implications of Equations 13.9, typical design curves for various *FS*-values as a function of slope angle and interface friction angle are given in Figure 13.4. Note that the curves are developed specifically for the variables stated in the legend of the figure. Example 13.1 illustrates the use of the analytic development and the

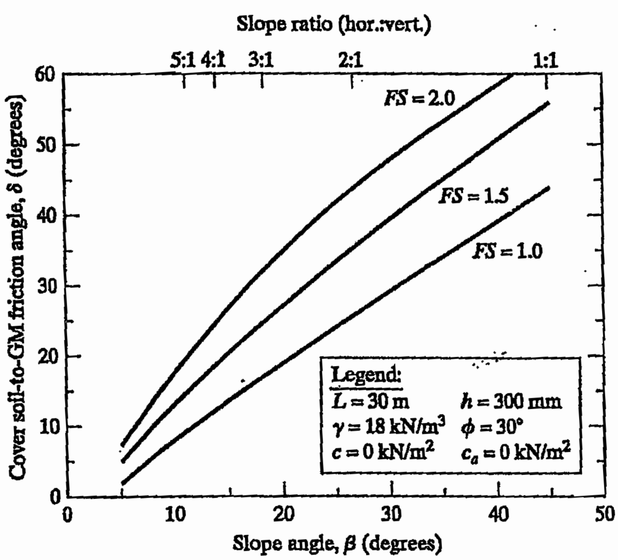


FIGURE 13.4 Design Curves for Stability of Uniform-Thickness Cohesionless Cover Soils on Linear Failure Planes for Various Global Factors of Safety

resulting design curves in what will be the standard example to which others [illegible] will be considered as compared.

EXAMPLE 13.1

The following are given: a 30-m slope with a uniformly thick 300-mm-deep cover soil [illegible] weight of 18 kN/m^3. The soil has a friction angle of 30° and zero cohesion (i.e., it is a [illegible] cover soil is placed directly on a geomembrane as shown in Figure 13.3. Direct shear [illegible] resulted in an interface friction angle between the cover soil and geomembrane of 22° [illegible] adhesion. What is the *FS*-value at a slope angle of 3(H)-to-1(V) (i.e., 18.4°)?

Solution Using Equation 13.9 to solve for the *FS*-value results in a value of 1.25, which [illegible] to be in agreement with the curves of Figure 13.4:

$$a = 14.7 \text{ kN/m}$$
$$b = -21.3 \text{ kN/m}$$
$$c = 3.5 \text{ kN/m}$$

Thus, $FS = 1.25$

This value can be confirmed using Figure 13.4.

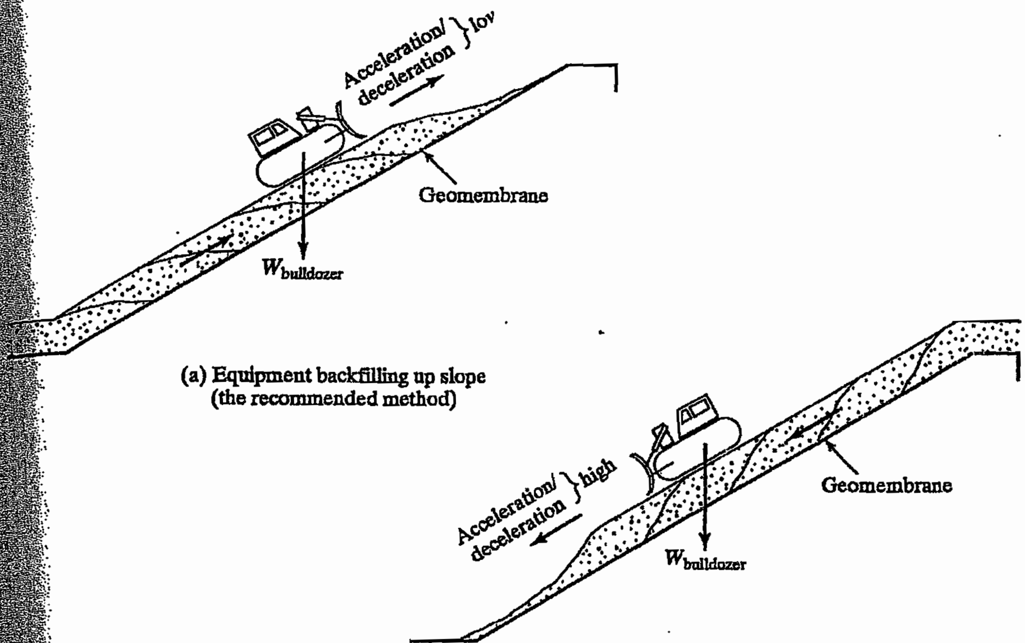
Comment In general, this is too low of a value for a final cover soil factor of safety and a redesign is necessary. There are many possible options to increase the value (e.g., changing the geometry of the situation, the use of toe berms, tapered cover soil thickness, and veneer reinforcement, see Koerner and Soong, 1998). Nevertheless, this general problem will be used throughout this section for comparison with other cover soil slope stability situations.

13.4.2 Tracked Construction Equipment Forces

The placement of cover soil on a slope with a relatively low shear strength interface (like a geomembrane) should always start at the toe and move upward to the crest. Figure 13.5(a) shows the recommended method. In doing so, the gravitational forces of the cover soil and live load of the construction equipment are compacting previously placed soil and working with an ever-present passive wedge and a stable lower portion beneath the active wedge. While it is necessary to specify low ground pressure equipment to place the soil, the reduction in the *FS*-value for this situation of equipment working up the slope will be seen to be relatively small.

For soil placement down the slope, however, a stability analysis cannot rely on toe buttressing and also a dynamic stress should be included in the calculation. These conditions decrease the *FS*-value—in some cases, to a great extent. Figure 13.5(b) shows this procedure. Unless absolutely necessary, it is not recommended that cover soil be placed on a slope in this manner. If it is necessary, the design must consider the unsupported soil mass and the possible dynamic force of the specific type of construction equipment and its manner of operation.

For the *first case* of a bulldozer pushing cover soil up from the toe of the slope to the crest, the analysis uses the free body diagram of Figure 13.6(a). The analysis uses a



(a) Equipment backfilling up slope (the recommended method)

(b) Equipment backfilling down slope (method is not recommended)

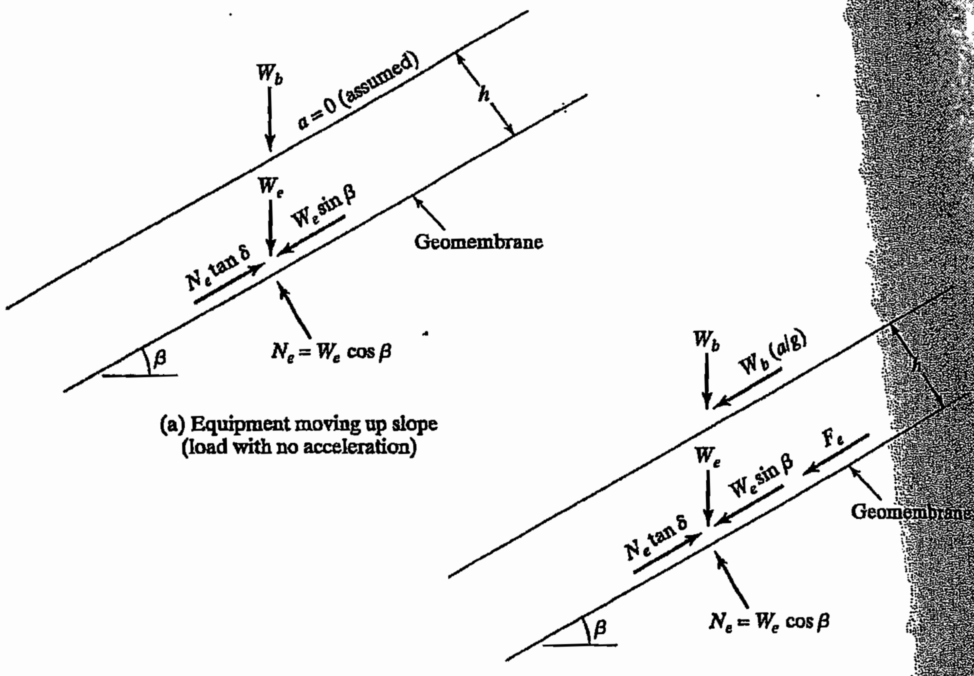
FIGURE 13.5 Construction Equipment Placing Cover Soil on Slopes Containing Geosynthetics

known type of construction equipment (such as a bulldozer characterized by its ground contact pressure) and dissipates this force or stress through the cover soil thickness to the surface of the geomembrane. A Boussinesq analysis is used (see Poulos and Davis, 1974). This results in an equipment force per unit width of

$$W_e = q \cdot w \cdot I \tag{13.10}$$

where W_e = equivalent equipment force per unit width at the geomembrane interface;
$q = W_b/(2 \cdot w \cdot b)$;
W_b = actual weight of equipment (e.g., a bulldozer);
w = length of equipment track;
b = width of equipment track;
I = influence factor at the geomembrane interface (see Figure 13.7).

Upon determining the additional equipment force at the cover soil-to-geomembrane interface, the analysis proceeds as described in Section 13.3.1 for gravitational forces only. In essence, the equipment moving up the slope adds an additional term (W_e) to the W_A-force in Equation 13.4. Note, however, that this involves the generation of a resisting force as well. Thus, the net effect of increasing the driving force as well as the resisting force is somewhat neutralized insofar as the resulting FS-value is



(a) Equipment moving up slope (load with no acceleration)

(b) Equipment moving down slope (load plus acceleration)

FIGURE 13.6 Additional (to Gravitational Forces) Limit Equilibrium Forces due to Construction Equipment Moving on Cover Soil (see Figure 13.3 for the gravitational soil force to which the above forces are added).

concerned. It should also be noted that no acceleration/deceleration forces are included in this analysis, which is somewhat idealistic. Using these concepts (the same equations used in Section 13.3.1 are used here), typical design curves for various *FS*-values as a function of equivalent ground contact equipment pressures and cover soil thicknesses are given in Figure 13.8. Note that the curves are developed specifically for the variables stated in the legend. Example 13.2 illustrates the use of the formulation.

EXAMPLE 13.2

The following are given: a 30-m-long slope with uniform cover soil of 300 mm thickness at a unit weight of 18 kN/m^3. The soil has a friction angle of 30° and zero cohesion (i.e., it is a sand). It is placed on the slope using a bulldozer moving from the toe of the slope up to the crest. The bulldozer has a ground pressure of 30 kN/m^2 and tracks that are 3.0 m long and 0.6 m wide. The cover soil to geomembrane friction angle is 22° with zero adhesion. What is the *FS*-value at a slope angle 3(H)-to-1(V)(i.e., 18.4°)?

Solution This problem follows Example 13.1 exactly except for the addition of the bulldozer moving up the slope. Using the additional equipment load, Equation 13.10 substituted into Equation 13.9 results in the following:

$$a = 73.1 \text{ kN/m}$$
$$b = -104.3 \text{ kN/m}$$
$$c = 17.0 \text{ kN/m}$$

Thus, $FS = 1.24$

This value can be confirmed using Figure 13.8.

Comment While the resulting *FS*-value is still low, the result is important to assess by comparing it with Example 13.1 (i.e., the same problem except without the bulldozer). It is seen that the *FS*-value has only decreased from 1.25 to 1.24. Thus, in general, a low ground contact pressure bulldozer placing cover soil up the slope with negligible acceleration/deceleration forces does not significantly decrease the factor-of-safety.

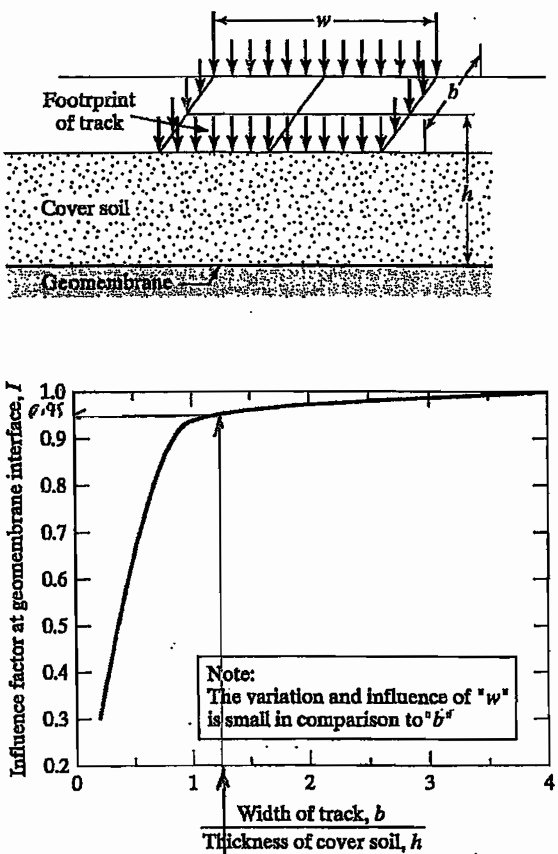


FIGURE 13.7 Values of Influence Factor, "I", for Use in Equation 13.10 to Dissipate Surface Force through the Cover Soil to the Geomembrane Interface (after Soong and Koerner, 1996)

1.25 For CAT D6 LGP

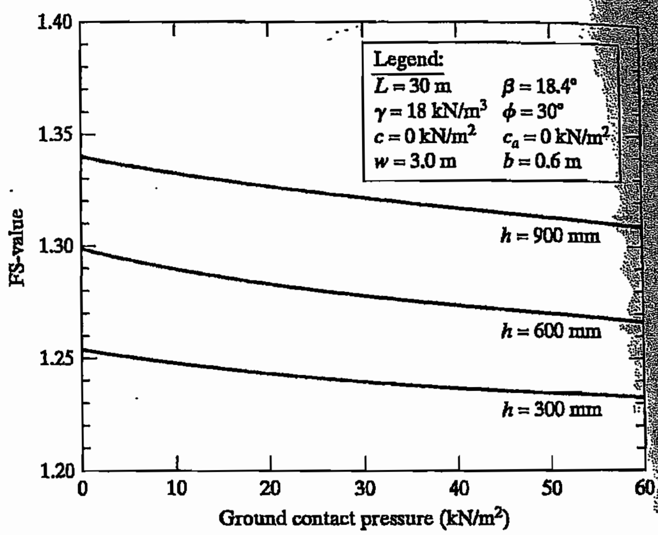


FIGURE 13.8 Design Curves for Stability of Different Thickness of Cover Soil for Various Construction Equipment Ground Contact Pressure

For the *second case* of a bulldozer pushing cover soil down from the crest of the slope to the toe as shown in Figure 13.5b, the analysis uses the force diagram of Figure 13.6(b). While the weight of the equipment is treated as just described, the lack of a passive wedge along with an additional force due to acceleration (or deceleration) of the equipment significantly decreases the resulting *FS*-values. This analysis again uses a specific piece of construction equipment operated in a specific manner. It produces a force parallel to the slope equivalent to $W_b \cdot (a/g)$, where W_b = the weight of the bulldozer, a = acceleration of the bulldozer, and g = acceleration due to gravity. Its magnitude is equipment operator dependent and related to both the equipment speed and time to reach such a speed (see Figure 13.9).

The acceleration of the bulldozer, coupled with an influence factor I from Figure 13.7, results in the dynamic force per unit width at the cover soil to geomembrane interface F_e. The relationship is given by

$$F_e = W_e \cdot (a/g) \tag{13.11}$$

where F_e = dynamic force per unit width parallel to the slope at the geomembrane interface;
W_e = equivalent equipment (e.g., bulldozer) force per unit width at geomembrane interface, recall Equation 13.10;
β = soil slope angle beneath geomembrane;
a = acceleration of the construction equipment;
g = acceleration due to gravity.

Using these concepts, the new force parallel to the cover soil surface is dissipated through the thickness of the cover soil to the interface of the geomembrane. Again, a

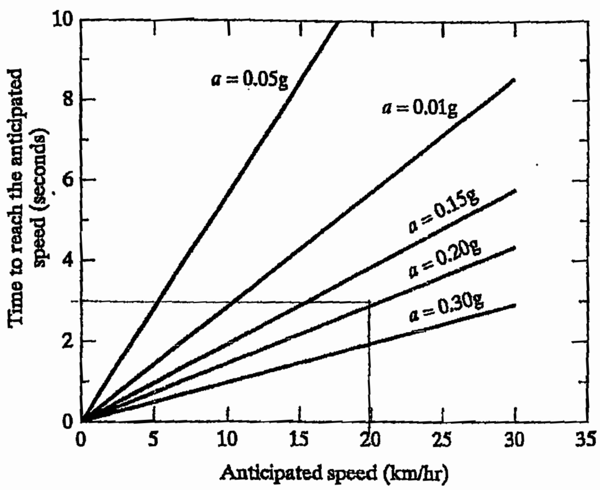


FIGURE 13.9 Graphic Relationship of Construction Equipment Speed and Rise Time to Obtain Equipment Acceleration.

Boussinesq analysis is used (see Poulos and Davis, 1974). The expression for determining the FS-value is derived next.

Considering the active wedge and balancing the forces in the direction parallel to the slope, the resulting formulation is

$$E_A + \frac{(N_e + N_A)\cdot\tan\delta + C_a}{FS} = (W_A + W_e)\cdot\sin\beta + F_e$$

where

N_e = effective equipment force normal to the failure plane of the active wedge.

$$N_e = W_E\cdot\cos\beta \qquad (13.12)$$

Note that all the other symbols have been previously defined.

The interwedge force acting on the active wedge can now be expressed as

$$E_A = \frac{(FS)[(W_A + W_e)\cdot\sin\beta + F_e]}{FS} - \frac{[(N_A + N_e)\cdot\tan\delta + C_a]}{FS}$$

The passive wedge can be treated in a similar manner. The following formulation of the interwedge force acting on the passive wedge results:

$$E_P = \frac{C + W_P\cdot\tan\phi}{\cos\beta\cdot(FS) - \sin\beta\cdot\tan\phi}$$

By setting $E_A = E_P$, the resulting equation can be arranged in the form of the quadratic equation $ax^2 + bx + c = 0$ which in this case, using FS-values, is

$$a\cdot FS^2 + b\cdot FS + c = 0$$

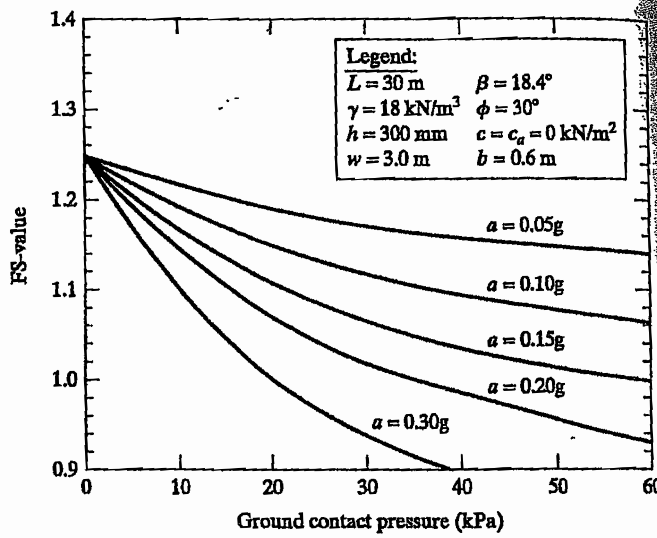


FIGURE 13.10 Design Curves for Stability of Different Construction Equipment Ground Contact Pressure for Various Equipment Accelerations

The resulting *FS*-value is then obtained from the conventional solution of the quadratic equation

$$FS = \frac{-b \pm (b^2 - 4\cdot a\cdot c)^{0.5}}{2\cdot a} \tag{13.13}$$

where
$$a = [(W_A + W_e)\cdot \sin\beta + F_e]\cdot \cos\beta$$
$$b = -\{[(N_A + N_e)\cdot \tan\delta + C_a]\cdot \cos\beta + [(W_A + W_e)\cdot \sin\beta + F_e]\cdot \sin\beta\cdot \tan\phi + (C + W_P\cdot \tan\phi)\}$$
$$c = [(N_A + N_e)\cdot \tan\delta + C_a]\cdot \sin\beta\cdot \tan\phi$$

Using these concepts, typical design curves for various *FS*-values as a function of equipment ground contact pressure and equipment acceleration can be developed (see Figure 13.10). Note that the curves are developed specifically for the variables stated in the legend. Example 13.3 illustrates the use of the formulation.

EXAMPLE 13.3

The following are given: a 30-m-long slope with uniform cover soil of 300-mm-thickness at a unit weight of 18 kN/m^3. The soil has a friction angle of 30° and zero cohesion (i.e., it is a sand). It is placed on the slope using a bulldozer moving from the crest of the slope down to the toe. The bulldozer has a ground contact pressure of 30 kN/m^2 and tracks that are 3.0 m long and 0.6 m wide. The estimated equipment speed is 20 km/hr, and the time to reach this speed is 3.0 seconds. The cover soil to geomembrane friction angle is 22 degrees with zero adhesion. What is the *FS*-value at a slope angle of 3(H)-to-1(V) (i.e., 18.4°)?

Solution Using the design curves of Figure 13.10 along with Equation 13.13, the solution can be obtained.

Source: NAVFAC DM 7.1

7.1-22

ATTACHMENT E

TABLE 6
Typical Values of Soil Index Properties

	Particle Size and Gradation				Voids[1]					Unit Weight[2] (lb./cu.ft.)						
	Approximate Size Range (mm)		Approx. D_{10} (mm)	Approx. Range Uniform Coefficient C_u	Void Ratio			Porosity (%)		Dry Weight			Wet Weight		Submerged Weight	
	D_{max}	D_{min}			e_{max} loose	e_{cr}	e_{min} dense	n_{max} loose	n_{min} dense	Min loose	100% Mod. AASHO	Max dense	Min loose	Max dense	Min loose	Max dense
GRANULAR MATERIALS																
Uniform Materials																
a. Equal spheres (theoretical values)	–	–	–	1.0	0.92	–	0.35	47.6	26	–	–	–	–	–	–	–
b. Standard Ottawa SAND	0.84	0.59	0.67	1.1	0.80	0.75	0.50	44	33	92	–	110	93	131	57	69
c. Clean, uniform SAND (fine or medium)	–	–	–	1.2 to 2.0	1.0	0.80	0.40	50	29	83	115	118	84	136	52	73
d. Uniform, inorganic SILT	0.05	0.005	0.012	1.2 to 2.0	1.1	–	0.40	52	29	80	–	118	81	136	51	73
Well-graded Materials																
a. Silty SAND	2.0	0.005	0.02	5 to 10	0.90	–	0.30	47	23	87	122	127	88	142	54	79
b. Clean, fine to coarse SAND	2.0	0.05	0.09	4 to 6	0.95	0.70	0.20	49	17	85	132	138	86	148	53	86
c. Micaceous SAND	–	–	–	–	1.2	–	0.40	55	29	76	–	120	77	138	48	76
d. Silty SAND & GRAVEL	100	0.005	0.02	15 to 300	0.85	–	0.14	46	12	89	–	146[3]	90	155[3]	56	92
MIXED SOILS																
Sandy or Silty CLAY	2.0	0.001	0.003	10 to 30	1.8	–	0.25	64	20	60	130	135	100	147	38	85
Skip-graded Silty CLAY with stones or rk fgmts	250	0.001	–	–	1.0	–	0.20	50	17	84	–	140	115	151	53	89
Well-graded GRAVEL, SAND, SILT & CLAY mixture	250	0.001	0.002	25 to 1000	0.70	–	0.13	41	11	100	140	148[4]	125	156[4]	62	94
CLAY SOILS																
CLAY (30%–50% clay sizes)	0.05	0.5μ	0.001	–	2.4	–	0.50	71	33	50	105	112	94	133	31	71
Colloidal CLAY (–0.002 mm: 50%)	0.01	10Å	–	–	12	–	0.60	92	37	13	90	106	71	128	8	66
ORGANIC SOILS																
Organic SILT	–	–	–	–	3.0	–	0.55	75	35	40	–	110	87	131	25	69
Organic CLAY (30% – 50% clay sizes)	–	–	–	–	4.4	–	0.70	81	41	30		100	81	125	18	62

ATTACHMENT F

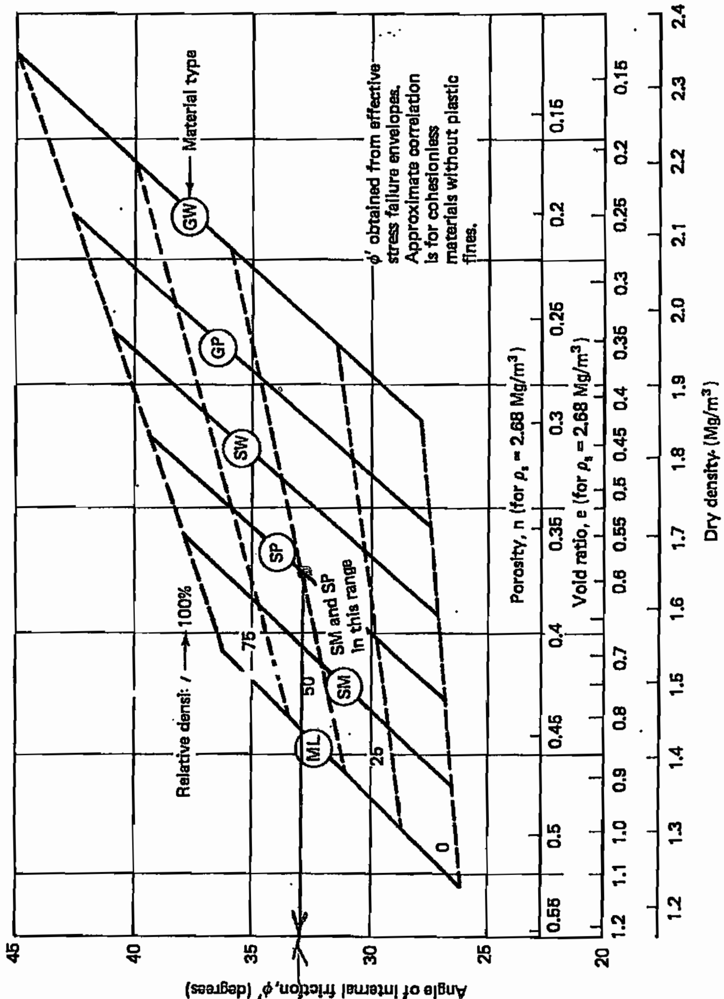


Fig. 11.13 Correlations between the effective friction angle in triaxial compression and the dry density, relative density, and soil classification (after U.S. Navy, 1971).

For moderately compacted sand, $\phi \approx 33°$

Source: An Introduction to Geotechnical Engineering, R.D. Holtz and W.D. Kovacs, Prentice-Hall, 1981.

have a complete vis
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laboratory testing p
you need for design.

11.7 THE
PRESSURE

In Sec. 7.6 we

where σ'_{ho} = the hc
σ'_{vo} = the ve
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ATTACHMENT G

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- » Road Reclaimers
- » Scrapers
- » Skid Steer Loaders
- » Skidders
- » Telehandlers
- » Track Loaders
- » Track-Type Tractors
  - › Small Track-Type Tractors
  - › Medium Track-Type Tractors
  - › Large Track-Type Tractors
  - › Waste Handling Track-Type Tractors
- » Underground Mining
- » Wheel Dozers
- » Wheel Excavators
- » Wheel Loaders

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OEM Solutions

Technology

D6K TRACK-TYPE TRACTOR

— Select a Model —

Overview | Specificatio | Benefits & Features | Standard / Optional Equipment | Machine Comparisor

SPECIFICATIONS

Units: US | Metric

Engine	
Engine Model	Cat® C6.6 ACERT™
Flywheel Power	125 hp
Net Power - Caterpillar	125 hp
Net Power - ISO 9249	125 hp
Net Power - SAE J1349	123 hp
Net Power - EU 80/1269	125 hp
Bore	4.13 in
Stroke	4.99 in
Displacement	403 in3

Weights	
Operating Weight	28409 lb
Operating Weight - XL	28409 lb
Shipping Weight - XL	27802 lb
Operating Weight - LGP	29690 lb
Shipping Weight - LGP	29083 lb

Blades	
Blade Type	VPAT
VPAT-Blade Capacity	3.53 yd3
VPAT-Blade Width	10095.11 ft
XL VPAT-Blade Capacity	3.5 yd3
XL VPAT-Blade Width	10 ft
LGP VPAT-Blade Capacity	3.8 yd3
LGP VPAT-Blade Width	11 ft

Undercarriage	
Shoe Type	single grouser

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Width of Shoe - XL	22 in
Width of Shoe - LGP	30 in
Shoes/Side - XL	40
Shoes/Side - LGP	40
Grouser Height	1.9 in
Track Gauge - XL	70 in
Track Gauge - LGP	79 in
Track on Ground - XL	104 in
Track on Ground - LGP	104 in
Ground Contact Area - XL	4650 in2
Ground Contact Area - LGP	6200 in2
Ground Pressure	6.16 psi
Ground Pressure - XL	6.16 psi
Ground Pressure - LPG	4.74 psi
Track Rollers/Side - XL	7
Track Rollers/Side - LGP	7

Service Refill Capacities

Fuel Tank	77.9 gal
Cooling System	6.4 gal
Engine Crankcase	4.35 gal
Hydraulic Tank	15.3 gal

Winch

Winch Model	PA50
Weight*	2000 lb
Winch and Bracket Length	33.1 in
Winch Case Width	35.6 in
Drum Diameter	8 in
Drum Width	11 in
Flange Diameter	18 in

Dimensions

Ground Clearance	14.19 in
Track Gauge	69.68 in
Width without Blade	91.73 in
Width with Blade	9.24 ft
Height	9.7 ft
Height ROPS/Canopy	9.7 ft
Overall Length Basic Tractor (with Drawbar)	12.41 ft
Length with VPAT-blade (straight)	3.92 ft

Ripper

Type	Parallelogram
Number of Pockets	3
Overall Beam Width	76.8 in

Beam Cross Section	165x211 mm 6.5x8.3 in.
Maximum Penetration - XL	14.2 in
Maximum Penetration - LGP	14.2 in
Weight - With One Shank	1863 lb
Each Additional Shank	75 lb

ATTACHMENT O.2
FINAL COVER DRAINAGE CALCULATIONS
SOIL LOSS CALCULATIONS

Project: CCSWDC		Computed: TMM	Date: 10/21/08
Subject: Phase I Closure Permit		Checked: DTD	Date: 1/21/10
Task: Geocomposite Capacity		Page: 1	of: 3
Job #: 88765		No:	

HDR | ONE COMPANY *Many Solutions*

PURPOSE: Verify that geonet composite used in final cover design will have enough flow capacity to contain all lateral flow above the geomembrane.

ASSUMPTIONS;

1. Final Cover design as shown in Att. A.
2. Geocomposite will daylight (i.e. drain) at the top of the 3:1 slope such that no flow from the top slope will enter the geocomposite on the 3:1 side slope.
3. Geocomposite will daylight at the stormwater terrace located approximately half way up the 3:1 side slope such that the maximum length of slope draining to geocomposite is 149 ft (see Veneer Slope Stability Calcs.
4. Estimate flow into geocomposite using unit gradient method.
5. Estimate geocomposite flow capacity using procedure in GRI Standard GC8.

PROCEDURE;

1. Estimate maximum flow into geocomposite using Unit Gradient method (Q_{in}) for 1 m wide strip of geocomposite.

Maximum length of geocomposite between drains = 149 feet.

From Att. B, borings from within proposed borrow area indicate borrow soils will be predominantly silty sand and clayey sand within upper 4' (limits of borrow excavation).

For worst case, assume all cover is silty sand. From Att. C, $k \approx 1 \times 10^{-4}$ cm/sec.

$\therefore$ $Q_{in} = K_{cover}\, i\, A$ where: i = inflow gradient (Assume = 1)

A = contributing flow area = 149 ft long × 1 m wide

$= 149\text{ ft}\left(\frac{0.3048\text{ m}}{\text{ft}}\right)(1\text{m}) = 45.42\text{ m}^2$

$\therefore$ $Q_{in} = (1\times10^{-4}\text{ cm/sec})(1)(45.42\text{ m}^2)\left(\frac{1\text{m}}{100\text{cm}}\right) = \underline{4.54\times10^{-5}\text{ m}^3/\text{sec}}$ per meter width of GDL

② Determine required transmissivity of geocomposite ($\Theta_{reqd.}$) for in-plane drainage of Qin.

$Q_{out} = Q_{in} = 4.54 \times 10^{-5}\ m^3/sec$ per meter width of GDL

$\Theta_{reqd.}$ = required transmissivity of GDL.

$Q_{out} = k_{reqd}\, i\, A$

where k_{reqd} = reqd. hydraulic conductivity of GDL,

i = hydraulic gradient of GDL = slope = $\frac{\Delta h}{\Delta L} = \frac{1}{3} = 0.333$ for 3:1 slope.

A = in plane flow area of geocomposite Assuming 1 meter wide.

$A = t \times w$, t = thickness of GDL (Assume 300 mil = 0.3 in = 0.00762 m)

w = width = 1 m

$\therefore A = 0.00762\,m\,(1m) = 0.00762\,m^2$

$\Theta_{reqd} = k_{reqd}\,(t)$

$\therefore k_{reqd} = \Theta_{reqd}/t$

$$\therefore Q_{out} = \frac{\Theta_{reqd.}}{t}\, i\, A \longrightarrow \Theta_{reqd.} = \frac{Q_{out}\,(t)}{i\,A}$$

$$\Theta_{reqd.} = \frac{4.54 \times 10^{-5}\ m^3/sec\ (0.00762\,m)}{0.333\ (0.00762\ m^2)} = 0.000136\ m^2/sec = \underline{1.36 \times 10^{-4}\ m^2/sec}$$

③ Determine design transmissivity of GDL (Θ_d) by multiplying Θ_{reqd} by safety factors according to GRI - GC8.

$\Theta_d = \Theta_{reqd}\, FS_D\, RF_{CR}\, RF_{CC}\, RF_{BC}$

where: FS_D = overall factor of safety for drainage

RF_{CR} = reduction factor for long-term creep

RF_{CC} = reduction factor for chemical clogging

RF_{BC} = reduction factor for biological clogging

Based on recommendations in GSE Drainage Design Manual:

$FS_D = 2.0$

$RF_{CR} = 1.1$ (for low pressure, 1000 psf)

$RF_{CC} = 1.0$

$RF_{BC} = 2.0$

$\therefore\ \Theta_d = 1.36\times10^{-4}\ m^2/sec\,(2.0)(1.1)(1.0)(2.0) = \underline{5.98\times10^{-4}\ m^2/sec}$

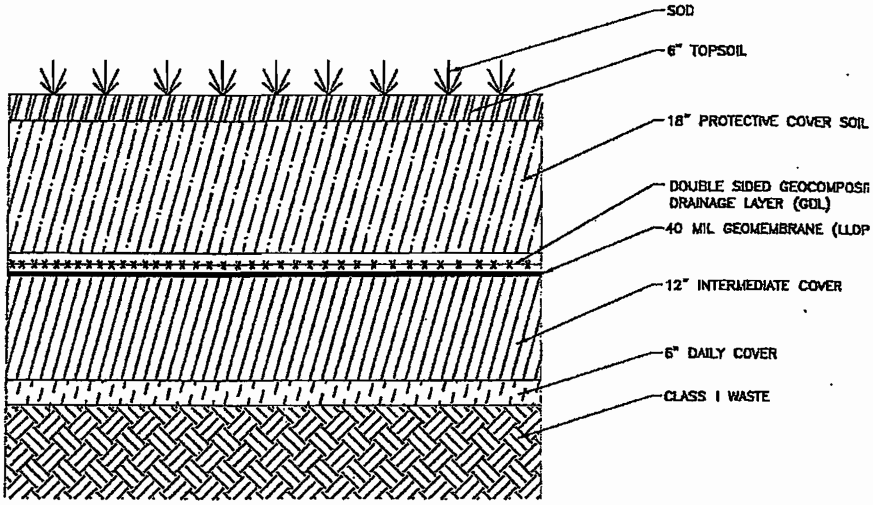
④ Compare Θ_d with 100-hr test results for actual geocomposites.

From Att. D, 100-hr transmissivity test for 300 mil Geocomposite tested at normal stress of 1,000 psf w/ gradient = 0.33:

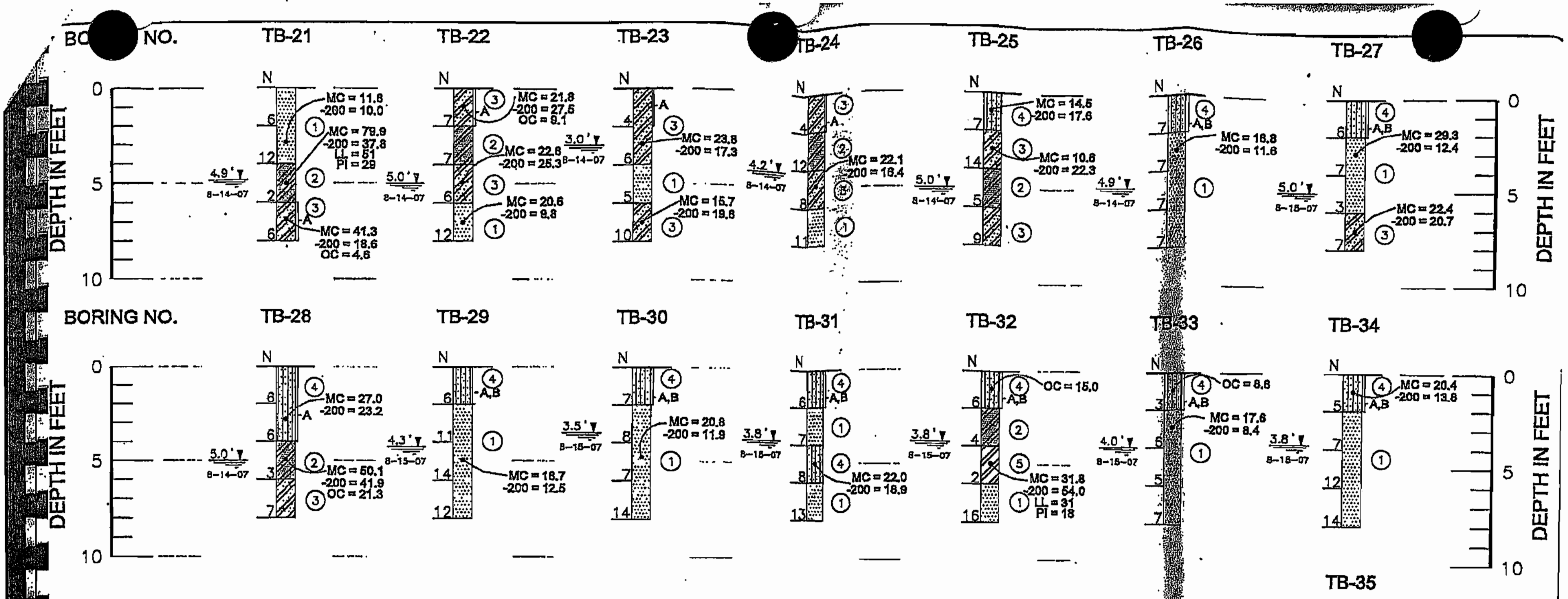
$\Theta_{100} \approx 1.3\times10^{-3}\ m^2/sec > \Theta_d = 5.98\times10^{-4}\ m^2/sec$ __OK__

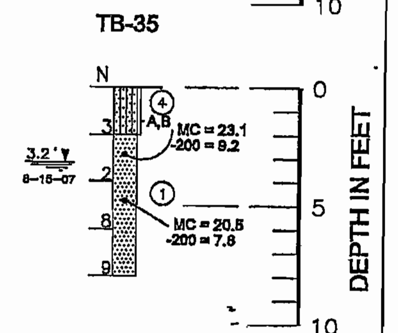
CONCLUSION: 300 mil geocomposite will provide sufficient drainage capacity for closure design.

ATTACHMENT A



FINAL COVER PROFILE (SIDE SLOPES)
NOT TO SCALE





LEGEND

- (1) Light gray, light brown, gray, and dark gray fine SAND, slightly silty and slightly clayey fine SAND (SP, SP-SM, SP-SC)
- (2) Black and dark gray sandy organic clay (OH)
- (3) Black and brown clayey fine SAND (SC)
- (4) Brown, and dark gray to black silty fine SAND (SM)
- (5) Light brown to tan sandy CLAY (CL)

A - With organics
B - With roots

N — Indicates the number of blows of a 140 pound hammer, freely falling a distance of 30 inches, required to drive a 2-inch diameter sampler 12 inches (ASTM D 1586)

SP — Unified Soil Classification System Group Symbol (ASTM D 2487)

MC — Moisture Content (%)

-200 — Percent of material passing US Standard Sieve No. 200 (%)

LL — Liquid Limit (%)

PI — Plasticity Index (%)

OC — Organic Content (%)

TB-21 — Standard Penetration Test (SPT) boring and number

4.9' 5-14-07 — Depth of groundwater (feet) & date measured

NOTES

(1) Borings were drilled on August 14 and 15, 2007 using a Central Mine Equipment Model 55 (CME 55) drilling rig.

(2) Strata boundaries are approximate and represent soil strata at each test hole location only. Soil transitions may be more gradual than implied.

(3) Groundwater depths shown on the subsurface profiles represent groundwater surfaces on the dates shown. Groundwater level fluctuations should be anticipated throughout the year.

DRAWN	GD
CHECKED	SF
APPROVED	PHA
SCALE	1" = 5'
REVISED	

SUBSURFACE PROFILES
CCSWDC BORROW PIT PHASE 3
SARASOTA, FLORIDA

DET DUNKELBERGER ENGINEERING & TESTING, INC.
Geotechnical Materials Testing/Inspection Environmental

DATE	PROJ. NO.	SHEET
8-17-07	SAR-07-828	2

ATT. 13

must be laminar or

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ATTACHMENT C

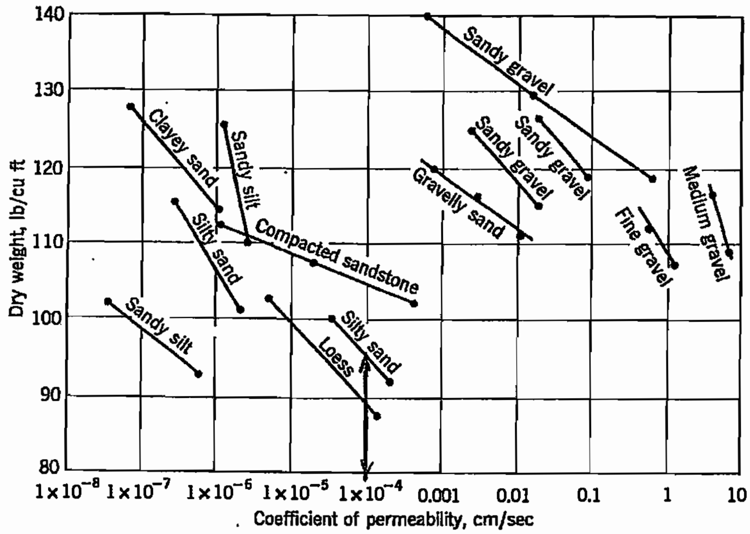

FIG. 2.8 Relation between coefficient of permeability and soil type and density (log scale).

mesh sieve. With no material finer than 100 mesh, the permeabilities ranged from 0.2 to 3 ft/day.

As a rule permeability should be determined by test, not from other properties such as grain size. The general soil type and grain size are useful, however, in indicating the approximate range of permeability to be expected. The general way in which the test permeability has been found to vary with the type of soil is illustrated in Fig. 2.8 which

TABLE 2.2 Influence of Percent of Minus 100 Fraction on Permeability of Washed Filter Aggregates (Typical)

Percentage Passing Number 100 Sieve	Permeability, ft/day
0	80 to 300
2	10 to 100
4	2 to 50
6	0.5 to 20
7	0.2 to 3

Source: Seepage, Drainage, and Flow Nets, H.R. Cedergren, John Wiley & Sons, 1977.

ATTACHMENT D

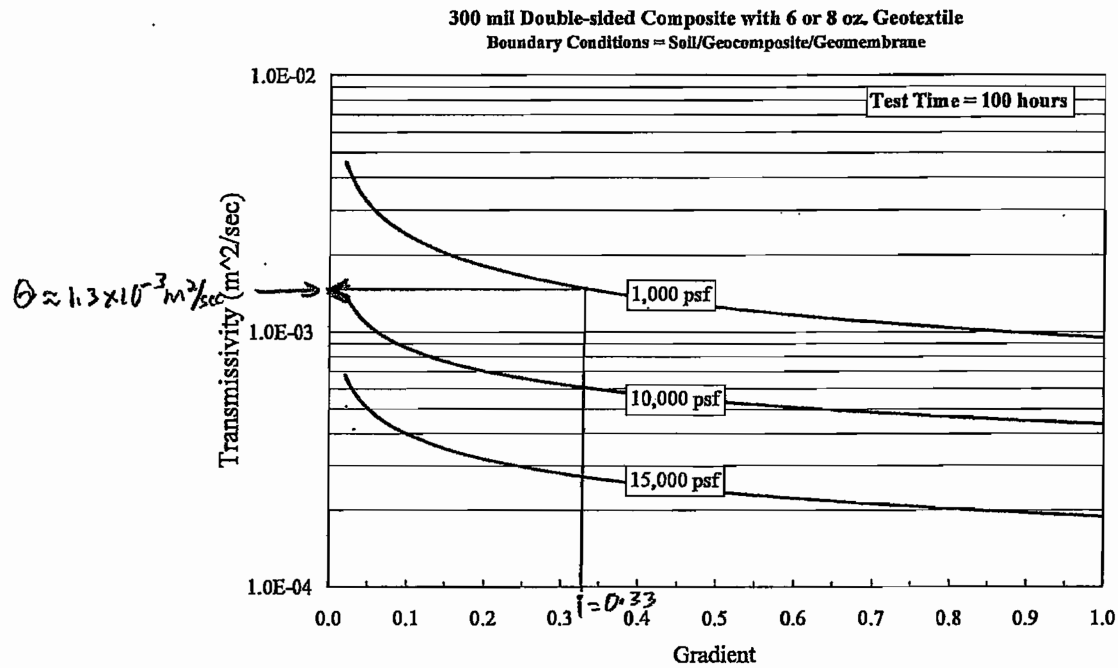

Figure A-9. Performance Transmissivity of a 300 mil GSE FabriNet UF geocomposite under Soil.

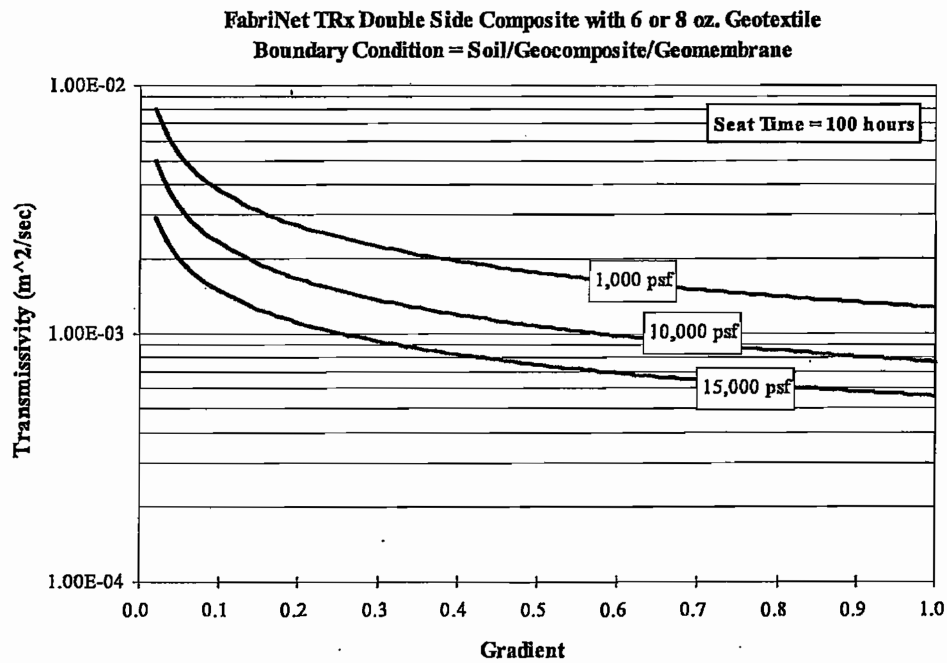

Figure A-10. Performance Transmissivity of GSE FabriNet TRx geocomposite under Soil.

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Project: CCSWDC		Computed: TMY	Date: 10/21/08
Subject: Phase I Closure Permit		Checked: DJD	Date: 1/21/10
Task: Geotextile Filter Calcs.		Page: 1	of: 2
Job #: 88765		No:	

PURPOSE: Confirm that separator geotextile specified for use in geocomposite drainage layer (GDL) of final cover system and as a filter for drainage stone will adequately filter soil and prevent it from entering GDL and drainage stone.

ASSUMPTIONS:

① Use procedure in "Geotechnical Aspects of Landfill Design and Construction", 2002, p. 259. (See Att. A)

② Use sieve analysis results from Phase 2 of the borrow pit as being representative of soils used for final cover construction.

③ From project spec. section 02778, Apparent Opening Size (AOS) of geotextiles = #70 U.S. Sieve = 0.212 mm = O_{95}

PROCEDURE:

Results of 3 sieve analyses from Phase 2 borrow area are provided in Att. B. The corresponding grain size distribution curves are provided in Att. C. The sieve analysis results are summarized below:

Sample No.	-200 (%)	d_{85} (mm)	d_{60} (mm)	d_{50} (mm)	d_{10} (mm)	$C_u = \frac{d_{60}}{d_{10}}$
SA-1	2.5	0.23	0.19	0.16	0.081	2.35
SA-2	3.4	0.24	0.16	0.13	0.080	2.00
SA-3	6.2	0.23	0.16	0.13	0.080	2.00
Avg.	4.0	0.23	0.17	0.14	0.080	2.12

Task Force 25 Method:

From test results, avg. fines content (i.e. -200) for protective cover soils = 4.0%

Since -200 of soil is < 50%, AOS of fabric > No. 30 sieve (i.e. O_{95} < 0.59 mm)

From specs., AOS of fabric = No. 70 sieve (i.e. O_{95} = 0.212 mm)

∴ No. 70 sieve > No. 30 sieve Ok

∴ O_{95} = 0.212 mm < 0.59 mm Ok

HDR ONE COMPANY *Many Solutions™*	Project:	Computed:	Date:
	Subject:	Checked:	Date:
	Task:	Page: 2	of: 2
	Job #:	No:	

Carroll Method:

$$O_{95} < (2 \text{ or } 3)\, d_{85}$$

O_{95} for geotextile = 0.212mm (from specs.)
d_{85} for protective cover soils = 0.23 mm

$2(d_{85}) = 2(0.23\text{mm}) = 0.46\text{ mm}$
$3(d_{85}) = 3(0.23\text{mm}) = 0.69\text{ mm}$

$\therefore$ Since $O_{95} = 0.212\text{mm} < (0.46\text{mm} \rightarrow 0.69\text{mm})$ OK

Giroud Method:

Use Case 2 for intermediate dense soils ($50\% < D_R < 80\%$) since protective cover soils will only be "tracked" in.

Since avg. C_u of soils = 2.12, use:
If $1 < C_u < 3$, $O_{95} < 1.5\,(C_u)(d_{50})$

Substituting appropriate numbers:
$0.212\text{mm} < 1.5(2.12)(0.14\text{mm})$
$0.212\text{mm} < 0.445\text{mm}$ OK

CONCLUSION:

Specified separator geotextile will adequately filter protective cover soil and prevent it from entering into the final cover GDL and stone drains.

ATTACHMENT A

A = filtration area, usually use 1 ft^2, 1 acre (1 acre = 43,560 ft^2), or 1 m^2, or 1 hectare (1 ha = 10,000 m^2);
ψ_{reqd} = required permittivity of geotextile, sec^{-1};
k_{reqd} = required cross-plane permeability coefficient of geotextile, ft/sec or m/sec;
i = hydraulic gradient;
Δh = liquid head from bottom of geotextile, ft or m;

and

$$\Delta h = H - t$$

where H = liquid head on the geomembrane liner, ft or m; and
t = thickness of drainage layer, ft or m.

In landfill design, the liquid head H on the geomembrane liner may be known based on hydrological analysis or regulatory requirement. Then, the liquid head from the bottom of geotextile, Δh, and the required permittivity of geotextile ψ_{reqd} can be determined using the preceding equations.

Using data from Table 8.5, the allowable permittivity or allowable permeability can be calculated from the following equations:

$$\psi_{allow} = \frac{\psi_{ult}}{RF_{SCB} \times RF_{CR} \times RF_{IN} \times RF_{CC} \times RF_{BC}}$$

$$k_{allow} = \frac{k_{ult}}{RF_{SCB} \times RF_{CR} \times RF_{IN} \times RF_{CC} \times RF_{BC}}$$

The values of ultimate permittivity, ψ_{ult}, and ultimate permeability, k_{ult}, are obtained from the approximate method. Then, the factor of safety that is used to evaluate the filtration capacity of the selected geotextile can finally be obtained:

$$FS = \psi_{allow}/\psi_{reqd} = k_{allow}/k_{reqd}$$

Equations 8.10 to 8.15 can be used to calculate the cross-plane flow capacity of the selected geotextile.

8.3.4 Soil Retention

To allow for the required flow of water through a geotextile, the void spaces in it must be adequately large. However, there is a limit, namely, when the upstream soil or waste fragment particles start to pass through the fabric voids along with the flowing liquid. This leads to an unacceptable situation called "piping", in which the finer particles are carried through the fabric, leaving large residual voids behind. The flow velocity then increases, accelerating the whole process, until the upgradient strata begins to collapse. This collapse often leads to minute sinkhole-type patterns that get larger with time.

This entire process can be prevented by making the geotextile voids small enough to retain the soil on the upstream side of the fabric. The coarser soil fraction must initially be retained; this is the targeted soil size in the design process. These ticles eventually block the finer sized particles by establishing a bridging mechanism. Fortunately, filtration concepts are well established in the design of soil filters, and those same ideas can be used to design an adequate geotextile filter.

There are a number of approaches for achieving soil retention, all of which use particle sizes that are measured by sieving and are compared with the O_{95} size (the apparent opening size) of the geotextile. The test for apparent opening size (AOS) was developed by the U.S. Army Corps of Engineers to evaluate woven fabrics. The test has since been extended to cover all fabrics, including nonwoven types. The apparent opening size (AOS) or equivalent opening size (EOS) are defined in CW-02215 as the U.S. standard sieve number having openings closest in size to the openings in the fabric. Note that AOS and EOS are equivalent terms. The equivalent ASTM test is designated D4751. The test uses known-sized glass beads designated by number and determines AOS by dry sieving. Sieving is done by using beads of successively smaller size until 5% or less pass through the fabric. The AOS or EOS of the fabric specimen is the "retained on" U.S. standard sieve number of the size. It is sometimes given as the equivalent sieve size opening in millimeters, and when done so is referred to as the 95% opening size or O_{95}. Thus, AOS, EOS, and O_{95} all refer to the same thing, the difference being that AOS and EOS are sieve numbers and O_{95} is the corresponding sieve opening size in millimeters. Table 8.6 gives the interrelated values. Note that as the AOS sieve number increases, the O_{95} particle size value decreases (i.e., they are inversely related to one another).

TABLE 8.6 Conversion of U. S. Standard Sieve Sizes to Equivalent Square Opening Sizes

Sieve Size (no.)	Opening Size	
	mm	mil
4	4.750	187.0
6	3.350	132.0
8	2.360	93.7
10	2.000	78.7
12	1.700	66.1
16	1.180	46.9
20	0.850	33.1
30	0.590	23.4
40	0.425	16.5
50	0.297	11.7
60	0.250	9.8
70	0.212	8.3
80	0.180	7.0
100	0.150	5.9
120	0.125	4.9
140	0.106	4.1
170	0.090	3.5
200	0.075	2.9
270	0.053	2.1
400	0.038	1.5

Note: 1 mil = 0.001 in.

Three approaches for determining soil retention opening size are described below in the subsections that follow.

8.3.4.1 Task Force 25 Method. The simplest of these methods examines the percentage of soil passing the No. 200 sieve (= 0.075 mm). The Task Force 25 (1983) makes the following recommendations:

1. Particles < 50% passing the No. 200 sieve
   AOS of the fabric > No. 30 sieve (i.e., $O_{95} < 0.59$ mm)
2. Particles > 50% passing the No. 200 sieve
   AOS of the fabric > No. 50 sieve (i.e., $O_{95} < 0.297$ mm)

8.3.4.2 Carroll Method. Slightly more restrictive is the recommendation of Carroll (1983) for the O_{95} size in millimeters, which is

$$O_{95} < (2 \text{ or } 3)d_{85}$$

where d_{85} = the particle size in millimeters for which 85% of sample is finer.

8.3.4.3 Giroud Method. The most conservative method is proposed by Giroud (1982), who presents a method for recommended O_{95} values (i.e., the opening size in millimeters corresponding to the AOS value) in terms of relative density (D_R), coefficient of uniformity (CU), and average particle size (d_{50}) for granular soils and in terms of Plasticity Index (PI) for fine-grained soils. It is presented below for steady-state flow conditions. There is a parallel set of criteria for dynamic-flow conditions, but these are not likely to occur in landfill filtration design situations.

Granular Soils. The definition of granular soils for the Giroud Method is the soil which contains less than 10% fines (less than #200 sieve opening size) or contains more than more than 10% fines, but the Plasticity Index (PI) is less than 5.

Case 1: For Loose Granular Soils ($D_R < 50\%$).

If $1 < CU < 3$, $O_{95} < (CU)(d_{50})$.
If $CU > 3$, $O_{95} < (9 \cdot d_{50})/CU$.

Case 2: For Intermediate Granular Soils ($50\% < D_R < 80\%$)

If $1 < CU < 3$, $O_{95} < 1.5 \cdot (CU)(d_{50})$.
If $CU > 3$, $O_{95} < (13.5 \cdot d_{50})/CU$.

Case 3: For Dense Granular Soils ($D_R > 80\%$)

If $1 < CU < 3$, $O_{95} < 2 \cdot (CU)(d_{50})$.
If $CU > 3$, $O_{95} < (18 \cdot d_{50})/CU$.

In all cases,

O_{95} = apparent opening size of geotextile, mm (if data is not given by the manufacturer, this value is approximately the AOS sieve value in millimeters);

CU =
d_{10} =
d_{60} =
d_{50} =

Fine-Grained
Plasticity Inde
considered fin
persive by the
than 0.21 mm (

Note that any s
sive soil.

8.3.5 Long Term Com

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ations that have b
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1. Use the large
2. For nonwove
   actual stress c
3. For woven ge

The porosity o

where n = geotext
μ = geotexti
t_g = geotexti
ρ = density c

Percent open a
woven fabrics, and eve
parison of the total o
specimen area. Woven
(POA ≈ 0) to some th
textiles are in the range
Other situations t
filtration of very high a
flow at the fabric interf

CU = coefficient of uniformity ($= d_{60}/d_{10}$);
d_{10} = soil particle size corresponding to 10% finer, mm;
d_{60} = soil particle size corresponding to 60% finer, mm; and
d_{50} = soil particle size corresponding to 50% finer, mm.

Fine-Grained Soils. If the soil contains more than 10% fine-size particles and the Plasticity Index is larger than 5 (thus lending cohesion to the soil structure), the soil is considered fine-grained for the Giroud Method. If the soil is determined to be nondispersive by the Double Hydrometer Method (i.e., DHR < 0.5), then 0_{95} must be less than 0.21 mm (i.e., less than #70 sieve) opening size. In other words,

$$0_{95} < 0.21 \text{ mm (for fine-grained soils).}$$

Note that any soil that is used to construct a compacted clay liner must be nondispersive soil.

8.3.5 Long Term Compatibility

Perhaps the most frequently asked question associated with the use of geotextiles in hydraulic related systems is, "Will it clog?" Undoubtedly, some soil particles will embed themselves within the fabric structure. A more relevant question is, "Will it excessively clog?"

A reasonable answer or response to the clogging question is simply to avoid situations that have been known to lead to severe clogging problems. To minimize the risk of clogging, the following precautions are recommended when using geotextiles:

1. Use the largest available opening size geotextile satisfying the retention criteria;
2. For nonwoven geotextiles (recall Tables 8.2 and 8.3): porosity > 40% under the actual stress conditions that the geotextile is serving;
3. For woven geotextiles (recall Table 8.4): percent open area (POA) > 6%.

The porosity of a nonwoven geotextile can be calculated using

$$n = 1 - \mu/(t_g \cdot \rho) \times 100\% \tag{8.16}$$

where n = geotextile porosity or planar porosity, expressed as a percentage;
μ = geotextile mass per unit area;
t_g = geotextile thickness; and
ρ = density of filaments.

Percent open area (POA) is a fabric property that has applicability only for woven fabrics, and even then primarily for monofilament woven fabric. POA is a comparison of the total open area (the void spaces between adjacent fibers) to the total specimen area. Woven monofilament fabrics vary from essentially a closed structure (POA ≈ 0) to some that are quite open (POA = 36%). Many commercial woven geotextiles are in the range of 4 to 20%.

Other situations that have caused excessive clogging problems of geotextiles are filtration of very high alkalinity groundwater. For high pH liquids, the retardation of flow at the fabric interface can cause a calcium, sodium, or magnesium precipitate to

ATTACHMENT B

HDR Engineering, Inc.
September 26, 2008
File No. 08-7611

Material Description: Pale light gray and gray fine sand with trace silt

Date Delivered: 9-25-08

Sample Location: SA-1, Borrow Pit II

SIEVE ANALYSIS

U.S. SIEVE SIZE	PERCENT RETAINED	PERCENT PASSING
No. 4	0.0	100.0
No. 10	0.1	99.9
No. 20	0.3	99.7
No. 40	3.2	96.8
No. 60	18.3	81.7
No. 100	54.3	45.7
No. 200	97.5	2.5

HDR Engineering, Inc.
September 26, 2008
File No. 08-7611

Material Description: Pale light brown fine sand with trace silt

Date Delivered: 9-25-08

Sample Location: SA-2, Borrow Pit II

SIEVE ANALYSIS

U.S. SIEVE SIZE	PERCENT RETAINED	PERCENT PASSING
No. 10	0.0	100.0
No. 20	0.2	99.8
No. 40	2.4	97.6
No. 60	17.7	82.3
No. 100	47.5	52.5
No. 200	96.6	3.4

HDR Engineering, Inc.
September 26, 2008
File No. 08-7611

Material Description: Very pale brown and orange brown fine sand with trace silt

Date Delivered: 9-25-08

Sample Location: SA-3, Borrow Pit II

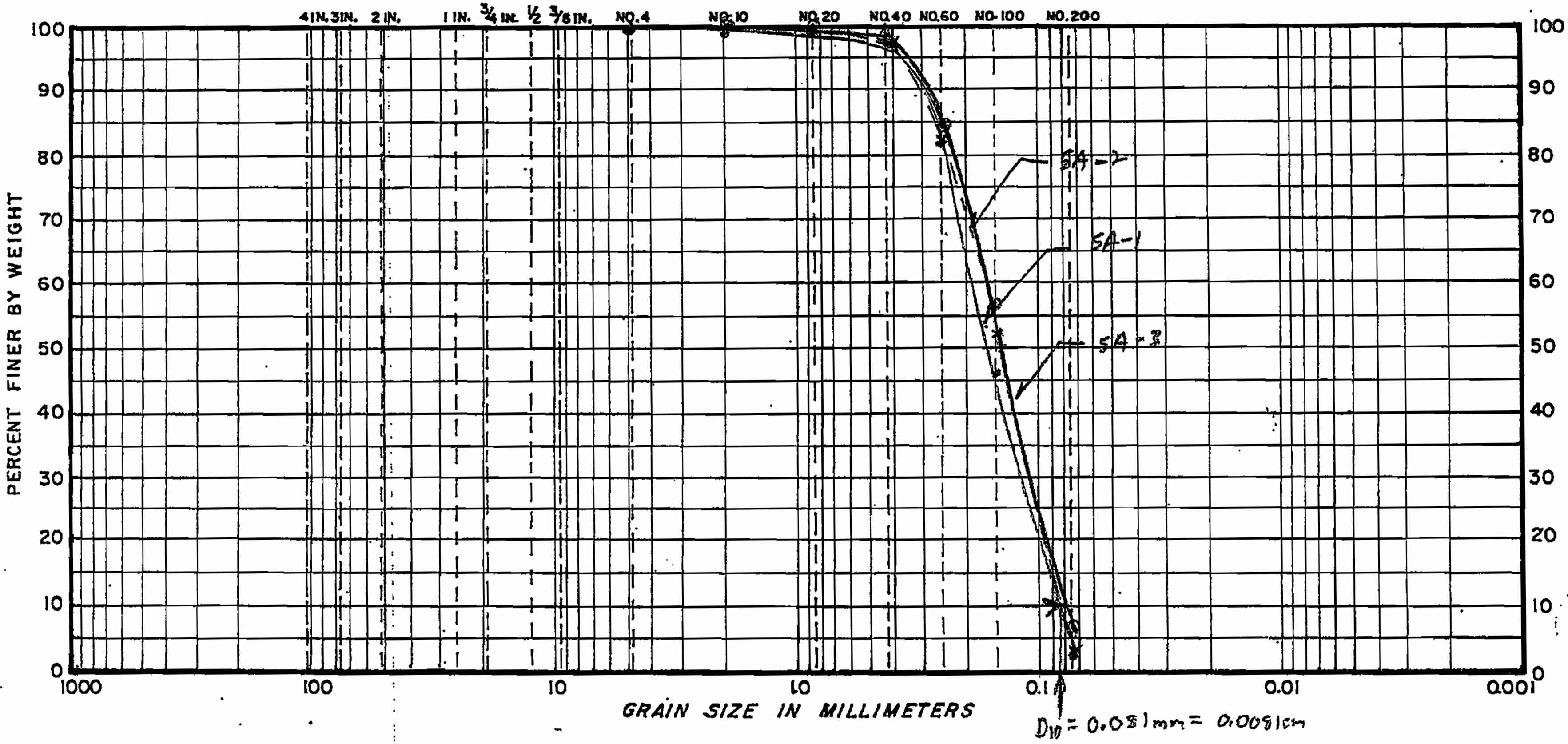
SIEVE ANALYSIS

U.S. SIEVE SIZE	PERCENT RETAINED	PERCENT PASSING
No. 10	0.0	100.0
No. 20	0.1	99.9
No. 40	2.0	98.0
No. 60	15.1	84.9
No. 100	43.1	56.9
No. 200	93.8	6.2

H&A FORM 40
OCT. 75

HALEY & ALDRICH, INC.

GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

UNIFIED SOIL CLASSIFICATION SYSTEM, CORPS OF ENGINEERS, U.S. ARMY

ATTACHMENT C

PROJECT ______

FILE NO. ______ DATE ______

RUSLE2 Profile Erosion Calculation Record

Info:

File: profiles\Sarasota Final Cover Sideslopes 33%

Inputs:
Location: Hillsborough county average (Tampa)
Soil: EauGallie fine sand 35%
Horiz. overland flow path length: 141 ft
Avg. slope steepness: 33 %

Management	*Vegetation*	*Yield units*	*Yield (# of units)*
dense grass	Cropland\forage crops\tall fescue mod production	lb	3000

Contouring: b perfect contouring
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
Soil loss erod. portion: 3.7 t/ac/yr
Detachment on slope: 3.7 t/ac/yr
Soil loss for cons. plan: 3.7 t/ac/yr
Sediment delivery: 3.7 t/ac/yr

Crit. slope length: 141 ft
Surf. cover after planting: 37 %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
1/1/0	basic/general\begin growth	Cropland\forage crops\tall fescue mod production	37

Soil Loss Calculation
CCSWDC Phase 1 Closure
3:1 Sideslopes

T.Y. 9/11/09
DTD 1/21/10

RUSLE2 Profile Erosion Calculation Record

Info:

File: profiles\Sarasota Final Cover Topslope 7%

Inputs:
Location: Hillsborough county average (Tampa)
Soil: EauGallie fine sand 35%
Horiz. overland flow path length: 200 ft
Avg. slope steepness: 7.0 %

Management		*Vegetation*	*Yield units*	*Yield (# of units)*
	dense grass	Cropland\forage crops\tall fescue mod production	lb	

3000
Contouring: b perfect contouring
Strips/barriers: (none)
Diversion/terrace, sediment basin: (none)
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
Soil loss erod. portion: 0.70 t/ac/yr
Detachment on slope: 0.70 t/ac/yr
Soil loss for cons. plan: 0.70 t/ac/yr
Sediment delivery: 0.70 t/ac/yr

Crit. slope length: 200 ft
Surf. cover after planting: 37 %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
1/1/0	basic/general\begin growth	Cropland\forage crops\tall fescue mod production	37

Soil Loss Calculation
CCSWDC Phase I Closure
7% Top slope

T.Y. 9/11/09

ATTACHMENT O.3
TEMPORARY FINAL COVER CALCULATIONS

Job No. 130526	No.

HDR Engineering, Inc.

Project	CCSWDC Class 1 Landfill	Computed KP	Date 1/22/2009
Subject	Design of Anchor Trenches	Checked MGR	Date 1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet 1	of 1

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_upper.xls]Theory

Required: Design of anchor trenches to prevent wind uplift.

Description:

The SEC anchor design considerations include material properties and wind uplift forces. Physical variables used in the anchor trench design include effective suction, velocity of wind, distances between anchor trenches, thickness of the material, percent strain at break, stress at yielding, geomembrane secant stiffness, interface friction between geomembrane and anchor trench fill material and, seam strength.

There have been hurricanes reported in Sarasota County, Florida in year 1995, 1998, 1999, 2000 and 2004. However, neither wind speed nor magnitude is reported. The wind velocities due to thunder storms have been reported. HDR reviewed thunder storm events and high wind events published by National Climatic Data Center (NCDC) for Sarasota County, FL from January, 1950 to Ocotober, 2008. The highest reported wind velocity within Sarasota is 82 mph in 1993. The EGC for CCSWDC is designed for a 130 mph wind event. This wind speed is compatible with basic wind speeds to be used to determine wind loads as published in Florida Building Code 2008 as attached. It should be noted that F2 magnitude Tonados are reported in Sarasota county. The wind speed of a F2 Tonado is 113-157 mph. The SEC is not designed to withstand these wind speeds.

In addition to the wind, the other important parameter that causes expansion and contraction of the material is, temperature variation. The highest reported temperature within the State of FL until December 2003 is 109 degrees F in June 1931. The lowest reported temperature during the same period within the State of FL is -2 degrees F in January, 1899. HDR conservatively assumed these extreme events when calculating maximum initial stresses and strains due to change in temperature.

Vertical intermediate anchor trenches are required at a minimum of 50 ft intervals. The design is based on a minimum factor of safety of 1.15. In addition, horizontal anchors are provided at grade change locations to provide additional support. These are secondary anchor trenches provided to accommodate site configuration and no additional calculations were performed to verify wind uplift.

The following describes a theoretical development and specimen calculation. The rest of the calculations are attached in the given tables following the theoretical development. Related references are attached to the end.

References

Gleason, M.H., Houlihan, M.F. and Giroud, J.P., 1998, "An Exposed Geomembrane Cover System for a Landfill", 6th International Conference on Geosynthetics, Atlanta, pp. 211-218.

Giroud, J.P., Gleason, M.H. and Zornberg, J.G., 1999, "Design of Geomembrane Anchorage Against Wind Uplift, Geosynthetics International, Vol. 6, pp. 481-506.

Encl.
Supplementary data used for anchor trench design.

Job No.	130526	No.	

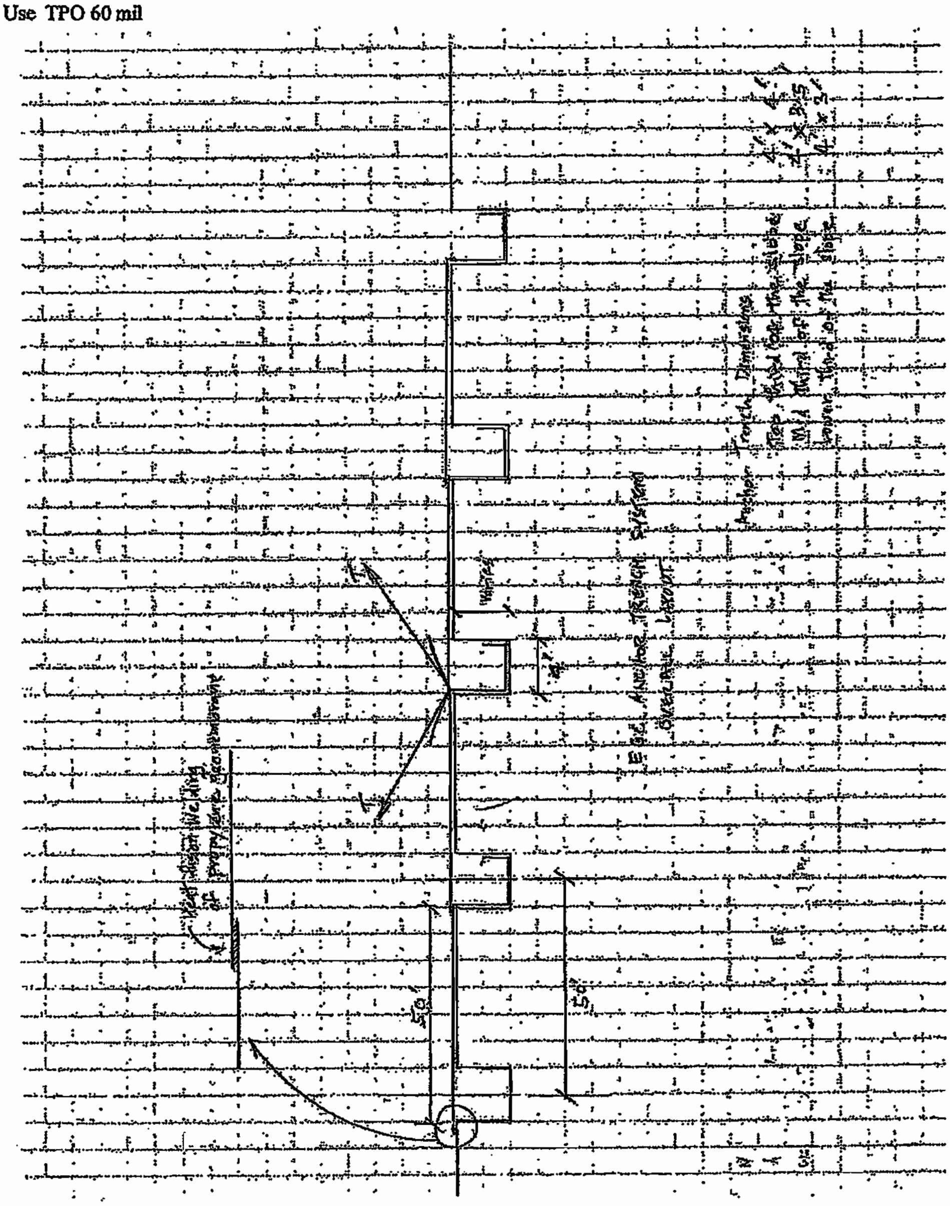
HDR Engineering, Inc.

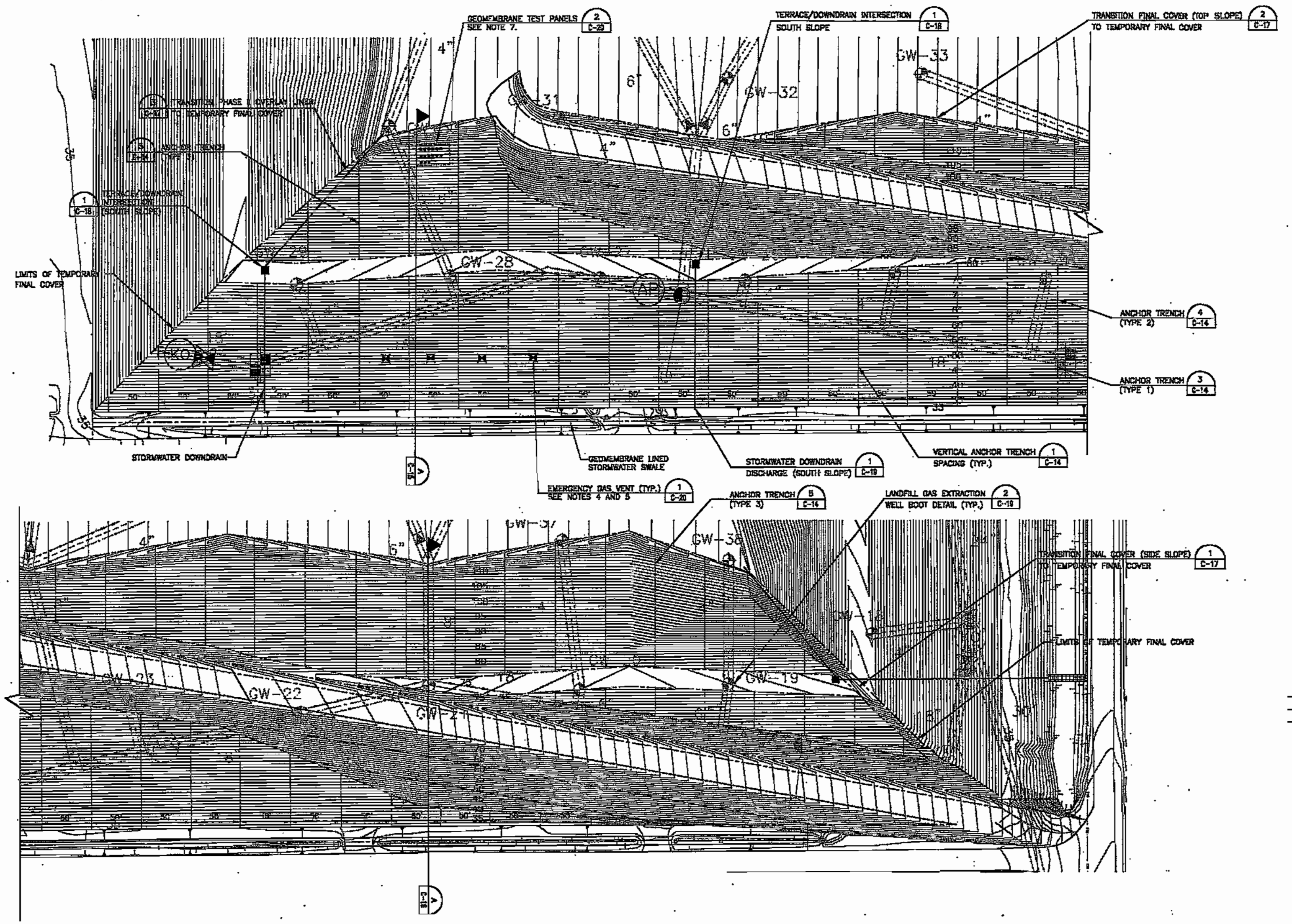
HDR

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Specimen Calculation-Intermediate Anchor Trench	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing upper 1/3 slope	Sheet	1	of	4

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@60)_70_upper.xls]Theory

Use TPO 60 mil





NOTES:

1. TOPOGRAPHY WITHIN PHASES I THROUGH IV AREAS COMPILED BY KUCERA INTERNATIONAL, INC., OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
2. LOCATION OF ANCHOR TRENCHES SHALL BE ADJUSTED IN THE FIELD BASED ON ACTUAL LOCATION OF GAS WELLS AND LFG ACCESS POINTS.
3. THE ANCHOR TRENCH LOACTIONS SHOWN ARE CONCEPTUAL AND SUBJECT TO CHANGE BASED ON CONTRACTORS APPROVED PANEL LAYOUT.
4. THE CONTRACTOR SHALL INSTALL EMERGENCY GAS VENTS FOR EACH PANEL. PLEASE NOTE THAT NOT ALL VENTS ARE SHOWN ON THIS DRAWING.
5. THE EMERGENCY GAS VENTS ARE GENERALLY CLOSED WITH A CAM GROOVE FITTING WHICH WILL BE OPENED MANUALLY IN THE EVENT OF PRESSURE BUILD UP. THE ACTIVE GAS COLLECTION SYSTEM MAY BE CONNECTED TO THESE VENTS IF DEEMED NECESSARY IN THE FUTURE FOR CONTINUOUS GAS EXTRACTION.
6. LANDFILL GAS COLLECTION SYSTEM LAYOUT BASED ON DESIGN SUBMITTED TO FDEP ON DECEMBER 29, 2008 BY HDR ENGINEERING, INC.
7. FIFTEEN 60-MIL TPO GEOMEMBRANE TEST PANELS TO BE PROVIDED IN DESIGNATED LOCATION.

LEGEND

- GW-38 LFG WELLS
- ℄ ANCHOR TRENCH (TYPE 3)
- ℄ ANCHOR TRENCH (TYPE 2)
- ℄ ANCHOR TRENCH (TYPE 1)
- LFG ACCESS POINT
- REMOTE WELLHEAD
- PROPOSED GAS VENT

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HDR
HDR Engineering, Inc.
5426 BayCenter Dr. Ste. 400
Tampa, Fl 33609-3444

ISSUE	DATE	DESCRIPTION
A	4/2010	ISSUED FOR APPROVAL

PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. YANDSCHAK
REVIEWED BY	M. ROBERTS
CIVIL DESIGN	K. PERERA
DRAWN BY	M. AUSTIN
PROJECT NUMBER	001916-92323-018

THOMAS M. YANDSCHAK, P. E.
CERTIFICATE NO. 44200

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS
SARASOTA COUNTY FLORIDA

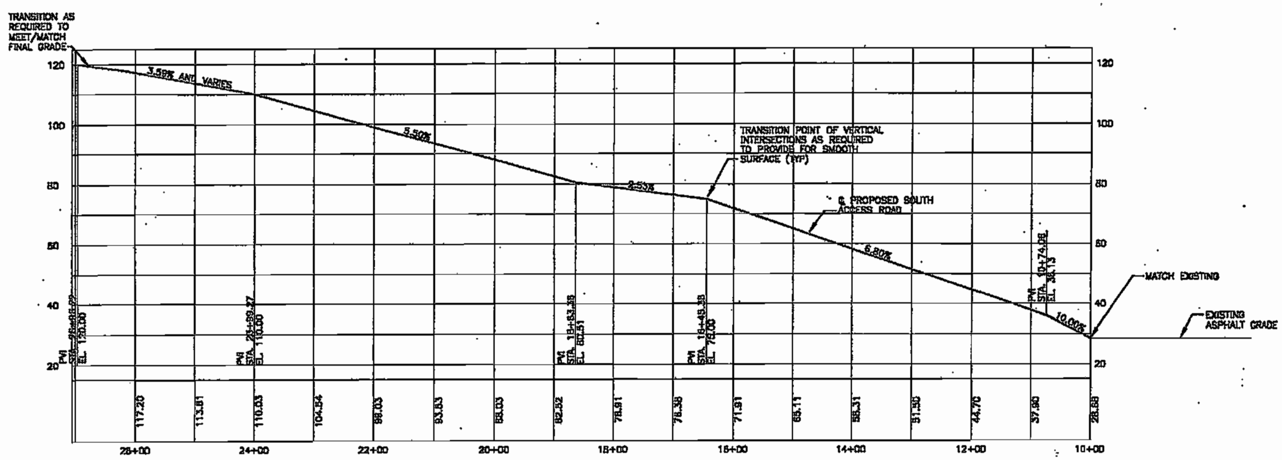
PHASE I TEMPORARY FINAL COVER LAYOUT AND ACHOR TRENCH PLAN

FILENAME	00C-13_rev.dwg	SHEET	00C-13
SCALE	N.T.S.		

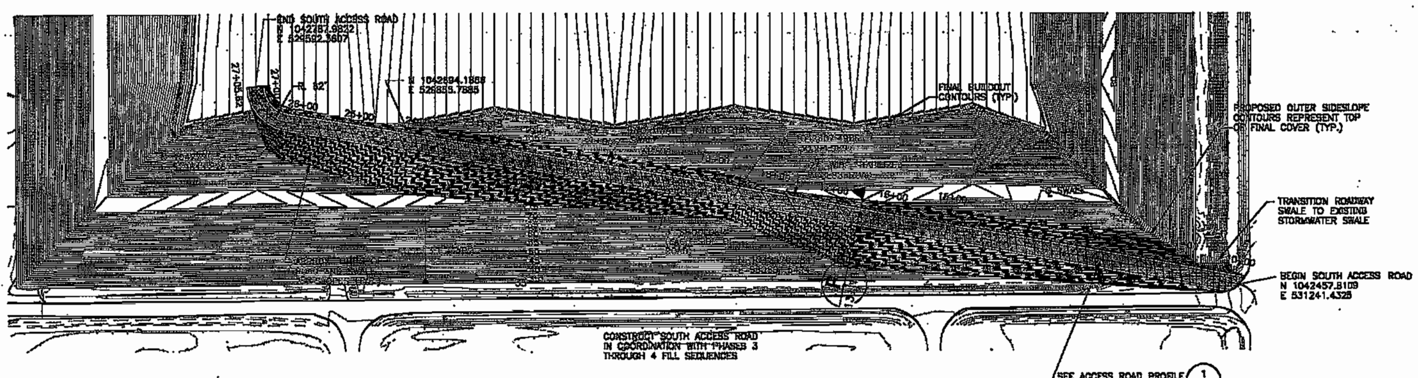
GRAPHIC SCALE

0 50 100 200

SCALE IN FEET
1" = 100'
AND AS SHOWN



ACCESS ROAD PROFILE (1 / C-07)
1" = 100' HORIZ. 1" = 20' VERT.



ACCESS ROAD PLAN (2 / C-05)
SCALE 1" = 100' HORIZ.

NOTES:

1. FILLING GRADES AND ELEVATIONS ARE APPROXIMATE, SEE PERMITTED FILLING PLAN PREPARED BY SCS ENGINEERS, DATED MARCH 2004, FOR GRADES AND ELEVATIONS.

2. OPERATIONAL AND FINAL GRADES SHALL NOT BE GREATER THAN 3:1.

3. MAINTAIN OPERATION BERMS AT ALL ACTIVE WORKING FACES TO CONTAIN ALL STORMWATER COMMINGLED WITH WASTE.

4. MAINTAIN POSITIVE DRAINAGE AT ALL TIMES.

5. CONSTRUCT SOUTH ACCESS ROAD IN COORDINATION WITH PHASE 3 THROUGH 4 FILL SEQUENCES.

HDR

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
A	4/2010	ISSUED FOR APPROVAL

PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

PLAN AND PROFILE
PHASE I ACCESS ROAD

FILENAME:
SCALE: AS SHOWN
SHEET: 00C-07

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Job No. 130526 | No.

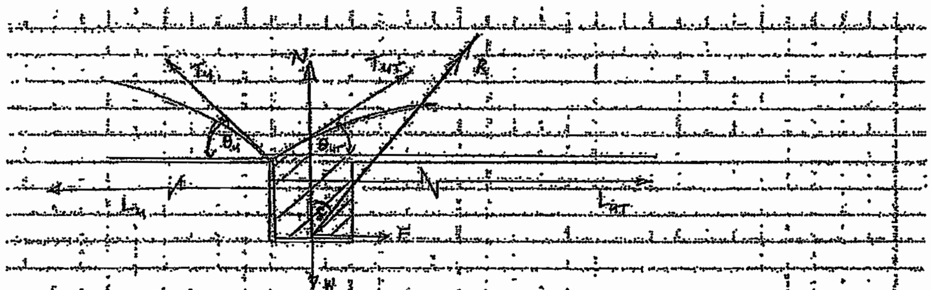
HDR Engineering, Inc.

HDR

Project: CCSWDC Class 1 Landfill	Computed: KP	Date: 1/22/2009
Subject: Specimen Calculation-Intermediate Anchor Trench	Checked: MGR	Date: 1/22/2009
Task: 130 mph wind event @ 50 ft spacing upper 1/3 slope	Sheet: 1	Of: 4

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@60)_70_upper.xls]Theory

Use TPO 60 mil



Case 1 – Anchor Trench Moving Left

$$F = \mu N = \tan\delta\, N$$

$$R = \sqrt{F^2 + N^2}$$

$$R \sin\delta = T_u \cos\theta_u - T_{uT} \cos\theta_{uT}$$

$$R = \frac{T_u \cos\theta_u - T_{uT} \cos\theta_{uT}}{\sin\delta}$$

$$W = R\cos\delta + T_u \sin\theta_u + T_{uT} \sin\theta_{uT}$$

$$W = \frac{T_u \cos\theta_u \cos\delta - T_{uT} \cos\theta_{uT} \cos\delta + T_u \sin\theta_u \sin\delta + T_{uT} \sin\theta_{uT} \sin\delta}{\sin\delta}$$

$$W = \frac{T_u (\cos\theta_u \cos\delta + \sin\theta_u \sin\delta) - T_{uT} (\cos\theta_{uT} \cos\delta - \sin\theta_{uT} \sin\delta)}{\sin\delta}$$

$$= \frac{T_u \cos(\theta_u - \delta) - T_{uT} \cos(\theta_{uT} + \delta)}{\sin\delta}$$

Intermediate Anchor Trench

$T_u = 12.88$ kN/m ; $T_{uT} = 12.88$ kN/m ; $\theta_u = 56.0°$; $\theta_{uT} = 56.0°$

$\delta = 22°$

$$W = \frac{12.88 \cos(56.0 - 22) - 12.88 \cos(56 + 22)}{\sin 22} = 21.36 \text{ kN/m}$$

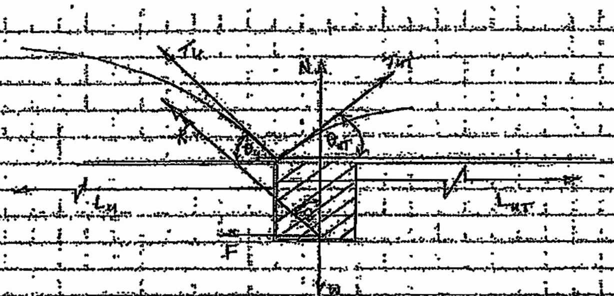
Job No.	130526	No.	

HDR Engineering, Inc.

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Specimen Calculation-Intermediate Anchor Trench	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing upper 1/3 slope	Sheet	1	Of	4

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_upper.xls]Theory

Use TPO 60 mil



Case I: Anchor Trench Moving to the Right

$$R \sin\delta = T_{UT}\cos\theta_{UT} - T_u\cos\theta_u$$

$$W = R\cos\delta + T_u\sin\theta_u + T_{UT}\sin\theta_{UT}$$

$$W = \frac{T_{UT}\cos\theta_{UT}\cos\delta - T_u\cos\theta_u\cos\delta + T_u\sin\theta_u\sin\delta + T_{UT}\sin\theta_{UT}\sin\delta}{\sin\delta}$$

$$= \frac{T_{UT}\cos(\theta_{UT}-\delta) - T_u\cos(\theta_u+\delta)}{\sin\delta}$$

$T_u = 12.88\ kN/m$; $T_{UT} = 12.88\ kN/m$; $\theta_u = 56.0^\circ$; $\theta_{UT} = 56.0^\circ$; $\delta = 22$

$$W = \frac{12.88\cos(56.0-22) - 12.88(56+22)}{\sin 22}$$

$$= 21.36\ kN/m$$

		Job No. 130526	No.

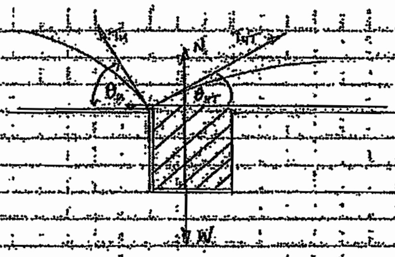
HDR Engineering, Inc.

HDR

Project	CCSWDC Class 1 Landfill	Computed KP	Date 1/22/2009
Subject	Specimen Calculation-Intermediate Anchor Trench	Checked MGR	Date 1/22/2009
Task	130 mph wind event @ 50 ft spacing upper 1/3 slope	Sheet 1	of 4

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_upper.xls]Theory

Use TPO 60 mil



Case 3 : Up lift of Anchor Trench

$W = T_u \sin\theta_u + T_{uT} \sin\theta_{uT}$

$T_u = 12.88$ kN/m ; $T_{uT} = 12.88$ kN/m ; $\theta_u = 56.0^\circ$; $\theta_{uT} = 56.0^\circ$

$W = 12.88 \sin 56 + 12.88 \sin 56.0$

$= 21.36$ kN/m

Use TPO 60 mil

Parameter	Definition	Value	Units		
α	Coefficient of thermal expansion of the geomembrane	0.000050	inch/inch ^{0}F		
g	Acceleration due to gravity	9.81	m/s		
λ	Suction factor	0.65	Dimensionless		
V_w	Design wind velocity	209	km/h	130.00	mph
β_u	Geomembrane slope angle to horizontal	0	degrees		
L_u	Length of geomembrane	15.24	m	50.00	ft
ε_a	Allowable tensile strain of the geomembrane	30.00%			
ρ	Density of geomembrane	1010	kg/m^3		
μ_{GM}	Surface density of geomembrane	1.42	kg/m^2	42 oz/sy	
J	Secant stiffness between origin and peak	70.0	kN/m	400.00	ppi
t	Thickness of the material	0.0015	m		
X	Weld strength	26.3	kN/m	150.00	ppi
z	Site elevation	35.7	m	117.00	ft

1. Determine geomembrane strain due to temperature variation.

All time recorded lowest temperature in the State of Florida (T_1) -2 ^{0}F (Reported on Feb. 13, 1899. Obtained from NCDC)

All time recorded highest temperature in the State of Florida (T_2) 109 ^{0}F (Reported on June 29, 1931. Obtained from NCDC)

$\varepsilon_t = \alpha \times (T_2 - T_1)$

$T_T = \varepsilon_t \times J$

$\varepsilon_t =$ 0.56%

$T_T =$ 0.39 kN/m

2. Determination of strain due to gravity

$T_g = \rho \times g \times L \times t \times \sin\beta$

$T_g =$ 0.00 kN/m

$\varepsilon_g = T_g/J$

$\varepsilon_g =$ 0.00%

3. Determine total initial strain of the geomembrane before wind uplift (ε_0)

$\varepsilon_0 = \varepsilon_g + \varepsilon_t$

$\varepsilon_0 =$ 0.56%

4. Determine total tension on the geomembrane before wind uplift (T_0)

$T_0 = T_g + T_T$

$T_0 =$ 0.39 kN/m

5. Determination of effective suction (S_e)

$$S_e = 0.050 \times \lambda \times V_w^2 \times e^{-(1.252\times10^{-4})z} - g \times \mu_{GM} \times Cos\beta$$

S_e=	1401.68	Pa
	1.402	kN/m^2

6. Determination of normalized tensile stiffness of geomembrane

= $J/S_e \times L$

= 3.279

7. Determination of strain due to wind

ε_w 17.84%

$$\frac{S_e L}{2J(\varepsilon_0+\varepsilon_w)} = Sin\left[\left(\frac{S_e L}{2J(\varepsilon_0+\varepsilon_w)} \times (1+\varepsilon_w)\right) \times \frac{180}{\pi}\right]$$

LHS	RHS
0.8291	0.8291

8. Determination of wind generated tension compnent (T_w)

$T_w = \varepsilon_w \times J$

T_w 12.49 kN/m

9. Determination of total stiffness (T) and strain (ε)

$T = T_0 + T_w$

T 12.9 kN/m

$\varepsilon_T = \varepsilon_0 + \varepsilon_w$

ε_T = 18.39%

10. Factor of safety against rupture

T_y	26.30	kN/m
S_e	1.402	kPa
L	15.24	m
$T_{y(min)}$	11.36	kN/m
ε_Y	0.30	

LHS	RHS
0.939993297	0.93999296

$FS_R = T_y/T_{y(min)}$

FS_R 2.31

Job No.	130526	No.	

HDR Engineering, Inc.

HDR

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches Upper 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	1	of	3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@50)_70_upper.xls]Theory

Use TPO 60 mil

Parameter	Definition	Value	Units		
Tu	Tensile stiffness in the geomembrane - left side of anchor trench	12.88	kN/m		
Td	Tensile stiffness in the geomembrane - right side of anchor trench	0.00	kN/m		
T_{dT}	Tensile stiffness in the geomembrane over anchor trench - right side	0.00	kN/m		
T_{uT}	Tensile stiffness in the geomembrane over anchor trench - left side	12.88	kN/m		
θ_u	Uplift angle of geomembrane - left side (Calculated below)	56.0	degrees		
θ_d	Uplift angle of geomembrane - right side (Calculated below)	0.0	degrees		
θ_{dT}	Uplift angle of geomembrane-anchor trench right side (Calculated below)	56.0	degrees		
θ_{uT}	Uplift angle of geomembrane- anchor trench left side (Calculated below)	56.0	degrees		
β_u	Geomembrane slope angle to horizontal-left side	0	degrees		
β_d	Geomembrane slope angle-right side	0	degrees		
β_s	Drainage slope of the geomembrane in the direction of uplift	0	degrees		
ε_a	Allowable tensile strain of the geomembrane	30%			
ε_{wu}	Tensile strain of the geomembrane due to wind-left side	17.84%			
ε_{wd}	Tensile strain of the geomembrane due to wind-right side	0.00%			
ε_{wT}	Tensile strain of the geomembrane due to wind-on the anchor trench	17.84%			
ε_u	Total applied strain-left side	18.39%			
ε_d	Total applied strain-right side	0.00%			
ε_T	Total applied strain-anchor trench	18.39%			
J	Secant stiffness between origin and peak	70.0	kN/m		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
FS_u	Factor of safety against uplift	1.17			
L_u	Length of geomembrane between anchors-left side	15.24	m		
L_d	Length of geomembrane between anchors-right side	0.00	m		
L_T	Length of geomembrane between anchors-terrace	15.24	m		
X	Weld strength	26.3	kN/m		

Note: For this case anchor trench geomembrane is considered to be the second span.

1. Determine angle of uplift geomembrane with upslope.
Note that for this case this is the span to the left of the anchor trench.

$$\varepsilon_{wu} = \frac{\theta_u}{Sin\,\theta_u} - 1$$

$$\frac{\theta_u}{Sin\,\theta_u} = \quad 1.1784$$

θ_u 56.00 degrees

Calculated $\frac{\theta_u}{Sin\,\theta_u}$ 1.1784

Total length of geomembrane during wind event (L'_u) upslope area

$L'_u = (1+\varepsilon_u) \times L_u$

Use TPO 60 mil

L'_u 18.04 m

Arc radius of geomembrane during wind event [R]

$$R_u = \frac{L'_u}{2\theta_u}$$

R_u 9.23 m

Uplift of the geomembrane due to wind on slope (u_u)

$u_u = R_u - R_u \times \cos\theta_u$

u_u 4.07 m

2. Determine angle of uplift geomembrane with downslope.
Note that this section is not applicable for the specific case.

N/A

$$\varepsilon_{wd} = \frac{\theta_d}{\sin\theta_d} - 1$$

$\frac{\theta_d}{\sin\theta_d}$ = 1.0000

θ_d 0.00 degrees

Calculated $\frac{\theta_d}{\sin\theta_d}$ = #DIV/0!

As discussed above, for the exposed geomembrane over the downslope area

L'_d = 0.00
R_d = #DIV/0!
u_d = #DIV/0!

3. Determine angle of uplift geomembrane with slope on the terrace.
Note that for this case this is the span to the right of the anchor trench.

$$\varepsilon_{uT} = \frac{\theta_{uT}}{\sin\theta_{uT}} - 1$$

$\frac{\theta_{uT}}{\sin\theta_{uT}}$ = 1.1784

θ_{uT} = 56.00 degrees

Calculated $\frac{\theta_{uT}}{\sin\theta_{uT}}$ = 1.1784

Job No.	130526	No.	

HDR Engineering, Inc.

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches Upper 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	3	of	3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermodiate Anchor(130mph@50)_70_upper.xls]Theory

Use TPO 60 mil

As discussed above, for the exposed geomembrane over the terrace

L'_T	=	18.04
R_T	=	9.23
u_T	=	4.07

A	0.00	degrees	T_d	0.00	kN/m
B	56.00	degrees	T_{dT}	0.00	kN/m
C	56.00	degrees	T_{uT}	12.88	kN/m
D	56.00	degrees	T_u	12.88	kN/m

4. Required minimum weight of anchor trench to prevent downslope movement (refer to Case 1 of free body diagram attached)

$$W_{min} = W_{min\ downsliding} = \frac{T_d \cos(A-\delta) - T_{dT}\cos(B+\delta) + T_{uT}\cos(C-\delta) - T_u \cos(D+\delta)}{\sin\delta}$$

$W_{min\ downsliding}$ = 21.36 kN/m

5. Required minimum weight of anchor trench to prevent upslope movement (refer to Case 2 of free body diagram attached)

$$W_{min} = W_{min\ upslope\ sliding} = \frac{-T_d \cos(A+\delta) + T_{dT}\cos(B-\delta) - T_{uT}\cos(C+\delta) + T_u \cos(D-\delta)}{\sin\delta}$$

$W_{min\ upslope\ sliding}$ = 21.36 kN/m

6. Required minimum weight of the anchor trench to prevent uplifting (refer to Case 3 of free body diagram attached)

$$W_{min} = W_{min\ uplifting} = T_d \sin A + T_{dT} \sin B + T_{uT} SinC + T_u SinD$$

$W_{min\ uplifting}$ = 21.36 kN/m

7. Required anchor trench area

$$A_{req} = \frac{W_{req}}{\gamma}$$

A_{req} 1.27 m^2 = 13.67 ft^2

Dimension of the proposed anchor trench

Depth of Anchor Trench	=	4.00 ft
Width of the Anchor Trench	=	4.00 ft
Area of the Anchor Trench	=	16.00 ft^2
Therefore, factor of safety against uplift	=	1.17

Job No. 130526	No.

HDR Engineering, Inc.

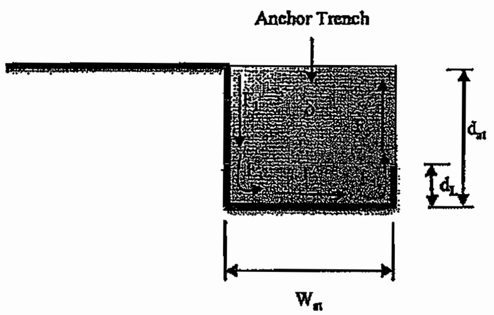
HDR

Project CCSWDC Class 1 Landfill	Computed KP	Date 1/22/2009
Subject Design for Anchor Trench Pullout	Checked MGR	Date 1/22/2009
Task 130 mph wind event @ 50 ft spacing	Sheet 1	Of 3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_upper.xls]Friction

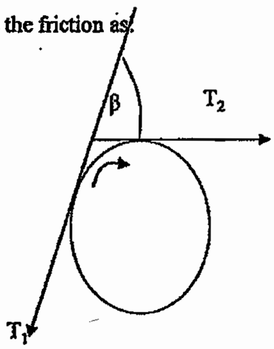
Use TPO 60 mil

Parame	Definition	Value	Units		
D_{at}	Depth of Anchor Trench	4.00	ft		
W_{at}	Width of the Anchor Trench	4.00	ft		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
d_L	Length of the geomembrane curved upward in the anchor trench	1.00	ft		
k	Coefficient of lateral earth pressure	0.60			



Forces F_1, F_2 and F_5 are frictional forces developed in the liner system due to shear resistance between layers
Forces F_3, and F_4 are frictional forces developed where the liner changes directions (bends). These forces are calculated by treating them as a belt sliding over a rigid, stationary body.

Ref. 1 gives the friction as:



$T_2 = T_1 e^{\mu\beta}$

Friction $= T_2 - T_1 = T_1 \times (e^{\tan\delta \times \beta} - 1)$

Where:

tanδ = coefficient of friction between layer and the rigid body

β = angle between T_1 and T_2 or angle of wrap (radians)

T_1 = tensile force holding the layer in place

T_2 = force needed to overcome T and friction

Because geomembrane is not completely rigid, the friction force obtained from the above equation was multiplied by 0.5.

The shear resistance forces F_1, F_2, F_3, F_4 and F_5 are calculated in the following manner:

$F = N \tan\delta$

Where:

N = normal force applied on the geosynthetic layer

δ = friction angle between geosynthetic layers, or soil and geosynthetic layers

$F_1 = 0.5 \times \gamma_{at} \times d_{at} \times k \times d_{at} \times \tan\delta_L$ (1)

$F_3 = \gamma_{at} \times d_{at} \times W_{at} \times \tan\delta$ (2)

$F_2 = (F_1 + F_3)(e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (3)

$F_4 = (F_3 + F_4) \times (e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (4)

$F_5 = 0.5 \times (\gamma_{at} \times d_{at} + \gamma_{at} \times (d_L - 1)) \times k \times d_{at} \times \tan\delta_L$ (5)

Job No.	130526	No.	

HDR Engineering, Inc.

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Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design for Anchor Trench Pullout	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	3	Of	3

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F_1	207.41	lbs/ft
F_3	691.36	lbs/ft
F_2	397.74	lbs/ft
F_4	194.55	lbs/ft
F_5	90.74	lbs/ft

Total Friction Force	1582	lbs/ft
	23	kN/m

Maximum uplift force	21.36	kN/m
Therefore, FS	1.09	

Since friction resistance force from the anchor trench is greater than uplift force, the anchor trench will not pullout.

Job No.	130526	No.	

HDR Engineering, Inc.

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Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches middle 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	1	of	2

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@50)_70_middle.xls]uplift

Use TPO 60 mil

Parameter	Definition	Value	Units		
α	Coefficient of thermal expansion of the geomembrane	0.000050	inch/inch ^{0}F		
g	Acceleration due to gravity	9.81	m/s		
λ	Suction factor	0.54	Dimensionless		
V_w	Design wind velocity	209	km/h	130.00	mph
β_u	Geomembrane slope angle to horizontal	0	degrees		
L_u	Length of geomembrane	15.24	m	50.00	ft
ε_a	Allowable tensile strain of the geomembrane	30.00%			
ρ	Density of geomembrane	1010	kg/m^3		
μ_{GM}	Surface density of geomembrane	1.42	kg/m^2	42 oz/sy	
J	Secant stiffness between origin and peak	70.0	kN/m	400.00	ppi
t	Thickness of the material	0.0015	m		
X	Weld strength	26.3	kN/m	150.00	ppi
z	Site elevation	35.7	m	117.00	ft

1. Determine geomembrane strain due to temperature variation.

All time recorded lowest temperature in the State of Florida (T_1) -2 ^{0}F (Reported on Feb. 13, 1899. Obtained from NCDC)

All time recorded highest temperature in the State of Florida (T_2) 109 ^{0}F (Reported on June 29, 1931. Obtained from NCDC)

$\varepsilon_t = \alpha \times (T_2 - T_1)$

$T_T = \varepsilon_t \times J$

$\varepsilon_t =$ 0.56%

$T_T =$ 0.39 kN/m

2. Determination of strain due to gravity

$T_g = \rho \times g \times L \times t \times \sin\beta$

$T_g =$ 0.00 kN/m

$\varepsilon_g = T_g/J$

$\varepsilon_g =$ 0.00%

3. Determine total initial strain of the geomembrane before wind uplift (ε_0)

$\varepsilon_0 = \varepsilon_g + \varepsilon_t$

$\varepsilon_0 =$ 0.56%

4. Determine total tension on the geomembrane before wind uplift (T_0)

$T_0 = T_g + T_T$

$T_0 =$ 0.39 kN/m

Job No.	130526	No.	

HDR Engineering, Inc.

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Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches middle 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	2	Of	2

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5. Determination of effective suction (S_e)

$$S_e = 0.050 \times \lambda \times V_w^2 \times e^{-(1.252\times10^{-4})z} - g \times \mu_{GM} \times Cos\beta$$

S_e=	1162.11	Pa
	1.162	kN/m²

6. Determination of normalized tensile stiffness of geomembrane

= $J/S_e \times L$

= 3.955

7. Determination of strain due to wind

ε_w 15.39%

$$\frac{S_e L}{2J(\varepsilon_0+\varepsilon_w)} = Sin\left[\left(\frac{S_e L}{2J(\varepsilon_0+\varepsilon_w)} \times (1+\varepsilon_w)\right) \times \frac{180}{\pi}\right]$$

LHS	RHS
0.7926	0.7926

8. Determination of wind generated tension compnent (T_w)

$T_w = \varepsilon_w \times J$

T_w 10.78 kN/m

9. Determination of total stiffness (T) and strain (ε)

$T = T_0 + T_w$

T 11.2 kN/m

$\varepsilon_T = \varepsilon_0 + \varepsilon_w$

ε_T = 15.95%

10. Factor of safety against rupture

T_y	26.30	kN/m
S_e	1.162	kPa
L	15.24	m
$T_{y(min)}$	[redacted]	kN/m
ε_y	0.30	

LHS	RHS
0.939993297	0.93999296

$FS_R = T_y/T_{y(min)}$

FS_R 2.79

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HDR Engineering, Inc.

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Project	CCSWDC Class 1 Landfill	Computed KP	Date 1/22/2009
Subject	Design of Anchor Trenches middle 1/3 of Slope	Checked MGR	Date 1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet 1	Of 3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@50)_70_middle.xls]anchor

Use TPO 60 mil

Parameter	Definition	Value	Units		
Tu	Tensile stiffness in the geomembrane - left side of anchor trench	11.17	kN/m		
Td	Tensile stiffness in the geomembrane - right side of anchor trench	0.00	kN/m		
T_{dT}	Tensile stiffness in the geomembrane over anchor trench - right side	0.00	kN/m		
T_{uT}	Tensile stiffness in the geomembrane over anchor trench - left side	11.17	kN/m		
θ_u	Uplift angle of geomembrane - left side (Calculated below)	[illegible]	degrees		
θ_d	Uplift angle of geomembrane - right side (Calculated below)	0.0	degrees		
θ_{dT}	Uplift angle of geomembrane-anchor trench right side (Calculated below)	[illegible]	degrees		
θ_{uT}	Uplift angle of geomembrane- anchor trench left side (Calculated below)	[illegible]	degrees		
β_u	Geomembrane slope angle to horizontal-left side	0	degrees		
β_d	Geomembrane slope angle-right side	0	degrees		
β_s	Drainage slope of the geomembrane in the direction of uplift	0	degrees		
ε_a	Allowable tensile strain of the geomembrane	30%			
ε_{wu}	Tensile strain of the geomembrane due to wind-left side	15.39%			
ε_{wd}	Tensile strain of the geomembrane due to wind-right side	0.00%			
ε_{wT}	Tensile strain of the geomembrane due to wind-on the anchor trench	15.39%			
ε_u	Total applied strain-left side	15.95%			
ε_d	Total applied strain-right side	0.00%			
ε_T	Total applied strain-anchor trench	15.95%			
J	Secant stiffness between origin and peak	70.0	kN/m		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
FS_u	Factor of safety against uplift	1.23			
L_u	Length of geomembrane between anchors-left side	15.24	m		
L_d	Length of geomembrane between anchors-right side	0.00	m		
L_T	Length of geomembrane between anchors-terrace	15.24	m		
X	Weld strength	26.3	kN/m		

Note: For this case anchor trench geomembrane is considered to be the second span.

1. Determine angle of uplift geomembrane with upslope.
Note that for this case this is the span to the left of the anchor trench.

$$\varepsilon_{wu} = \frac{\theta_u}{\sin\theta_u} - 1$$

$$\frac{\theta_u}{\sin\theta_u} = 1.1539$$

θ_u 52.43 degrees

Calculated $\frac{\theta_u}{\sin\theta_u}$ 1.1539

Total length of geomembrane during wind event (L'_u) upslope area

$L'_u = (1+\varepsilon_u) \times L_u$

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HDR Engineering, Inc.

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Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches middle 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	2	Of	3

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Use TPO 60 mil

L'_u 17.67 m

Arc radius of geomembrane during wind event [R]

$$R_u = \frac{L'_u}{2\theta_u}$$

R_u 9.66 m

Uplift of the geomembrane due to wind on slope (u_u)

$u_u = R_u - R_u \times \cos\theta_u$

u_u 3.77 m

2. Determine angle of uplift geomembrane with downslope.
Note that this section is not applicable for the specific case.

N/A

$$\varepsilon_{ud} = \frac{\theta_d}{\sin\theta_d} - 1$$

$\frac{\theta_d}{\sin\theta_d}$ = 1.0000

θ_d 0.00 degrees

Calculated $\frac{\theta_d}{\sin\theta_d}$ = #DIV/0!

As discussed above, for the exposed geomembrane over the downslope area

L'_d = 0.00
R_d = #DIV/0!
u_d = #DIV/0!

3. Determine angle of uplift geomembrane with slope on the terrace.
Note that for this case this is the span to the right of the anchor trench.

$$\varepsilon_{uT} = \frac{\theta_{uT}}{\sin\theta_{uT}} - 1$$

$\frac{\theta_{uT}}{\sin\theta_{uT}}$ = 1.1539

θ_{uT} = 52.43 degrees

Calculated $\frac{\theta_{uT}}{\sin\theta_{uT}}$ = 1.1539

Use TPO 60 mil

As discussed above, for the exposed geomembrane over the terrace

L'_T = 17.67
R_T = 9.66
u_T = 3.77

A	0.00	degrees	T_d	0.00	kN/m
B	52.43	degrees	T_{dT}	0.00	kN/m
C	52.43	degrees	T_{uT}	11.17	kN/m
D	52.43	degrees	T_u	11.17	kN/m

4. Required minimum weight of anchor trench to prevent downslope movement (refer to Case 1 of free body diagram attached)

$$W_{min} = W_{min\ downsliding} = \frac{T_d\cos(A-\delta) - T_{dT}\cos(B+\delta) + T_{uT}\cos(C-\delta) - T_u\cos(D+\delta)}{\sin\delta}$$

$W_{min\ downsliding}$ = 17.71 kN/m

5. Required minimum weight of anchor trench to prevent upslope movement (refer to Case 2 of free body diagram attached)

$$W_{min} = W_{min\ upslope\ sliding} = \frac{-T_d\cos(A+\delta) + T_{dT}\cos(B-\delta) - T_{uT}\cos(C+\delta) + T_u\cos(D-\delta)}{\sin\delta}$$

$W_{min\ upslope\ sliding}$ = 17.71 kN/m

6. Required minimum weight of the anchor trench to prevent uplifting (refer to Case 3 of free body diagram attached)

$$W_{min} = W_{min\ uplifting} = T_d \sin A + T_{dT}\sin B + T_{uT} Sin C + T_u Sin D$$

$W_{min\ uplifting}$ = 17.71 kN/m

7. Required anchor trench area

$$A_{req} = \frac{W_{req}}{\gamma}$$

A_{req} 1.05 m^2 = 11.34 ft^2

Dimension of the proposed anchor trench

Depth of Anchor Trench	=	3.50 ft
Width of the Anchor Trench	=	4.00 ft
Area of the Anchor Trench	=	14.00 ft^2
Therefore, factor of safety against uplift	=	1.23

Job No. 130526	No.

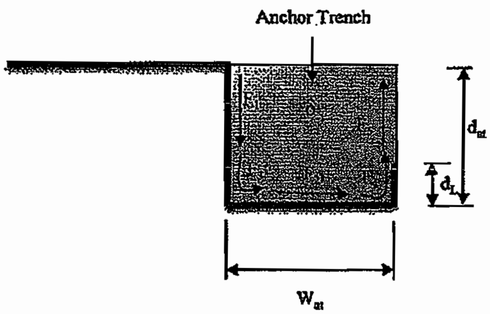
HDR Engineering, Inc.

Project CCSWDC Class 1 Landfill	Computed KP	Date 1/22/2009
Subject Design for Anchor Trench Pullout	Checked MGR	Date 1/22/2009
Task 130 mph wind event @ 50 ft spacing	Sheet 1	of 3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_middle.xls]anchor

Use TPO 60 mil

Param	Definition	Value	Units		
D_{at}	Depth of Anchor Trench	3.50	ft		
W_{at}	Width of the Anchor Trench	4.00	ft		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
d_L	Length of the geomembrane curved upward in the anchor trench	1.00	ft		
k	Coefficient of lateral earth pressure	0.60			



Forces F_1, F_2 and F_5 are frictional forces developed in the liner system due to shear resistance between layers

Forces F_3, and F_4 are frictional forces developed where the liner changes directions (bends). These forces are calculated by treating them as a belt sliding over a rigid, stationary body.

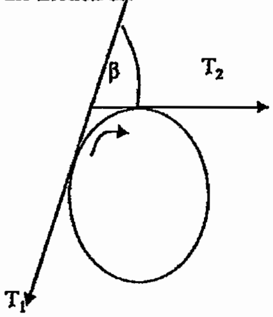
Job No.	130526	No.	

HDR Engineering, Inc. HDR

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design for Anchor Trench Pullout	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	2	Of	3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_middle.xls]anchor

Ref. 1 gives the friction as:



$T_2 = T_1 e^{\mu\beta}$

Friction $= T_2 - T_1 = T_1 \times (e^{\tan\delta \times \beta} - 1)$

Where:

tanδ = coefficient of friction between layer and the rigid body

β = angle between T_1 and T_2 or angle of wrap (radians)

T_1 = tensile force holding the layer in place

T_2 = force needed to overcome T and friction

Because geomembrane is not completely rigid, the friction force obtained from the above equation was multiplied by 0.5.

The shear resistance forces F_1, F_2, F_3, F_4 and F_5 are calculated in the following manner:

F = N tanδ

Where:

N = normal force applied on the geosynthetic layer

δ = friction angle between geosynthetic layers, or soil and geosynthetic layers

$F_1 = 0.5 \times \gamma_{at} \times d_{at} \times k \times d_{at} \times \tan\delta_L$ (1)

$F_3 = \gamma_{at} \times d_{at} \times W_{at} \times \tan\delta$ (2)

$F_2 = (F_1 + F_3)(e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (3)

$F_4 = (F_5 + F_4) \times (e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (4)

$F_5 = 0.5 \times (\gamma_{at} \times d_{at} + \gamma_{at} \times (d_L - 1)) \times k \times d_{at} \times \tan\delta_L$ (5)

F_1	158.80	lbs/ft
F_3	604.94	lbs/ft
F_2	337.98	lbs/ft
F_4	169.83	lbs/ft
F_5	77.78	lbs/ft

Total Friction Force	1349	lbs/ft
	20	kN/m

Maximum uplift force 17.71 kN/m

Therefore, FS 1.12

Since friction resistance force from the anchor trench is greater than uplift force, the anchor trench will not pullout.

Use TPO 60 mil

Parameter	Definition	Value	Units		
α	Coefficient of thermal expansion of the geomembrane	0.000050	inch/inch °F		
g	Acceleration due to gravity	9.81	m/s		
λ	Suction factor	0.42	Dimensionless		
V_w	Design wind velocity	209	km/h	130.00	mph
β_u	Geomembrane slope angle to horizontal	0	degrees		
L_u	Length of geomembrane	15.24	m	50.00	ft
ε_a	Allowable tensile strain of the geomembrane	30.00%			
ρ	Density of geomembrane	1010	kg/m^3		
μ_{GM}	Surface density of geomembrane	1.42	kg/m^2	42 oz/sy	
J	Secant stiffness between origin and peak	70.0	kN/m	400.00	ppi
t	Thickness of the material	0.0015	m		
X	Weld strength	26.3	kN/m	150.00	ppi
z	Site elevation	35.7	m	117.00	ft

1. Determine geomembrane strain due to temperature variation.

All time recorded lowest temperature in the State of Florida (T_1) -2 °F (Reported on Feb. 13, 1899. Obtained from NCDC)

All time recorded highest temperature in the State of Florida (T_2) 109 °F (Reported on June 29, 1931. Obtained from NCDC)

$\varepsilon_t = \alpha \times (T_2 - T_1)$
$T_T = \varepsilon_t \times J$

$\varepsilon_t =$ 0.56%
$T_T =$ 0.39 kN/m

2. Determination of strain due to gravity

$T_g = \rho \times g \times L \times t \times \sin\beta$
$T_g =$ 0.00 kN/m

$\varepsilon_g = T_g / J$
$\varepsilon_g =$ 0.00%

3. Determine total initial strain of the geomembrane before wind uplift (ε_0)

$\varepsilon_0 = \varepsilon_g + \varepsilon_t$
$\varepsilon_0 =$ 0.56%

4. Determine total tension on the geomembrane before wind uplift (T_0)

$T_0 = T_g + T_T$
$T_0 =$ 0.39 kN/m

5. Determination of effective suction (S_e)

$$S_e = 0.050 \times \lambda \times V_w^2 \times e^{-(1.252 \times 10^{-4})z} - g \times \mu_{GM} \times Cos\beta$$

S_e=	900.77	Pa
	0.901	kN/m^2

6. Determination of normalized tensile stiffness of geomembrane

= $J/S_e \times L$

= 5.103

7. Determination of strain due to wind

ε_w 12.64%

$$\frac{S_e L}{2J(\varepsilon_0 + \varepsilon_w)} = Sin\left[\left(\frac{S_e L}{2J(\varepsilon_0 + \varepsilon_w)} \times (1 + \varepsilon_w)\right) \times \frac{180}{\pi}\right]$$

LHS	RHS
0.7425	0.7425

8. Determination of wind generated tension compnent (T_W)

$T_w = \varepsilon_w \times J$

T_w 8.86 kN/m

9. Determination of total stiffness (T) and strain (ε)

$T = T_0 + T_w$

T 9.2 kN/m

$\varepsilon_T = \varepsilon_0 + \varepsilon_w$

ε_T = 13.20%

10. Factor of safety against rupture

T_y	26.30	kN/m
S_e	0.901	kPa
L	15.24	m
$T_{y(min)}$	7.30	kN/m
ε_Y	0.30	

LHS	RHS
0.93999306	0.93999243

$FS_R = T_y/T_{y(min)}$

FS_R 3.60

HDR Engineering, Inc.

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches Lower 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 60 ft spacing	Sheet	1	of	3

C:\HDR Projects\Sarasota County\SEC\EGC\[intermediate Anchor(130mph@60)_70_lower.xls]anchor

Use TPO 60 mil

Parameter	Definition	Value	Units		
Tu	Tensile stiffness in the geomembrane - left side of anchor trench	9.24	kN/m		
Td	Tensile stiffness in the geomembrane - right side of anchor trench	0.00	kN/m		
T_{dT}	Tensile stiffness in the geomembrane over anchor trench - right side	0.00	kN/m		
T_{uT}	Tensile stiffness in the geomembrane over anchor trench - left side	9.24	kN/m		
θ_u	Uplift angle of geomembrane - left side (Calculated below)	47.9	degrees		
θ_d	Uplift angle of geomembrane - right side (Calculated below)	0.0	degrees		
θ_{dT}	Uplift angle of geomembrane-anchor trench right side (Calculated below)	47.9	degrees		
θ_{uT}	Uplift angle of geomembrane- anchor trench left side (Calculated below)	47.9	degrees		
β_u	Geomembrane slope angle to horizontal-left side	0	degrees		
β_d	Geomembrane slope angle-right side	0	degrees		
β_a	Drainage slope of the geomembrane in the direction of uplift	0	degrees		
ε_a	Allowable tensile strain of the geomembrane	30%			
ε_{wu}	Tensile strain of the geomembrane due to wind-left side	12.64%			
ε_{wd}	Tensile strain of the geomembrane due to wind-right side	0.00%			
ε_{wT}	Tensile strain of the geomembrane due to wind-on the anchor trench	12.64%			
ε_u	Total applied strain-left side	13.20%			
ε_d	Total applied strain-right side	0.00%			
ε_T	Total applied strain-anchor trench	13.20%			
J	Secant stiffness between origin and peak	70.0	kN/m		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
FS_u	Factor of safety against uplift	1.37			
L_u	Length of geomembrane between anchors-left side	15.24	m		
L_d	Length of geomembrane between anchors-right side	0.00	m		
L_T	Length of geomembrane between anchors-terrace	15.24	m		
X	Weld strength	29.3	kN/m		

Note: For this case anchor trench geomembrane is considered to be the second span.

1. Determine angle of uplift geomembrane with upslope.
Note that for this case this is the span to the left of the anchor trench.

$$\varepsilon_{wu} = \frac{\theta_u}{Sin\,\theta_u} - 1$$

$$\frac{\theta_u}{Sin\,\theta_u} = 1.1264$$

θ_u 47.94 degrees

Calculated $\frac{\theta_u}{Sin\,\theta_u}$ 1.1264

Total length of geomembrane during wind event (L'_u) upslope area

$L'_u = (1+\varepsilon_u) \times L_u$

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HDR Engineering, Inc.

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Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches Lower 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	2	Of	3

C:\HDR Projects\Sarasota County\SEC\EGC\[intermediate Anchor(130mph@50)_70_lower.xls]anchor

Use TPO 60 mil

L'_u 17.25 m

Arc radius of geomembrane during wind event [R]

$$R_u = \frac{L'_u}{2\theta_u}$$

R_u 10.31 m

Uplift of the geomembrane due to wind on slope (u_u)

$u_u = R_u - R_u \times \cos\theta_u$

u_u 3.40 m

2. Determine angle of uplift geomembrane with downslope.
Note that this section is not applicable for the specific case. N/A

$$\varepsilon_{ud} = \frac{\theta_d}{\sin\theta_d} - 1$$

$\frac{\theta_d}{\sin\theta_d}$ = 1.0000

θ_d 0.00 degrees

Calculated $\frac{\theta_d}{\sin\theta_d}$ = #DIV/0!

As discussed above, for the exposed geomembrane over the downslope area

L'_d = 0.00
R_d = #DIV/0!
u_d = #DIV/0!

3. Determine angle of uplift geomembrane with slope on the terrace.
Note that for this case this is the span to the right of the anchor trench.

$$\varepsilon_{uT} = \frac{\theta_{uT}}{\sin\theta_{uT}} - 1$$

$\frac{\theta_{uT}}{\sin\theta_{uT}}$ = 1.1264

θ_{uT} = 47.94 degrees

Calculated $\frac{\theta_{uT}}{\sin\theta_{uT}}$ = 1.1264

Use TPO 60 mil

As discussed above, for the exposed geomembrane over the terrace

L'_T	=	17.25
R_T	=	10.31
u_T	=	3.40

A	0.00	degrees	T_d	0.00	kN/m
B	47.94	degrees	T_{dT}	0.00	kN/m
C	47.94	degrees	T_{uT}	9.24	kN/m
D	47.94	degrees	T_u	9.24	kN/m

4. Required minimum weight of anchor trench to prevent downslope movement (refer to Case 1 of free body diagram attached)

$$W_{min} = W_{min\ downsliding} = \frac{T_d\cos(A-\delta) - T_{dT}\cos(B+\delta) + T_{uT}\cos(C-\delta) - T_u\cos(D+\delta)}{\sin\delta}$$

$W_{min\ downsliding}$ = 13.73 kN/m

5. Required minimum weight of anchor trench to prevent upslope movement (refer to Case 2 of free body diagram attached)

$$W_{min} = W_{min\ upslope\ sliding} = \frac{-T_d\cos(A+\delta) + T_{dT}\cos(B-\delta) - T_{uT}\cos(C+\delta) + T_u\cos(D-\delta)}{\sin\delta}$$

$W_{min\ upslope\ sliding}$ = 13.73 kN/m

6. Required minimum weight of the anchor trench to prevent uplifting (refer to Case 3 of free body diagram attached)

$$W_{min} = W_{min\ uplifting} = T_d\sin A + T_{dT}\sin B + T_{uT}SinC + T_uSinD$$

$W_{min\ uplifting}$ = 13.73 kN/m

7. Required anchor trench area

$$A_{req} = \frac{W_{req}}{\gamma}$$

A_{req} 0.82 m^2 = 8.79 ft^2

Dimension of the proposed anchor trench

Depth of Anchor Trench	=	3.00	ft
Width of the Anchor Trench	=	4.00	ft
Area of the Anchor Trench	=	12.00	ft^2
Therefore, factor of safety against uplift	=	1.37	

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HDR Engineering, Inc.

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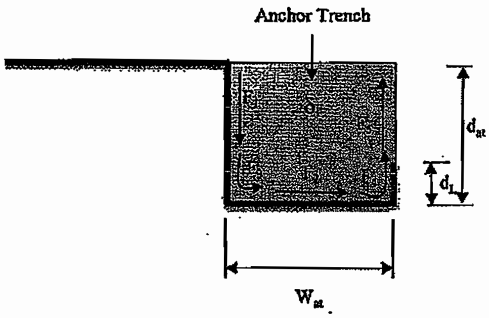
Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design for Anchor Trench Pullout	Checked	MGR	Date	1/22/2009
Task	130 mph wind event @ 50 ft spacing	Sheet	1	of	3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_lower.xls]Friction

Use TPO 60 mil

Param	Definition	Value	Units		
D_{at}	Depth of Anchor Trench	3.00	ft		
W_{at}	Width of the Anchor Trench	4.00	ft		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
d_L	Length of the geomembrane curved upward in the anchor trench	1.00	ft		
k	Coefficient of lateral earth pressure	0.60			



Forces F_1, F_2 and F_5 are frictional forces developed in the liner system due to shear resistance between layers

Forces F_3, and F_4 are frictional forces developed where the liner changes directions (bends). These forces are calculated by treating them as a belt sliding over a rigid, stationary body.

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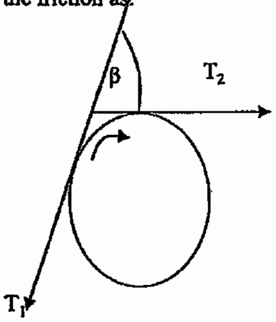
HDR Engineering, Inc.		HDR
Project CCSWDC Class 1 Landfill	Computed KP	Date 1/22/2009
Subject Design for Anchor Trench Pullout	Checked MGR	Date 1/22/2009
Task 130 mph wind event @ 50 ft spacing	Sheet 2	Of 3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_lower.xls]Friction

Ref. 1 gives the friction as:



$T_2 = T_1 e^{\mu\beta}$

Friction $= T_2 - T_1 = T_1 \times (e^{\tan\delta \times \beta} - 1)$

Where:
tanδ = coefficient of friction between layer and the rigid body
β = angle between T_1 and T_2 or angle of wrap (radians)
T_1 = tensile force holding the layer in place
T_2 = force needed to overcome T and friction

Because geomembrane is not completely rigid, the friction force obtained from the above equation was multiplied by 0.5.

The shear resistance forces F_1, F_2, F_3, F_4 and F_5 are calculated in the following manner:

$F = N \tan\delta$

Where:
N = normal force applied on the geosynthetic layer
δ = friction angle between geosynthetic layers, or soil and geosynthetic layers

$F_1 = 0.5 \times \gamma_{at} \times d_{at} x\, k \times d_{at} \times \tan \delta_L$ (1)

$F_3 = \gamma_{at} \times d_{at} \times W_{at} \times \tan\delta$ (2)

$F_2 = (F_1 + F_3)(e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (3)

$F_4 = (F_3 + F_4) \times (e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (4)

$F_5 = 0.5 \times (\gamma_{at} \times d_{at} + \gamma_{at} \times (d_L - 1)) x\, k \times d_{at} \times \tan \delta_L$ (5)

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HDR Engineering, Inc.			HDR
Project CCSWDC Class 1 Landfill	Computed KP		Date 1/22/2009
Subject Design for Anchor Trench Pullout	Checked MGR		Date 1/22/2009
Task 130 mph wind event @ 50 ft spacing .	Sheet 3		of 3

C:\HDR Projects\Sarasota County\SEC\EGC\[Intermediate Anchor(130mph@80)_70_lower.xls]Friction

F_1	116.67	lbs/ft
F_3	518.52	lbs/ft
F_2	281.09	lbs/ft
F_4	145.11	lbs/ft
F_5	64.81	lbs/ft

Total Friction Force	1126	lbs/ft
	17	kN/m
Maximum uplift force	13.73	kN/m
Therefore, FS	1.21	

Since friction resistance force from the anchor trench is greater than uplift force, the anchor trench will not pullout.

HDR Engineering, Inc.

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Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches Upper 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event horizontal anchor at upslope of 2:1	Sheet	1	Of	2

C:\HDR Projects\Sarasota County\SEC\EGC\[horizontal Anchor(130mph@80)_70_upper.xls]Friction

Use TPO 60 mil

Parameter	Definition	Value	Units		
α	Coefficient of thermal expansion of the geomembrane	0.000050	inch/inch °F		
g	Acceleration due to gravity	9.81	m/s		
λ	Suction factor	0.65	Dimensionless		
V_w	Design wind velocity	209	km/h	130.00	mph
β_u	Geomembrane slope angle to horizontal	26.56	degrees		
L_u	Length of geomembrane	7.62	m	25.00	ft
ε_a	Allowable tensile strain of the geomembrane	30.00%			
ρ	Density of geomembrane	1010	kg/m^3		
μ_{GM}	Surface density of geomembrane	1.42	kg/m^2	42 oz/sy	
J	Secant stiffness between origin and peak	70.0	kN/m	400.00	ppi
t	Thickness of the material	0.0015	m		
X	Weld strength	26.3	kN/m	150.00	ppi
z	Site elevation	35.7	m	117.00	ft

1. Determine geomembrane strain due to temperature variation.

All time recorded lowest temperature in the State of Florida (T_1) -2 °F (Reported on Feb. 13, 1899. Obtained from NCDC)

All time recorded highest temperature in the State of Florida (T_2) 109 °F (Reported on June 29, 1931. Obtained from NCDC)

$$\varepsilon_t = \alpha \times (T_2 - T_1)$$
$$T_T = \varepsilon_t \times J$$

$\varepsilon_t =$ 0.56%

$T_T =$ 0.39 kN/m

2. Determination of strain due to gravity

$T_g = \rho \times g \times L \times t \times \sin\beta$

$T_g =$ 0.05 kN/m

$\varepsilon_g = T_g/J$

$\varepsilon_g =$ 0.07%

3. Determine total initial strain of the geomembrane before wind uplift (ε_0)

$\varepsilon_0 = \varepsilon_g + \varepsilon_t$

$\varepsilon_0 =$ 0.63%

4. Determine total tension on the geomembrane before wind uplift (T_0)

$T_0 = T_g + T_T$

$T_0 =$ 0.44 kN/m

5. Determination of effective suction (S_e)

$$S_e = 0.050 \times \lambda \times V_w^2 \times e^{-(1.252\times10^{-4})z} - g \times \mu_{GM} \times Cos\beta$$

S_e=	1403.15	Pa
	1.403	kN/m^2

6. Determination of normalized tensile stiffness of geomembrane

= $J/S_e \times L$

= 6.551

7. Determination of strain due to wind

ε_w 10.40%

$$\frac{S_e L}{2J(\varepsilon_0+\varepsilon_w)} = Sin\left[\left(\frac{S_e L}{2J(\varepsilon_0+\varepsilon_w)}\times(1+\varepsilon_w)\right)\times\frac{180}{\pi}\right]$$

LHS	RHS
0.6923	0.6923

8. Determination of wind generated tension compnent (T_w)

$T_w = \varepsilon_w \times J$

T_w 7.28 kN/m

9. Determination of total stiffness (T) and strain (ε)

$T = T_0 + T_w$

T 7.7 kN/m

$\varepsilon_T = \varepsilon_0 + \varepsilon_w$

ε_T = 11.02%

10. Factor of safety against rupture

T_y	26.30	kN/m
S_e	1.403	kPa
L	7.62	m
$T_{y(min)}$	5.69	kN/m
ε_Y	0.30	

LHS	RHS
0.939994097	0.93999476

$FS_R = T_y/T_{y(min)}$

FS_R 4.62

		Job No.	130526
		No.	

HDR Engineering, Inc.

HDR

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches Upper 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event horizontal anchor at upslope of 2:1	Sheet	1	of	3

C:\HDR Projects\Sarasota County\SEC\EGC\[horizontal Anchor(130mph@80)_70_upper.xls]anchor

Use TPO 60 mil

Parameter	Definition	Value	Units		
Tu	Tensile stiffness in the geomembrane - left side of anchor trench	0.00	kN/m		
Td	Tensile stiffness in the geomembrane - right side of anchor trench	7.72	kN/m		
T_{dT}	Tensile stiffness in the geomembrane over anchor trench - right side	0.00	kN/m		
T_{uT}	Tensile stiffness in the geomembrane over anchor trench - left side	0.00	kN/m		
θ_u	Uplift angle of geomembrane - left side (Calculated below)	0.0	degrees		
θ_d	Uplift angle of geomembrane - right side (Calculated below)	[illegible]	degrees		
θ_{dT}	Uplift angle of geomembrane-anchor trench right side (Calculated below)	0.0	degrees		
θ_{uT}	Uplift angle of geomembrane- anchor trench left side (Calculated below)	[illegible]	degrees		
β_u	Geomembrane slope angle to horizontal-left side	0	degrees		
β_d	Geomembrane slope angle-right side	26.56	degrees		
β_s	Drainage slope of the geomembrane in the direction of uplift	0	degrees		
ε_a	Allowable tensile strain of the geomembrane	30%			
ε_{wu}	Tensile strain of the geomembrane due to wind-left side	0.00%			
ε_{wd}	Tensile strain of the geomembrane due to wind-right side	10.40%			
ε_{wT}	Tensile strain of the geomembrane due to wind-on the anchor trench	0.00%			
ε_u	Total applied strain-left side	0.00%			
ε_d	Total applied strain-right side	11.02%			
ε_T	Total applied strain-anchor trench	0.00%			
J	Secant stiffness between origin and peak	70.0	kN/m		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
FS_u	Factor of safety against uplift	1.22			
L_u	Length of geomembrane between anchors-left side	7.62	m		
L_d	Length of geomembrane between anchors-right side	0.00	m		
L_T	Length of geomembrane between anchors-terrace	7.62	m		
X	Weld strength	26.3	kN/m		

Note: For this case anchor trench geomembrane is considered to be the second span.

1. Determine angle of uplift geomembrane with upslope.
Note that for this case this is the span to the left of the anchor trench.

$$\varepsilon_{wu} = \frac{\theta_u}{\sin\theta_u} - 1$$

N/A

$$\frac{\theta_u}{\sin\theta_u} = 1.0000$$

θ_u 0.00 degrees

Calculated $\frac{\theta_u}{\sin\theta_u}$ #DIV/0!

Total length of geomembrane during wind event (L'_u) upslope area

$L'_u = (1+\varepsilon_u) \times L_u$

Use TPO 60 mil

L'_u 7.62 m

Arc radius of geomembrane during wind event [R]

$$R_u = \frac{L'_u}{2\theta_u}$$

R_u #DIV/0! m

Uplift of the geomembrane due to wind on slope (u_u)

$u_u = R_u - R_u \times Cos\theta_u$

u_u #DIV/0! m

2. Determine angle of uplift geomembrane with downslope.
Note that this section is not applicable for the specific case.

$$\varepsilon_{wd} = \frac{\theta_d}{Sin\,\theta_d} - 1$$

$\frac{\theta_d}{Sin\,\theta_d}$ = 1.1040

θ_d 43.81 degrees

Calculated $\frac{\theta_d}{Sin\,\theta_d}$ = 1.1040

As discussed above, for the exposed geomembrane over the downslope area

L'_d = 0.00
R_d = 0.00
u_d = 0.00

3. Determine angle of uplift geomembrane with slope on the terrace.
Note that for this case this is the span to the right of the anchor trench. N/A

$$\varepsilon_{wT} = \frac{\theta_{uT}}{Sin\,\theta_{uT}} - 1$$

$\frac{\theta_{uT}}{Sin\,\theta_{uT}}$ = 1.0000

θ_{uT} = 0.00 degrees

Calculated $\frac{\theta_{uT}}{Sin\,\theta_{uT}}$ = #DIV/0!

Use TPO 60 mil

As discussed above, for the exposed geomembrane over the terrace

L'_T	=	7.62
R_T	=	#DIV/0!
u_T	=	#DIV/0!

A	17.25	degrees	T_d	7.72	kN/m
B	0.00	degrees	T_{dT}	0.00	kN/m
C	0.00	degrees	T_{uT}	0.00	kN/m
D	0.00	degrees	T_u	0.00	kN/m

4. Required minimum weight of anchor trench to prevent downslope movement (refer to Case 1 of free body diagram attached)

$$W_{min} = W_{min\ downsliding} = \frac{T_d\cos(A-\delta) - T_{dT}\cos(B+\delta) + T_{uT}\cos(C-\delta) - T_u\cos(D+\delta)}{\sin\delta}$$

$W_{min\ downsliding}$ = 20.54 kN/m

5. Required minimum weight of anchor trench to prevent upslope movement (refer to Case 2 of free body diagram attached)

$$W_{min} = W_{min\ upslope\ sliding} = \frac{-T_d\cos(A+\delta) + T_{dT}\cos(B-\delta) - T_{uT}\cos(C+\delta) + T_u\cos(D-\delta)}{\sin\delta}$$

$W_{min\ upslope\ sliding}$ = -15.96 kN/m

6. Required minimum weight of the anchor trench to prevent uplifting (refer to Case 3 of free body diagram attached)

$$W_{min} = W_{min\ uplifting} = T_d\sin A + T_{dT}\sin B + T_{uT}SinC + T_u SinD$$

$W_{min\ uplifting}$ = 2.29 kN/m

7. Required anchor trench area

$$A_{req} = \frac{W_{req}}{\gamma}$$

A_{req} 1.22 m^2 = 13.15 ft^2

Dimension of the proposed anchor trench

Depth of Anchor Trench	=	4.00	ft
Width of the Anchor Trench	=	4.00	ft
Area of the Anchor Trench	=	16.00	ft^2
Therefore, factor of safety against uplift	=	1.22	

Job No.	130526	No.	

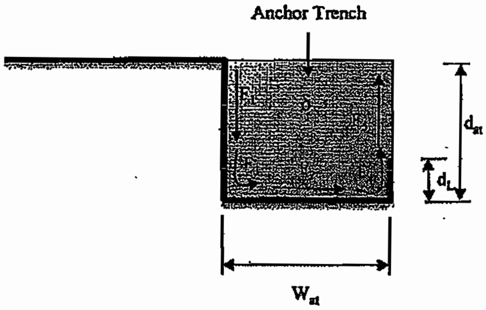
HDR Engineering, Inc. HDR

Project: CCSWDC Class 1 Landfill	Computed: KP	Date: 1/22/2009	
Subject: Design for Anchor Trench Pullout	Checked: MGR	Date: 1/22/2009	
Task: 130 mph wind event horizontal anchor at upslope of 2:1	Sheet: 1	of: 3	

C:\HDR Projects\Sarasota County\SEC\EGC\[horizontal Anchor(130mph@80)_70_upper.xls]anchor

Use TPO 60 mil

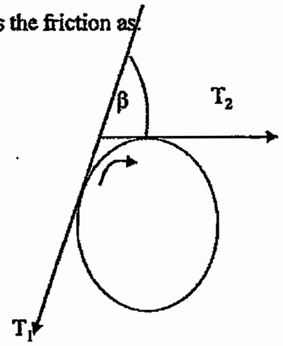
Param	Definition	Value	Units		
D_{at}	Depth of Anchor Trench	4.00	ft		
W_{at}	Width of the Anchor Trench	4.00	ft		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
d_L	Length of the geomembrane curved upward in the anchor trench	1.00	ft		
k	Coefficient of lateral earth pressure	0.60			



Forces F_1, F_2 and F_5 are frictional forces developed in the liner system due to shear resistance between layers

Forces F_3, and F_4 are frictional forces developed where the liner changes directions (bends). These forces are calculated by treating them as a belt sliding over a rigid, stationary body.

Ref. 1 gives the friction as:



$T_2 = T_1 e^{\mu\beta}$

Friction $= T_2 - T_1 = T_1 \times (e^{\tan\delta \times \beta} - 1)$

Where:

tanδ = coefficient of friction between layer and the rigid body

β = angle between T_1 and T_2 or angle of wrap (radians)

T_1 = tensile force holding the layer in place

T_2 = force needed to overcome T and friction

Because geomembrane is not completely rigid, the friction force obtained from the above equation was multiplied by 0.5.

The shear resistance forces F_1, F_2, F_3, F_4 and F_5 are calculated in the following manner:

$F = N \tan\delta$

Where:

N = normal force applied on the geosynthetic layer

δ = friction angle between geosynthetic layers, or soil and geosynthetic layers

$F_1 = 0.5 \times \gamma_{at} \times d_{at} \times k \times d_{at} \times \tan\delta_L$ (1)

$F_3 = \gamma_{at} \times d_{at} \times W_{at} \times \tan\delta$ (2)

$F_2 = (F_1 + F_3)(e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (3)

$F_4 = (F_3 + F_4) \times (e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (4)

$F_5 = 0.5 \times (\gamma_{at} \times d_{at} + \gamma_{at} \times (d_L - 1)) \times k \times d_{at} \times \tan\delta_L$ (5)

F_1	207.41	lbs/ft
F_3	691.36	lbs/ft
F_2	397.74	lbs/ft
F_4	194.55	lbs/ft
F_5	90.74	lbs/ft

Total Friction Force	1582	lbs/ft
	23	kN/m
Max downslope force	20.54	kN/m
Therefore, FS	1.13	

Since friction resistance force from the anchor trench is greater than uplift force, the anchor trench will not pullout.

Job No.	130526	No.

HDR Engineering, Inc.

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches Middle 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event horizontal anchor at upslope of 2:1	Sheet	1	of	2

C:\HDR Projects\Sarasota County\SEC\EGC\horizontal Anchor(130mph@80)_70_middle.xls]uplift

Use TPO 60 mil

Parameter	Definition	Value	Units		
α	Coefficient of thermal expansion of the geomembrane	0.000050	inch/inch ^{0}F		
g	Acceleration due to gravity	9.81	m/s		
λ	Suction factor	0.54	Dimensionless		
V_w	Design wind velocity	209	km/h	130.00	mph
β_u	Geomembrane slope angle to horizontal	26.56	degrees		
L_u	Length of geomembrane	9.75	m	32.00	ft
ε_a	Allowable tensile strain of the geomembrane	30.00%			
ρ	Density of geomembrane	1010	kg/m^3		
μ_{GM}	Surface density of geomembrane	1.42	kg/m^2	42 oz/sy	
J	Secant stiffness between origin and peak	70.0	kN/m	400.00	ppl
t	Thickness of the material	0.0015	m		
X	Weld strength	26.3	kN/m	150.00	ppi
z	Site elevation	35.7	m	117.00	ft

1. Determine geomembrane strain due to temperature variation.

All time recorded lowest temperature in the State of Florida (T_1) -2 ^{0}F (Reported on Feb. 13, 1899. Obtained from NCDC)

All time recorded highest temperature in the State of Florida (T_2) 109 ^{0}F (Reported on June 29, 1931. Obtained from NCDC)

$\varepsilon_t = \alpha \times (T_2 - T_1)$

$T_T = \varepsilon_t \times J$

$\varepsilon_t =$ 0.56%

$T_T =$ 0.39 kN/m

2. Determination of strain due to gravity

$T_g = \rho \times g \times L \times t \times \sin\beta$

$T_g =$ 0.07 kN/m

$\varepsilon_g = T_g / J$

$\varepsilon_g =$ 0.09%

3. Determine total initial strain of the geomembrane before wind uplift (ε_0)

$\varepsilon_0 = \varepsilon_g + \varepsilon_t$

$\varepsilon_0 =$ 0.65%

4. Determine total tension on the geomembrane before wind uplift (T_0)

$T_0 = T_g + T_T$

$T_0 =$ 0.45 kN/m

5. Determination of effective suction (S_e)

$$S_e = 0.050 \times \lambda \times V_w^2 \times e^{-(1.252\times10^{-4})z} - g \times \mu_{GM} \times Cos\beta$$

S_e=	1163.58	Pa
	1.164	kN/m^2

6. Determination of normalized tensile stiffness of geomembrane

$= J/S_e \times L$

= 6.172

7. Determination of strain due to wind

ε_w 10.87%

$$\frac{S_e L}{2J(\varepsilon_0 + \varepsilon_w)} = Sin\left[\left(\frac{S_e L}{2J(\varepsilon_0 + \varepsilon_w)} \times (1+\varepsilon_w)\right) \times \frac{180}{\pi}\right]$$

LHS	RHS
0.7036	0.7036

8. Determination of wind generated tension compnent (T_w)

$T_w = \varepsilon_w \times J$

T_w	7.61	kN/m

9. Determination of total stiffness (T) and strain (ε)

$T = T_0 + T_w$

T	8.1	kN/m

$\varepsilon_T = \varepsilon_0 + \varepsilon_w$

ε_T = 11.51%

10. Factor of safety against rupture

T_y	26.30	kN/m
S_e	1.164	kPa
L	9.75	m
$T_{y(min)}$	6.04	kN/m
ε_Y	0.30	

LHS	RHS
0.939993255	0.93999286

$FS_R = T_y/T_{y(min)}$

FS_R 4.36

Job No.	130526	No.	

HDR Engineering, Inc.

HDR

Project	CCSWDC Class 1 Landfill	Computed	KP	Date	1/22/2009
Subject	Design of Anchor Trenches Middle 1/3 of Slope	Checked	MGR	Date	1/22/2009
Task	130 mph wind event horizontal anchor at upslope of 2:1	Sheet	1	Of	3

C:\HDR Projects\Sarasota County\SEC\EGC\[horizontal Anchor(130mph@60)_70_middle.xls]uplift

Use TPO 60 mil

Parameter	Definition	Value	Units		
Tu	Tensile stiffness in the geomembrane - left side of anchor trench	0.00	kN/m		
Td	Tensile stiffness in the geomembrane - right side of anchor trench	8.07	kN/m		
T_{dT}	Tensile stiffness in the geomembrane over anchor trench - right side	0.00	kN/m		
T_{uT}	Tensile stiffness in the geomembrane over anchor trench - left side	0.00	kN/m		
θ_u	Uplift angle of geomembrane - left side (Calculated below)	[illegible]	degrees		
θ_d	Uplift angle of geomembrane - right side (Calculated below)	[illegible]	degrees		
θ_{dT}	Uplift angle of geomembrane-anchor trench right side (Calculated below)	[illegible]	degrees		
θ_{uT}	Uplift angle of geomembrane- anchor trench left side (Calculated below)	[illegible]	degrees		
β_u	Geomembrane slope angle to horizontal-left side	0	degrees		
β_d	Geomembrane slope angle-right side	26.56	degrees		
β_s	Drainage slope of the geomembrane in the direction of uplift	0	degrees		
ε_a	Allowable tensile strain of the geomembrane	30%			
ε_{wu}	Tensile strain of the geomembrane due to wind-left side	0.00%			
ε_{wd}	Tensile strain of the geomembrane due to wind-right side	10.87%			
ε_{wT}	Tensile strain of the geomembrane due to wind-on the anchor trench	0.00%			
ε_u	Total applied strain-left side	0.00%			
ε_d	Total applied strain-right side	11.51%			
ε_T	Total applied strain-anchor trench	0.00%			
J	Secant stiffness between origin and peak	70.0	kN/m		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
FS_u	Factor of safety against uplift	1.16			
L_u	Length of geomembrane between anchors-left side	9.75	m		
L_d	Length of geomembrane between anchors-right side	0.00	m		
L_T	Length of geomembrane between anchors-terrace	9.75	m		
X	Weld strength	26.3	kN/m		

Note: For this case anchor trench geomembrane is considered to be the second span.

1. Determine angle of uplift geomembrane with upslope.

Note that for this case this is the span to the left of the anchor trench.

$$\varepsilon_{wu} = \frac{\theta_u}{Sin\,\theta_u} - 1$$

$$\frac{\theta_u}{Sin\,\theta_u} = 1.0000$$

N/A

θ_u 0.00 degrees

Calculated $\frac{\theta_u}{Sin\,\theta_u}$ #DIV/0!

Total length of geomembrane during wind event (L'_u) upslope area

$L'_u = (1+\varepsilon_u) \times L_u$

Use TPO 60 mil

L'_u 9.75 m

Arc radius of geomembrane during wind event (R)

$$R_u = \frac{L'_u}{2\theta_u}$$

R_u #DIV/0! m

Uplift of the geomembrane due to wind on slope (u_u)

$u_u = R_u - R_u \times Cos\theta_u$

u_u #DIV/0! m

2. Determine angle of uplift geomembrane with downslope.
Note that this section is not applicable for the specific case.

$$\varepsilon_{ud} = \frac{\theta_d}{Sin\,\theta_d} - 1$$

$\frac{\theta_d}{Sin\,\theta_d}$ = 1.1087

θ_d 44.71 degrees

Calculated $\frac{\theta_d}{Sin\,\theta_d}$ = 1.1087

As discussed above, for the exposed geomembrane over the downslope area

L'_d	=	0.00
R_d	=	0.00
u_d	=	0.00

3. Determine angle of uplift geomembrane with slope on the terrace.
Note that for this case this is the span to the right of the anchor trench.

$$\varepsilon_{uT} = \frac{\theta_{uT}}{Sin\theta_{uT}} - 1$$

$\frac{\theta_{uT}}{Sin\theta_{uT}}$ = 1.0000

N/A

θ_{uT} = 0.00 degrees

Calculated $\frac{\theta_{uT}}{Sin\theta_{uT}}$ = #DIV/0!

Use TPO 60 mil

As discussed above, for the exposed geomembrane over the terrace

L'_T = 9.75
R_T = #DIV/0!
u_T = #DIV/0!

A	18.15	degrees	T_d	8.07	kN/m
B	0.00	degrees	T_{dT}	0.00	kN/m
C	0.00	degrees	T_{uT}	0.00	kN/m
D	0.00	degrees	T_u	0.00	kN/m

4. Required minimum weight of anchor trench to prevent downslope movement (refer to Case 1 of free body diagram attached)

$$W_{min} = W_{min\ downsliding} = \frac{T_d \cos(A-\delta) - T_{dT}\cos(B+\delta) + T_{uT}\cos(C-\delta) - T_u\cos(D+\delta)}{\sin\delta}$$

$W_{min\ downsliding}$ = 21.48 kN/m

5. Required minimum weight of anchor trench to prevent upslope movement (refer to Case 2 of free body diagram attached)

$$W_{min} = W_{min\ upslope\ sliding} = \frac{-T_d \cos(A+\delta) + T_{dT}\cos(B-\delta) - T_{uT}\cos(C+\delta) + T_u\cos(D-\delta)}{\sin\delta}$$

$W_{min\ upslope\ sliding}$ = -16.46 kN/m

6. Required minimum weight of the anchor trench to prevent uplifting (refer to Case 3 of free body diagram attached)

$$W_{min} = W_{min\ uplifting} = T_d \sin A + T_{dT} \sin B + T_{uT} Sin C + T_u Sin D$$

$W_{min\ uplifting}$ = 2.51 kN/m

7. Required anchor trench area

$$A_{req} = \frac{W_{req}}{\gamma}$$

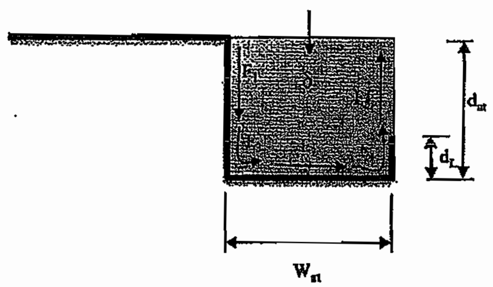
A_{req} 1.28 m^2 = 13.75 ft^2

Dimension of the proposed anchor trench

Depth of Anchor Trench	=	4.00	ft
Width of the Anchor Trench	=	4.00	ft
Area of the Anchor Trench	=	16.00	ft^2
Therefore, factor of safety against uplift	=	1.16	

Use TPO 60 mil

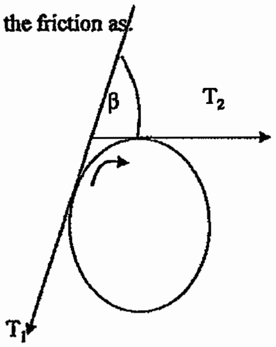
Parame	Definition	Value	Units		
D_{at}	Depth of Anchor Trench	4.00	ft		
W_{at}	Width of the Anchor Trench	4.00	ft		
δ	Interface friction angle between geomembrane and underlying soil	22.0	degrees		
γ	Unit weight of anchor trench material	16.81	kN/m^3	107.01	pcf
d_L	Length of the geomembrane curved upward in the anchor trench	1.00	ft		
k	Coefficient of lateral earth pressure	0.60			



Forces F_1, F_2 and F_5 are frictional forces developed in the liner system due to shear resistance between layers

Forces F_3, and F_4 are frictional forces developed where the liner changes directions (bends). These forces are calculated by treating them as a belt sliding over a rigid, stationary body.

Ref. 1 gives the friction as:



$T_2 = T_1 e^{\mu\beta}$

Friction $= T_2 - T_1 = T_1 \times (e^{\tan\delta \times \beta} - 1)$

Where:

tanδ = coefficient of friction between layer and the rigid body

β = angle between T_1 and T_2 or angle of wrap (radians)

T_1 = tensile force holding the layer in place

T_2 = force needed to overcome T and friction

Because geomembrane is not completely rigid, the friction force obtained from the above equation was multiplied by 0.5.

The shear resistance forces F_1, F_2, F_3, F_4 and F_5 are calculated in the following manner:

F = N tanδ

Where:

N = normal force applied on the geosynthetic layer

δ = friction angle between geosynthetic layers, or soil and geosynthetic layers

$F_1 = 0.5 \times \gamma_{at} \times d_{at} \times k \times d_{at} \times \tan\delta_L$ (1)

$F_3 = \gamma_{at} \times d_{at} \times W_{at} \times \tan\delta$ (2)

$F_2 = (F_1 + F_3)(e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (3)

$F_4 = (F_3 + F_4) \times (e^{(\tan\delta)\frac{\pi}{2}} - 1) \times 0.5$ (4)

$F_5 = 0.5 \times (\gamma_{at} \times d_{at} + \gamma_{at} \times (d_L - 1)) \times k \times d_{at} \times \tan\delta_L$ (5)

F_1	207.41	lbs/ft
F_3	691.36	lbs/ft
F_2	397.74	lbs/ft
F_4	194.55	lbs/ft
F_5	90.74	lbs/ft

Total Friction Force	1582	lbs/ft
	23	kN/m
Max downslope force	21.48	kN/m
Therefore, FS	1.08	

Since friction resistance force from the anchor trench is greater than uplift force, the anchor trench will not pullout.

REFERENCE 1
WIND DATA

Use 130 mph
for sarasota
County.

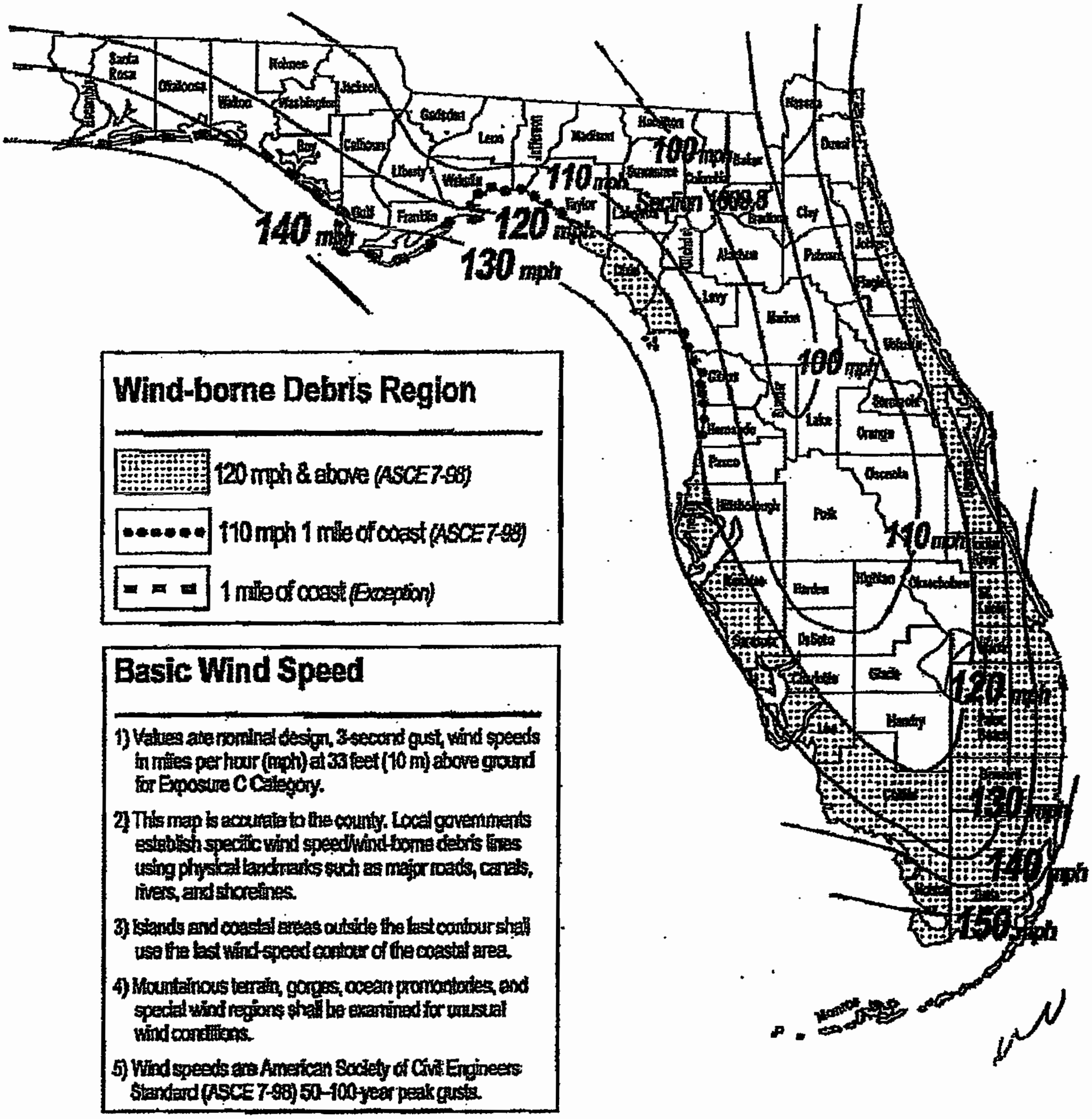


Figure 1609
STATE OF FLORIDA
WIND-BORNE DEBRIS REGION & BASIC WIND SPEED

NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)

National Climatic Data Center
U.S. Department of Commerce

DOC >NOAA >NESDIS >NCDC Search Field: Search NCDC

Query Results

127 THUNDERSTORM & HIGH WIND event(s) were reported in **Sarasota County, Florida** between **01/01/1950** and **10/31/2008.**

Mag: Magnitude
Dth: Deaths
Inj: Injuries
PrD: Property Damage
CrD: Crop Damage

Click on Location or County to display Details.

Florida

Location or County	Date	Time	Type	Mag	Dth	Inj	PrD	CrD
1 SARASOTA	10/31/1960	1100	Tstm Wind	62 kts.	0	0	0	0
2 SARASOTA	07/25/1963	1510	Tstm Wind	0 kts.	0	0	0	0
3 SARASOTA	08/18/1963	1426	Tstm Wind	60 kts.	0	0	0	0
4 SARASOTA	11/11/1968	1110	Tstm Wind	0 kts.	0	0	0	0
5 SARASOTA	05/16/1969	1930	Tstm Wind	61 kts.	0	0	0	0
6 SARASOTA	09/22/1973	1400	Tstm Wind	50 kts.	0	0	0	0
7 SARASOTA	03/23/1974	1600	Tstm Wind	55 kts.	0	0	0	0
8 SARASOTA	08/08/1975	1600	Tstm Wind	0 kts.	0	0	0	0
9 SARASOTA	08/09/1975	1630	Tstm Wind	0 kts.	0	0	0	0
10 SARASOTA	06/14/1977	1702	Tstm Wind	0 kts.	0	0	0	0
11 SARASOTA	05/04/1978	1200	Tstm Wind	0 kts.	0	0	0	0

				kts.				
32 SARASOTA	06/18/1989	1615	Tstm Wind	50 kts.	0	0	0	0
33 SARASOTA	08/18/1989	1645	Tstm Wind	50 kts.	0	0	0	0
34 SARASOTA	08/22/1989	1830	Tstm Wind	50 kts.	0	0	0	0
35 SARASOTA	09/05/1989	1430	Tstm Wind	50 kts.	0	0	0	0
36 SARASOTA	05/10/1990	0530	Tstm Wind	0 kts.	0	0	0	0
37 SARASOTA	06/07/1990	1730	Tstm Wind	0 kts.	0	0	0	0
38 SARASOTA	07/01/1990	1200	Tstm Wind	0 kts.	0	0	0	0
39 SARASOTA	07/10/1990	1520	Tstm Wind	0 kts.	0	0	0	0
40 SARASOTA	07/11/1990	1300	Tstm Wind	0 kts.	0	0	0	0
41 SARASOTA	07/14/1990	0830	Tstm Wind	0 kts.	0	0	0	0
42 SARASOTA	09/11/1990	1425	Tstm Wind	52 kts.	0	0	0	0
43 SARASOTA	01/19/1991	2246	Tstm Wind	0 kts.	0	0	0	0
44 SARASOTA	05/16/1991	1240	Tstm Wind	0 kts.	0	0	0	0
45 SARASOTA	05/17/1991	1630	Tstm Wind	0 kts.	0	0	0	0
46 SARASOTA	05/18/1991	1520	Tstm Wind	0 kts.	0	0	0	0
47 SARASOTA	07/19/1991	1430	Tstm Wind	0 kts.	0	0	0	0
48 SARASOTA	08/06/1991	1733	Tstm Wind	0 kts.	0	0	0	0
49 SARASOTA	08/06/1991	1833	Tstm Wind	0 kts.	0	0	0	0
50 SARASOTA	09/07/1991	1730	Tstm Wind	0 kts.	0	0	0	0

			Winds	kts.				
71 SARASOTA	08/10/1994	1546	Thunderstorm Winds	0 kts.	0	0	0	0
72 SARASOTA	08/10/1994	1623	Thunderstorm Winds	0 kts.	0	0	0	0
73 Sarasota	06/10/1995	1920	Thunderstorm Winds	0 kts.	0	0	5K	0
74 Sarasota	07/14/1995	1559	Thunderstorm Winds	0 kts.	0	0	0	0
75 Sarasota	07/14/1995	1559	Thunderstorm Winds	0 kts.	0	0	1K	0
76 Englewood	10/04/1995	1635	Thunderstorm Winds	69 kts.	0	0	0	0
77 S Venice	10/04/1995	1700	Thunderstorm Winds	58 kts.	0	0	0	0
78 Sarasota	06/21/1996	02:41 PM	Tstm Wind	0 kts.	0	0	10K	0
79 Venice	07/29/1996	04:00 PM	Tstm Wind	0 kts.	0	0	10K	0
80 Venice	07/29/1996	04:00 PM	Tstm Wind	66 kts.	0	0	20K	0
81 Venice	08/23/1996	03:30 PM	Tstm Wind	52 kts.	0	0	0	0
82 Sarasota	04/23/1997	01:31 PM	Tstm Wind	52 kts.	0	0	0	0
83 Sarasota	04/23/1997	01:35 PM	Tstm Wind	0 kts.	0	0	125K	0
84 Sarasota	04/23/1997	02:10 PM	Tstm Wind	0 kts.	0	0	1K	0
85 Sarasota	04/23/1997	02:45 PM	Tstm Wind	0 kts.	0	0	150K	0
86 Sarasota	04/23/1997	03:35 PM	Tstm Wind	0 kts.	0	0	50K	0
87 North Port	05/28/1997	04:30 PM	Tstm Wind	0 kts.	0	0	1K	0
88 Venice	02/02/1998	07:15 PM	Tstm Wind (g45)	0 kts.	0	0	5K	0
89 Sarasota	02/17/1998	04:30 AM	Tstm Wind	0 kts.	0	0	4K	0

				kts.				
110 Sarasota	03/04/2001	11:26 AM	Tstm Wind	0 kts.	0	0	150K	0
111 North Port	06/05/2001	03:00 PM	Tstm Wind	0 kts.	0	0	5K	0
112 Sarasota	09/22/2001	04:10 PM	Tstm Wind	0 kts.	0	0	50K	0
113 Sarasota	09/22/2001	04:20 PM	Tstm Wind	0 kts.	0	0	5K	0
114 FLZ049>052 - 055>057 - 060>062 - 065	03/02/2002	11:00 AM	Wind	N/A	0	0	7K	0
115 North Port	07/29/2002	02:33 PM	Tstm Wind	50 kts.	0	0	0	0
116 FLZ039 - 042>043 - 048>052 - 055>057 - 060>062 - 065	01/23/2003	10:00 PM	Extreme Windchill	N/A	0	0	0	8.5M
117 FLZ049>052 - 055>056 - 060>062 - 065	01/25/2003	01:00 AM	Extreme Windchill	N/A	0	0	0	8.5M
118 Sarasota	03/17/2003	04:05 PM	Tstm Wind	52 kts.	0	0	10K	5K
119 Sarasota	04/26/2003	01:40 AM	Tstm Wind	55 kts.	0	0	0	0
120 Venice	07/26/2003	03:40 PM	Tstm Wind	55 kts.	0	0	0	0
121 Sarasota	11/19/2003	09:00 AM	Tstm Wind	40 kts.	0	0	5K	0
122 Sarasota Arpt	04/12/2004	04:43 AM	Tstm Wind	58 kts.	0	0	0	0
123 FLZ060	04/12/2004	11:40 AM	High Wind	52 kts.	0	0	55K	0
124 FLZ048>049 - 052 - 060 - 062 - 065	12/26/2004	04:00 AM	Strong Wind	39 kts.	0	0	25K	0
125 Venice	04/07/2005	05:50 PM	Tstm Wind	50 kts.	0	5	10K	0
126 Sarasota	07/17/2006	05:57 PM	Tstm Wind	50 kts.	0	0	0	0

REFERENCE 2
TEMPERATURE DATA

RECORD LOWEST TEMPERATURES BY STATE
(Thru December 2003)

State	Temp. degrees F.	Date	Station	Elevation Feet
Alabama	-27	Jan. 30, 1966	New Market	760
Alaska	-80	Jan. 23, 1971	Prospect Creek Camp	1,100
Arizona	-40	Jan. 7, 1971	Hawley Lake	8,180
Arkansas	-29	Feb. 13, 1905	Pond	1,250
California	-45	Jan. 20, 1937	Boca	5,532
Colorado	-61	Feb. 1, 1985	Maybell	5,920
Connecticut	-32	Jan. 22, 1961*	Coventry	480
Delaware	-17	Jan. 17, 1893	Millsboro	20
Florida	- 2	Feb. 13, 1899	Tallahassee	193
Georgia	-17	Jan. 27, 1940	CCC Camp F-16	est. 1,000
Hawaii	12	May 17, 1979	Mauna Kea Obs 111.2	13,770
Idaho	-60	Jan. 18, 1943	Island Park Dam	6,285
Illinois	-36	Jan. 5, 1999	Congerville	635
Indiana	-36	Jan. 19, 1994	New Whiteland	785
Iowa	-47	Feb. 3, 1996*	Elkader	770
Kansas	-40	Feb. 13, 1905	Lebanon	1,812
Kentucky	-37	Jan. 19, 1994	Shelbyville	730
Louisiana	-16	Feb. 13, 1899	Minden	194
Maine	-48	Jan. 19, 1925	Van Buren	510
Maryland	-40	Jan. 13, 1912	Oakland	2,461
Massachusetts	-35	Jan. 12, 1981	Chester	640
Michigan	-51	Feb. 9, 1934	Vanderbilt	785
Minnesota	-60	Feb. 2, 1996	Tower	1,460
Mississippi	-19	Jan. 30, 1966	Corinth	420
Missouri	-40	Feb. 13, 1905	Warsaw	700
Montana	-70	Jan. 20, 1954	Rogers Pass	5,470
Nebraska	-47	Dec. 22, 1989*	Oshkosh	3,379
Nevada	-50	Jan. 8, 1937	San Jacinto	5,200
New Hampshire	-47	Jan. 29, 1934	Mt Washington	6.262
New Jersey	-34	Jan 5, 1904	River Vale	70
New Mexico	-50	Feb. 1, 1951	Gavilan	7,350
New York	-52	Feb. 18, 1979*	Old Forge	1,720
North Carolina	-34	Jan. 21, 1985	Mt. Mitchell	6,525
North Dakota	-60	Feb. 15, 1936	Parshall	1,929
Ohio	-39	Feb. 10, 1899	Milligan	800
Oklahoma	-27	Jan. 18, 1930*	Watts	958
Oregon	-54	Feb. 10, 1933*	Seneca	4,700
Pennsylvania	-42	Jan. 5, 1904	Smethport	est. 1,500
Rhode Island	-25	Feb. 5, 1996	Greene	425
South Carolina	-19	Jan. 21, 1985	Caesars Head	3,115
South Dakota	-58	Feb. 17, 1936	McIntosh	2,277
Tennessee	-32	Dec. 30, 1917	Mountain City	2,471
Texas	-23	Feb. 8, 1933*	Seminole	3,275
Utah	-69	Feb. 1, 1985	Peter's Sink	8,092
Vermont	-50	Dec. 30, 1933	Bloomfield	915
Virginia	-30	Jan. 22, 1985	Mtn. Lake Bio. Stn.	3,870
Washington	-48	Dec. 30, 1968	Mazama & Winthrop	2,120;1,755
West Virginia	-37	Dec. 30, 1917	Lewisburg	2,200
Wisconsin	-55	Feb. 4, 1996	Couderay	1,300
Wyoming	-66	Feb. 9, 1933	Riverside R.S.	6,500

*Also on earlier dates at the same or other places.

RECORD HIGHEST TEMPERATURES BY STATE
(Thru December 2003)

State	Temp. degrees F.	Date	Station	Elevation Feet
Alabama	112	Sep. 5, 1925	Centerville	345
Alaska	100	Jun. 27, 1915	Fort Yukon	est. 420
Arizona	128	Jun. 29, 1994	Lake Havasu City	505
Arkansas	120	Aug. 10, 1936	Ozark	396
California	134	Jul. 10, 1913	Greenland Ranch	-178
Colorado	118	Jul. 11, 1888	Bennett	5,484
Connecticut	106	Jul. 15, 1995	Danbury	450
Delaware	110	Jul. 21, 1930	Millsboro	20
Florida	109	Jun. 29, 1931	Monticello	207
Georgia	112	Aug. 20, 1983	Greenville	860
Hawaii	100	Apr. 27, 1931	Pahala	850
Idaho	118	Jul. 28, 1934	Orofino	1,027
Illinois	117	Jul. 14, 1954	East St. Louis	410
Indiana	116	Jul. 14, 1936	Collegeville	672
Iowa	118	Jul. 20, 1934	Keokuk	614
Kansas	121	Jul. 24, 1936*	Alton (near)	1,651
Kentucky	114	Jul. 28, 1930	Greensburg	581
Louisiana	114	Aug. 10, 1936	Plain Dealing	268
Maine	105	Jul. 10, 1911*	North Bridgton	450
Maryland	109	Jul. 10, 1936*	Cumberland & Frederick	623; 325
Massachusetts	107	Aug. 2, 1975	New Bedford & Chester	120; 640
Michigan	112	Jul. 13, 1936	Mio	963
Minnesota	114	Jul. 6, 1936*	Moorhead	904
Mississippi	115	Jul. 29, 1930	Holly Springs	600
Missouri	118	Jul. 14, 1954*	Warsaw & Union	705; 560
Montana	117	Jul. 5, 1937	Medicine Lake	1,950
Nebraska	118	Jul. 24, 1936*	Minden	2,169
Nevada	125	Jun. 29, 1994*	Laughlin	605
New Hampshire	106	Jul. 4, 1911	Nashua	125
New Jersey	110	Jul. 10, 1936	Runyon	18
New Mexico	122	Jun. 27, 1994	Waste Isolat. Pilot Plt	3,418
New York	108	Jul. 22, 1926	Troy	35
North Carolina	110	Aug. 21, 1983	Fayetteville	213
North Dakota	121	Jul. 6, 1936	Steele	1,857
Ohio	113	Jul. 21, 1934*	Gallipolis (near)	673
Oklahoma	120	Jun. 27, 1994*	Tipton	1,350
Oregon	119	Aug. 10, 1898*	Pendleton	1,074
Pennsylvania	111	Jul. 10, 1936*	Phoenixville	100
Rhode Island	104	Aug. 2, 1975	Providence	51
South Carolina	111	Jun. 28, 1954*	Camden	170
South Dakota	120	Jul. 5, 1936	Gannvalley	1,750
Tennessee	113	Aug. 9, 1930*	Perryville	377
Texas	120	Jun. 28, 1994*	Monahans	2,660
Utah	117	Jul. 5, 1985	Saint George	2,880
Vermont	105	Jul. 4, 1911	Vernon	310
Virginia	110	Jul. 15, 1954	Balcony Falls	725
Washington	118	Aug. 5, 1961*	Ice Harbor Dam	475
West Virginia	112	Jul. 10, 1936*	Martinsburg	435
Wisconsin	114	Jul. 13, 1936	Wisconsin Dells	900
Wyoming	115	Aug. 8, 1983	Basin	3,500

*Also on earlier dates at the same time or other places.

REFERENCE 3
GEOMEMBRANE SPECIFICATIONS

July 14, 2009

Mail To: **Bill To:**

Mr. Paul Oliveira <= Same
Firestone Specialty Products, LLC

Dear Mr. Oliveira:

Thank you for consulting TRI/Environmental, Inc. (TRI) for your geosynthetics testing needs. TRI is pleased to submit this final report for laboratory testing.

TRI Job Reference Number: E2330-61-02

Material(s) Tested: 1 TPO Reinforced Geomembrane

Test(s) Requested: Wide Width Tensile (ASTM D 4885)

If you have any questions or require any additional information, please call us at 1-800-880-8378.

Sincerely,

Sam R. Allen

Sam Allen
Vice President
Geosynthetic Services Division
www.GeosyntheticTesting.com

TRI / Environmental, Inc.
A Texas Research International Company

GEOMEMBRANE TEST RESULTS

TRI Client: Firestone Specialty Products, LLC

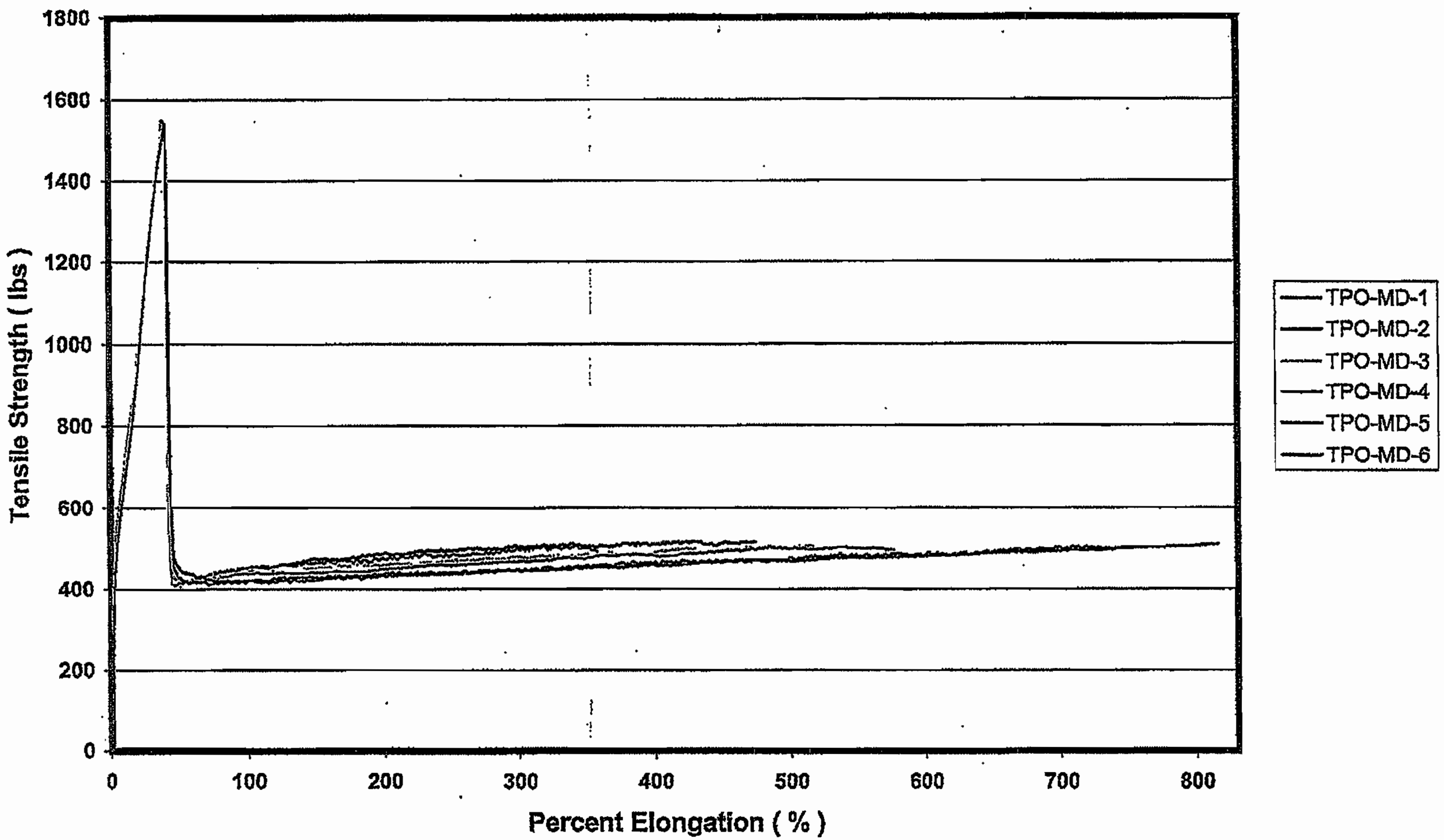
Material: TPO Reinforced Geomembrane
Sample Identification: No Label
TRI Log #: E2330-61-02

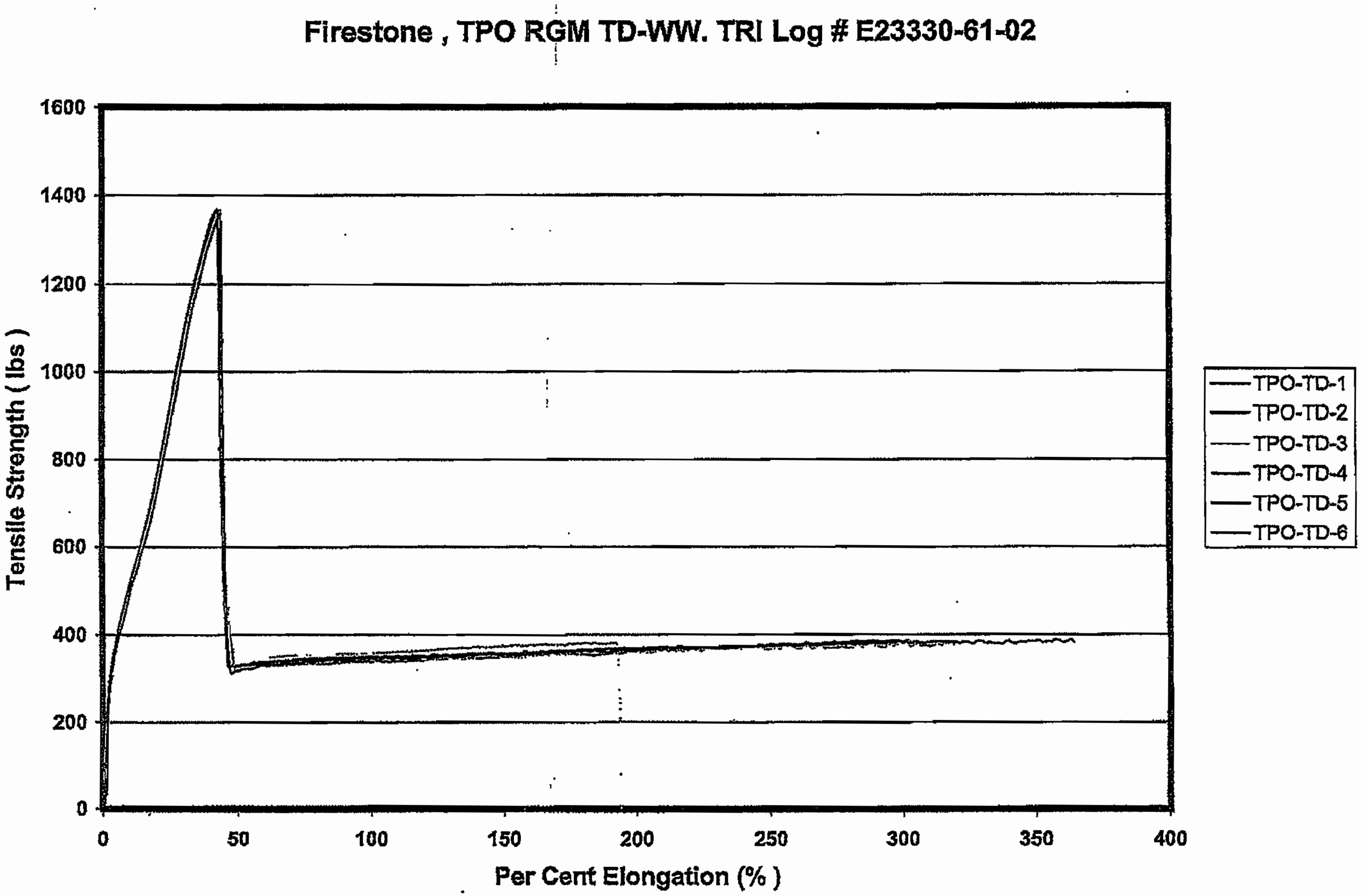
PARAMETER	TEST REPLICATE NUMBER										MEAN	STD. DEV.
	1	2	3	4	5	6	7	8	9	10		
Wide Width Tensile (ASTM D 4885)												
MD Specimen Width (in)	8											
MD Peak Load (lbs)	1530	1548	1519	1521	1521	1537					1529	12
MD Peak Strength (ppi)	191	194	190	190	190	192					191	1
MD Peak Strength (kN/m)	33.5	33.9	33.3	33.3	33.3	33.7					33.5	0.3
MD Elongation @ Peak Load (%)	40.9	39.6	37.9	39.6	41.2	41.2					40.1	1.3
MD Load at Max. Strain (lbs)	489	516	506	495	500	509					503	10
MD Strength at Max. Strain (ppi)	61.1	64.5	63.3	61.9	62.5	63.6					62.8	1.2
MD Strength at Max. Strain (kN/m)	10.7	11.3	11.1	10.8	11.0	11.1					11.0	0.2
MD Elongation @ Max. Strain (%)	359	473	538	576	734	816					583	168
TD Specimen Width (inches)	8											
TD Ultimate Strength (lbs)	1359	1357	1360	1365	1356	1366					1361	4
TD Ultimate Strength (ppi)	170	170	170	171	170	171					170	1
TD Ultimate Strength (kN/m)	29.8	29.7	29.8	29.9	29.7	29.9					29.8	0.1
TD Elongation @ Max Load (%)	42.6	43.7	43.9	43.7	43.8	42.8					43.4	0.6
TD Load at Max. Strain (lbs)	383	368	379	383	388	386					381	7
TD Strength at Max. Strain (ppi)	47.9	46.0	47.4	47.9	48.5	48.3					47.6	0.9
TD Strength at Max. Strain (kN/m)	8.4	8.1	8.3	8.4	8.5	8.5					8.3	0.2
TD Elongation @ Max. Strain (%)	323	230	193	364	302	297					285	63

MD Machine Direction   TD Transverse Direction

GeosyntheticTesting.com
9063 Bee Caves Road / Austin, TX 78733 / 512 263 2101 / fax 512 263 2558

Firestone , TPO RGM MD-WW. TRI Log # E23330-61-02




Firestone , TPO RGM TD-WW. TRI Log # E23330-61-02
Tensile Strength (lbs)
1600
1400
1200
1000
800
600
400
200
0
0
50
100
150
200
250
300
350
400
Per Cent Elongation (%)
TPO-TD-1
TPO-TD-2
TPO-TD-3
TPO-TD-4
TPO-TD-5
TPO-TD-6

TECHNICAL INFORMATION SHEET

201
1/26/2010

Firestone BUILDING PRODUCTS

UltraPly™ TPO

DESCRIPTION:

Firestone UltraPly™ TPO is a flexible Thermoplastic Polyolefin roofing membrane that is produced with polyester weft-inserted reinforcement. This heat weldable TPO membrane is available in 45 mil (1.1 mm) and 60 mil (1.5 mm) thicknesses in 8' (2.4 m), 10' (3 m) and 12'4" (3.76 m) widths. The colors available are white, tan or gray. This reflective membrane is suitable for a variety of low slope applications.

METHOD OF APPLICATION:

1. Firestone UltraPly TPO membrane is installed as continuous roofing or waterproofing layer on the roof. Rolls are overlapped (side laps and end laps) prior to the heat welding of the seam areas.
2. Install the UltraPly TPO Roofing System in accordance with current Firestone UltraPly TPO specifications, details and workmanship requirements.
3. Please contact Firestone Roofing Solutions or visit the Firestone Technical Database for additional information at www.Firestonebpco.com.

PRODUCT DATA:

Thickness:	~~0.045" (1.1 mm)~~
	0.060" (1.5 mm) *
Width:	5 ft to ~~12 ft 4 in~~ (1.5 m to 3.75 m)
Length:	100 ft (30.5 m)
Colors:	White, Tan, Gray

STORAGE:

- Store away from sources of punctures, and physical damage.
- Assure that structural decking will support the loads incurred by material when stored on rooftop. The deck load limitations should be specified by the project designer.
- Store away from ignition sources as membrane will burn when exposed to open flame.

PRECAUTIONS:

- Exercise caution when lifting, moving, transporting, storing or handling membrane rolls to avoid sources of punctures and possible physical damage.
- Contact Firestone Roofing Solutions Department for specific recommendations regarding chemical or waste product compatibility with Firestone UltraPly TPO Membrane.
- Refer to Material Safety Data Sheets (MSDS) for safety information

LEED INFORMATION:

Post Consumer Recycled Content:	0%
Post Industrial Recycled Content:	15%
Manufacturing Location:	Wellford, SC
	Las Vegas, NV
	Tuscumbia, AL

Firestone GREEN ONE TEAM. ONE PLANET

FM APPROVED

CLASSIFIED c UL US

CCMC 13348-R

MIAMI-DADE COUNTY APPROVED

CRRC COOL ROOF RATING COUNCIL CHARTER MEMBER

ENERGY STAR

Firestone Building Products Company, LLC
250 W. 96th Street, Indianapolis, IN 46260
Sales: (800) 428-4442 • Technical (800) 428-4511
www.firestonebpco.com

TECHNICAL INFORMATION SHEET

201
1/26/2010

UltraPly™ TPO

Firestone
BUILDING PRODUCTS

PHYSICAL PROPERTIES

*

Property	Test Method	ASTM D 6878 Specification	Typical Values	
			45 mil	60 mil
Overall Thickness	ASTM D751	0.039" (1.0 mm) min	0.045" (1.1 mm) ± 10%	0.060" (1.5 mm) ± 10%
Coating Over Scrim	ASTM D6878, Annex A	0.012" (0.305 mm) min	0.020" (0.51 mm)	0.025" (0.64 mm)
Breaking strength	ASTM D751, Grab Method	220 lb_f (975 N) min	340 lbf (1,510 N)	390 lbf (1,730 N)
Elongation at Reinforcement Break	ASTM D751, Grab Method	15% min	25%	25%
Tearing Strength	ASTM D751	55 lb_f (245 N) min	120 lb_f (530 N)	120 lb_f (530 N)
Brittleness Point	ASTM D2137	-40 °F (-40 °C)	Pass	Pass
Ozone resistance, no cracks	ASTM D1149	Pass (no cracks)	Pass	Pass
Heat Aged Properties	ASTM D573			
Retention of Breaking Strength	ASTM D751, Grab Method	90% min	> 90%	> 90%
Elongation at Reinforcement Break	ASTM D751, Grab Method	90% min	> 90%	> 90%
Retention of Tearing Strength	ASTM D751	60% min	> 60%	> 60%
Weight Change (Membrane)		± 1% max	< 1%	< 1%
Linear Dimension Change	ASTM D1204 6 h at 158 °F (70 °C)	± 1% max	< 1%	< 1%
Water Absorption	ASTM D471	± 3.0% max	< 3%	< 3%
Weather Resistance	ASTM G155, 80 °C Black Panel, no cracking, crazing when wrapped around a 3" mandrel and inspected at 7x magnification	10,080 kJ/m² min	> 20,160 kJ/m²	> 20,160 kJ/m²
Puncture Resistance	FTM 101C Method 2031	—	265 lbf (1,180 N)	300 lbf (1,300 N)

Values were obtained from independent testing for the CRRC table below.
SRI is calculated from Solar Reflectance Index (SRI) calculator from the USGBC.

ENERGY STAR®	White	Tan	Gray
Initial Solar Reflectance	0.79	0.60	
Aged Solar Reflectance (3 years)	0.78	0.54	
Cleaned prior to aged test?	Yes	No	
Initial Emittance	0.85	0.81	

Cool Roof Rating Council (CRRC)	White	Tan	Gray
Solar Reflectance Initial	0.79	0.60	
Solar Reflectance Weathered	0.68	0.55	
Thermal Emittance Initial	0.85	0.81	
Thermal Emittance Weathered	0.83	0.84	

LEED	Test Method	White	Tan	Gray
Solar Reflectance	ASTM E903	0.81	0.63	0.37
Thermal Emittance	ASTM E408	0.95	0.95	0.95
Solar Reflectance Index (SRI)	ASTM E1980	102	77	43

TRI/ENVIRONMENTAL, INC.
A Texas Research International Company

August 03, 2007

Mr. Paul Oliveira
Firestone Building Products
310 East 96th Street
Indianapolis, IN 46240

Subject: Interface Friction Test Results
Firestone 45-mil f-PP Geomembrane
(TRI Log #: E2243-84-04)

Dear Mr. Olivlera,

This letter summarizes the final results for the large scale interface friction tests performed in support of the Firestone Building Products 45-mil f-PP geomembrane interface friction testing program. The interface friction data was developed for normal compressive loads of 250, 500, 1,000, 2,500, and 5,000 psf. All testing work was performed in general accordance with ASTM D 5321; "*Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear*", and ASTM D 6243; "*Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by Direct Shear*".

Testing Equipment and Procedures

Test Apparatus

TRI/Environmental, Inc.'s (TRI's) large scale direct shear box is a Durham Geo model LG-115 measuring 12 inches × 12 inches × 4 inches. The lower box is 16 inches in length to afford a full 12 inch × 12 inch interface during testing. The lower box is mounted on low friction rollers and attached to a mechanical drive screw equipped with a load cell for measuring the shearing force and a displacement transducer for measuring the horizontal displacement. The normal compressive loads were applied via dead weight and pneumatic loading equipment. The LG-115 upper box is removable for soil and geosynthetic remolding and mounting. After mounting, the upper box is locked into the shear frame and remains stationary during shearing.

Test Materials and Interfaces

A sample of the 45-mil f-PP geomembrane was submitted by Firestone on December 04, 2006. An 8 oz Non-woven Geotextile, a Double-sided Geocomposite with a 200-mil geonet and 8-oz geotextiles, a GCL, a 200-mil geonet, a uniform sand and lean clay were provided by TRI.

The following interfaces were evaluated:

Table 1 Interface Friction Testing

Test #	Interface (Upper/Lower)
1	Firestone 45 mil f-PP Geomembrane (smooth) vs. GSE 8 oz., 200 mil Double-sided Geocomposite
2	Firestone 45 mil f-PP Geomembrane (smooth) vs. GSE 200 mil Geonet
3	Firestone 45 mil f-PP Geomembrane (smooth) vs. Clay Soil
4	Firestone 45 mil f-PP Geomembrane (smooth) vs. Concrete Sand
5	Firestone 45 mil f-PP Geomembrane (smooth) vs. Bentofix NSL GCL
6	Firestone 45 mil f-PP Geomembrane (smooth) vs. TNS 080 Non-woven Geotextile
7	Firestone 45 mil f-PP Geomembrane (scrim) vs. GSE 8 oz., 200 mil Double-sided Geocomposite
8	Firestone 45 mil f-PP Geomembrane (scrim) vs. GSE 200 mil Geonet
9	Firestone 45 mil f-PP Geomembrane (scrim) vs. Clay Soil
10	Firestone 45 mil f-PP Geomembrane (scrim) vs. Concrete Sand
11	Firestone 45 mil f-PP Geomembrane (scrim) vs. Bentofix NSL GCL
12	Firestone 45 mil f-PP Geomembrane (scrim) vs. TNS 080 Non-woven Geotextile

Preparation of the Shear Box for Interface Friction Testing

Standard Interface Testing

Geomembrane Attachment to Lower Shear Box. The geomembrane test specimens were trimmed in such a way to fit the lower box dimensions, and then were then attached to lower box on a coarse emery surface. The leading travel edge of the geosynthetic was clamped to the lower shear box using a full width bolted bar clamp. The clamps are located outside the test region and penetrated the full thickness of the geosynthetic.

Geosynthetic Attachment to Upper Shear Box. Geosynthetic test specimens were trimmed in such a way to fit the upper box dimensions, and then were attached to the upper box on a coarse emery surface. The trailing travel edge of the geosynthetic was clamped to the upper shear box using a full width bolted bar clamp. The clamps are located outside the test region and penetrated the full thickness of the geosynthetic.

Soil Placement in the Upper Shear Box. The clay soil was placed in a one-inch thick lift in the 12-in by 12-in upper shear box and compacted to 95% of the maximum dry density as determined by the standard Proctor, at the optimum moisture content. The Concrete sand was placed loose and moderately tamped to simulate "tracking in" from the construction equipment.

Application of Normal Load. Once constructed, all interface friction geosynthetic to geosynthetic and soil to geosynthetic interfaces were loaded then immediately inundated with water such that the interface was submerged under water. The 250 and 500 psf loads were applied using steel weights while the 1,000, 2,500 and 5,000 psf load was applied with a pneumatic bladder. All interfaces were consolidated for a minimum of 24 hours prior to shearing.

Shearing. As listed in Table 1, all interface friction testing were performed using one test replicate (or shear run) per interface per normal compressive load. Geosynthetic test specimens were only test once; new specimens were used for each run. Interfaces involving a geotextile or a geocomposite were sheared at a rate of 0.2 inches/minute. Interfaces involving GCL, or soil were sheared at a rate of 0.04 inches/minute. Shearing continued until approximately 3 inches of displacement had been achieved.

Results

Attached are the individual reports for each interface tested. The friction angle and adhesion values are calculated by plotting the peak or the large displacement shear stresses with their associated normal loads, and then using linear regression analysis of the four points to determine the best-fit line. This analysis is included in the test report. Please note that the reported friction angle is specific over the normal compressive load range specified, and may not be descriptive of the frictional characteristics at higher load ranges or conditions. Peak and large displacement friction angles are summarized in Table 2 & 3.

Table 2 Summary of Interface Friction Testing Results for Smooth Side of Geomembrane

Test #	Interface	Peak Shear		Large Displacement	
	VS Firestone 45-mil f-PP Geomembrane (smooth side)	Friction Angle (degrees)	Adhesion (psf)	Friction Angle (degrees)	Adhesion (psf)
1	GSB Double-sided Geocomposite	19.4	0	14.8	4
2	GSB 200 mil Geonet	16.8	4	13.5	18
3	Clay Soil	16.3	16	11.6	36
4	Concrete Sand	25.3	46	22.9	32
5	Bentofix NSL GCL 19,0		0	14.3	44
6	TNS 080 Non-woven Geotextile	23.7	0	19.1	4

Table 3 Summary of Interface Friction Testing Results for Scrim Side of Geomembrane

Test #	Interface	Peak Shear		Large Displacement	
	VS Firestone 45-mil f-PP Geomembrane (scrim side)	Friction Angle (degrees)	Adhesion (psf)	Friction Angle (degrees)	Adhesion (psf)
7	GSB 8 oz., 200 mil Double-sided Geocomposite	18.5	0	15.0	25
8	GSB 200 mil Geonet	14.8	14	12.5	28
9	Clay Soil	14.4	159	10.4	116
10	Concrete Sand	25.2	0	23.6	0
11	Bentofix NSL GCL	12.2	87	10.3	108
12	TNS 080 Non-woven Geotextile	20.0	26	19.1	15

Conclusion

TRI is pleased to present this final report. Please feel free to call if we can answer any questions or provide any additional information.

Sincerely,

John M. Allen, E.I.T.
Director TRI Geosynthetics Interaction Laboratory
Geosynthetics Services Division
Cc: Sam Allen

MOISTURE DENSITY RELATIONSHIP

ASTM D698-91 SOP-S12

geotechnics
INTEGRITY IN TESTING

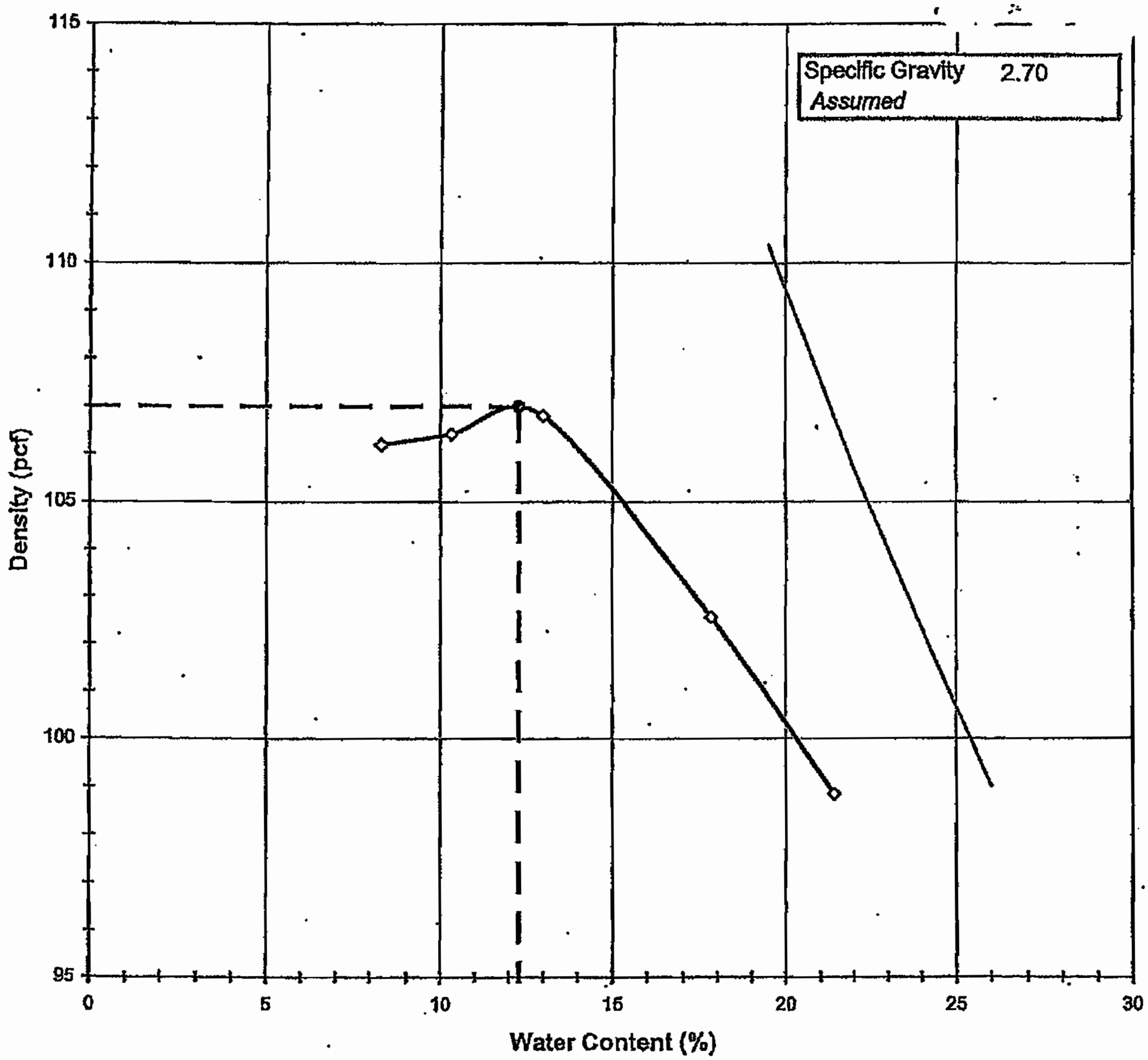
Client	GLOVER CONSTRUCTION	Boring No.	PHASE II
Client Reference	SARASOTA LF.	Depth (ft)	EAST
Project No.	2009-603-07	Sample No.	SF-02
Lab ID	2009-603-07-01	Test Method	STANDARD

Visual Description GRAY/BLACK POORLY GRADED SAND WITH SILT

Use dry density 102.4 with 95% compaction and 10% moisture

Use γ = 107 pcf

Optimum Water Content	12.3
Maximum Dry Density	107.0



Tested By SD *Date* 2/11/2009 *Checked By* GEM *Date* 2-18-09

DCN:CT-S12 DATE: 6-25-98 REVISION 3

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REFERENCE 4
TECHNICAL NOTE – AN EXPOSED GEOMEMBRANE COVER SYSTEM FOR A LANDFILL

An Exposed Geomembrane Cover System for a Landfill

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ABSTRACT: Landfill closure represents a significant cost to owners and operators when the combined costs of cover system construction, maintenance of the cover system, and maintenance of the storm-water management system are considered. Owners and operators may reduce costs by constructing a cover system that consists of an exposed geomembrane (i.e., a cover system that does not include the typical drainage, vegetative support, and topsoil layers of the cover system), thereby eliminating the construction and maintenance costs associated with the portions of the cover system overlying the geomembrane. The advantages and disadvantages of the exposed geomembrane cover system, selection criteria for the exposed geomembrane, and key design considerations for the exposed geomembrane cover system are discussed in this paper. Two of the key design considerations, for which design approaches have only recently been developed, are then discussed in detail: (i) damage of the geomembrane by hail stones; and (ii) resistance of the exposed geomembrane to uplift forces caused by wind. Lastly, a case history for design is presented. By providing the necessary tools for selecting a geomembrane that is resistant to environmental factors, this paper can be used by landfill owners and designers as a basis to consider the exposed geomembrane closure approach for potentially appropriate sites.

KEYWORDS: Exposed geomembrane, Cover system, Landfills, Wind uplift, Hail impact.

1 INTRODUCTION

Solid and hazardous waste landfills are typically required to be closed with a cover system. The purposes of the cover system are to prevent direct contact of people and the environment with the waste, to prevent erosion of the waste materials, and to minimize infiltration of storm water (which causes leachate) into the landfill. From top to bottom, the components of a typical final cover system for a municipal solid waste landfill consist of: (i) a topsoil layer; (ii) a vegetative support soil layer; (iii) a drainage layer; (iv) a low-permeability layer (i.e., compacted clay or geomembrane); and (v) a soil final grading layer over the existing daily/intermediate cover layer and waste (Figure 1). Once constructed, such final cover systems require inspection and maintenance, such as mowing of vegetation and repair of eroded areas. In addition, construction of the typical final cover system represents a significant cost to owners and operators; this approach to closure may not be cost-effective, particularly in the cases where the design life of the cover system is relatively short (i.e., approximately 5 to 10 years), when future removal of the cover system may be required (e.g., for landfill reclamation), or when the landfill may be overfilled in the future. In these cases, it may be more cost-effective to construct an exposed geomembrane cover system. An example of the exposed geomembrane cover system is presented in Figure 2. As described in this paper, exposed geomembrane cover systems represent a new direction in landfill cover system design that, depending on site-specific requirements, may represent a more cost-effective method of landfill closure.

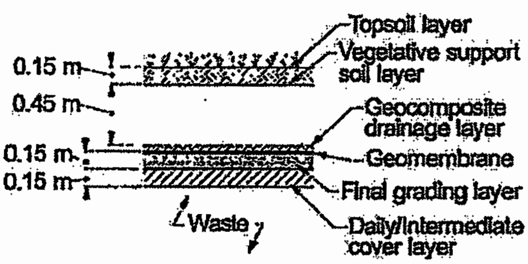

Figure 1. Typical Final Cover System

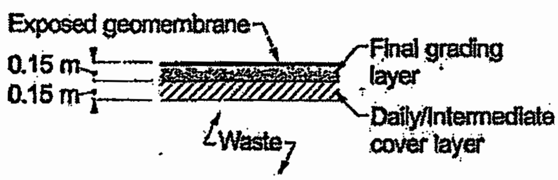

Figure 2. Exposed Geomembrane Cover System

In this paper, the applicability and design methods for an exposed geomembrane cover system are discussed; this discussion is focused on the design of an exposed geomembrane cover system for a 17-hectare landfill (Cell 1&2) at the Delaware Solid Waste Authority's (DSWA's) disposal facility in Sussex County, Delaware. Based on experience from numerous designs of typical final cover systems and the design of this exposed geomembrane cover system, the advantages and disadvantages of exposed geomembrane cover systems are presented in Section 2. The design considerations required for selection of the exposed geomembrane component of the cover system are presented in Section 3. A summary of the design methods (e.g., geomembrane selection) and design features (e.g., geomembrane anchors) necessary to satisfy these considerations are then described in Section 4. The application of these design methods are described in the case history presented in Section 5. Finally, in the conclusion of the paper (Section 6), recommendations are provided regarding the applicability of exposed geomembrane cover systems to other sites.

2 ADVANTAGES AND DISADVANTAGES

2.1 Introduction

As indicated in Figure 2, the exposed geomembrane cover system represents a simpler design than the typical cover system (Figure 1), which results in several advantages. However, the functions performed by the materials overlying the geomembrane in the typical final cover system are not performed in the case of the exposed geomembrane cover system, which results in disadvantages. The advantages and disadvantages for the exposed geomembrane cover system are presented in the subsections 2.2 and 2.3 and should be reviewed prior to proceeding with any design.

2.2 Advantages

The typical advantages of an exposed geomembrane cover system are: (i) reduced construction cost; (ii) reduced soil maintenance requirements, (iii) increased landfill volume; (iv) easier access to landfilled materials for reclamation; (v) reduced post-construction waste settlement; (vi) reduced hydraulic head on the cover system barrier layer, and (vii) enhanced visual inspection. These advantages are described below.

Reduced Construction Cost. Elimination of the topsoil layer, vegetative support soil layer, and drainage layer components of the typical final cover system may reduce construction costs by as much as $80,000 to $120,000 per hectare, depending on site-specific conditions and the availability of construction materials at the site.

Reduced Soil Maintenance Requirements. The level of soil maintenance required for the exposed geomembrane cover system is expected to be much less than that required for a typical final cover system. Because the amount of soil on an exposed geomembrane cover system is limited, repairs to eroded areas would be minimized and mowing of vegetation would be eliminated.

Increased Landfill Volume. Using an exposed geomembrane adds volume to the landfill if the final elevation of the geomembrane is set equal to the permitted final grades of the typical final cover system. For potential lateral landfill expansions, eliminating the soils overlying the geomembrane also results in added volume when the lateral landfill expansion is developed. In addition, because there is no potentially unstable material on top of the exposed geomembrane, it can be constructed on a slope that is steeper than a typical final cover system, thereby increasing landfill volume.

Easier Access to Landfilled Materials for Reclamation. Elimination of the cover soils allows the owner easier access to the waste in the event of future landfill reclamation without having to remove the existing cover soils.

Reduced Post-Construction Waste Settlement. Because an exposed geomembrane cover system is lighter than an a typical final cover system, post-construction settlement of the waste and settlement around landfill structures (i.e., landfill gas wells, drainage terraces, etc.) is reduced.

Reduced Hydraulic Head on Cover System Barrier Layer. Drainage off an exposed geomembrane cover system is not restricted by the hydraulic conductivity of cover drainage materials. Accordingly, the hydraulic head on the cover system barrier layer is reduced compared to a typical final cover system.

Enhanced Visual Inspection. Because the geomembrane is exposed, it may be easily inspected for damage; any identified damage may be inexpensively repaired.

2.3 Disadvantages

Several potential disadvantages of an exposed geomembrane cover system must be considered prior to initiating the design, including: (i) increased vulnerability to environmental damage; (ii) increased volume and velocity of storm-water runoff; (iii) susceptibility to uplift damage by landfill gas; (iv) limited vehicular access; (v) limited design life; (vi) limited regulatory approval; and (vii) aesthetic concerns. These potential disadvantages are described below.

Increased Vulnerability to Environmental Damage. Because the geomembrane is not protected by overlying cover soils, it is susceptible to damage from vandalism, animals, exposure to sunlight, low temperatures, and extreme weather (i.e., puncture from hail and damage from wind uplift). Potential damage to the exposed geomembrane from hail and wind is discussed in greater detail in Section 4 of this paper.

Increased Volume and Velocity of Storm-Water Runoff. Because there are no soils or vegetation over the exposed geomembrane, storm-water runoff is conveyed quickly off of the cover system, resulting in increased peak flow quantities and increased runoff velocities. The increased peak flow quantity requires that storm-water drainage features (i.e., ditches and culverts) be designed for a greater flow capacity and that the on-site storm-water management ponds be designed for a significantly greater storage capacity than for a typical final cover system.

Susceptibility to Uplift Damage by Landfill Gas. Because there is no overlying cover soil to limit uplift of the geomembrane by landfill gas, a landfill gas collection and removal system must be designed to effectively collect landfill gas that is generated within the landfill.

Limited Vehicular Access. Vehicular access on the landfill is usually required to perform maintenance and associated repairs to damaged features on landfill cover systems. On a typical final cover system, light vehicles can usually drive on any soil-covered portion of the landfill cover system; for the exposed geomembrane cover system, vehicular access must be restricted to only the landfill cover access road.

Limited Design Life. Because the exposed geomembrane is not protected from environmental damage, it has an expected design life that is shorter than that of a geomembrane in a typical final cover system.

Limited Regulatory Approval. Because an exposed geomembrane cover system is not common, there may be concerns among regulators regarding its technical feasibility. Also because this cover system represents a departure from typical final cover systems, regulatory approval may be difficult, or may have strict limitations.

Aesthetic Concerns. A large landfill that is covered by an exposed geomembrane cover system may be perceived as less visually appealing than a landfill with a fully-vegetated typical final cover system.

3 DESIGN CRITERIA

To prevent impacts to the environment or excessive operation and maintenance costs, each of the disadvantages listed in Section 2.3 must be addressed and resolved during the cover system design. This paper is only focused on selection and design of the geomembrane component of the exposed geomembrane cover system. Design criteria that are directly related to selection of the geomembrane are presented in this section. The exposed geomembrane component of the cover system should be designed to meet the following criteria: (i) resist damage caused by exposure to sunlight; (ii) resist damage caused by low temperatures; (iii) resist damage caused by tensile strain due to downslope creep; (iv) resist puncture damage from hail stones; and (v) resist damage from wind. These criteria are discussed below.

Resistance to Sunlight. The geomembrane must not be adversely affected by long-term exposure to sunlight, which generates heat and contains ultra-violet radiation. Therefore, geomembranes having plasticizers that could volatilize or geomembranes having components that could degrade during long-term exposure to ultra-violet radiation should not be used.

Resistance to Low Temperatures. The geomembrane polymer must not become brittle when subjected to low temperatures. The effect of low temperatures on the field performance of geomembranes is discussed in Giroud (1994) and Koerner and Koerner (1995).

Resistance to Downslope Creep. The combined action of gravity and thermal expansion/contraction of the geomembrane over long periods of time could lead to downslope creep of the geomembrane, thus creating additional stresses at the anchors. Desirable geomembrane properties are: (i) light color; (ii) low coefficient of thermal expansion; (iii) high interface friction with the underlying material; (iv) low bending modulus to minimize the formation of large wrinkles (Giroud and Morel, 1992); and (v) high tensile modulus and high activation stress to minimize creep. Only geomembranes that consist of a flexible polymer and are reinforced internally with a scrim can meet both the low bending modulus and high tensile modulus requirements.

Resistance to Puncture from Hail Stones. The exposed geomembrane would be susceptible to damage caused by extreme weather, including puncture from large-diameter hail stones. Geomembranes with a low resistance to puncture should not be used. Resistance to damage caused by hail stones is addressed in Section 4.2.

Resistance to Wind Damage. The geomembrane must have sufficient tensile strength and must be sufficiently anchored to the landfill slope to resist the tensile stresses caused by wind uplift. Use of unreinforced geomembranes, which have a relatively low tensile strength, would require closely spaced anchor trenches (i.e., 3-m to 5-m vertical intervals) or closely spaced surface anchors (such as sandbags, tires, or other ballast placed every 1 to 3 square meters on the landfill slope) to prevent wind damage. The surface anchors would be effective for short-term conditions; however, over a period of several years, they would likely move under the combined effects of wind, storm-water runoff, and thermal expansion/ contraction of the geomembrane. In addition, the surface anchors would require regular maintenance, which could possibly offset the initial construction cost savings. A cost-effective design for providing protection against wind uplift damage involves selecting a geomembrane having a high tensile strength and constructing geomembrane anchors at widely spaced vertical intervals (i.e., 10 to 12 m). Resistance to damage caused by wind uplift is addressed in Section 4.3.

Other Criteria. There are other site-specific considerations that should be addressed, such as the potential for damage caused by vandalism or by animals (e.g., chewing or hooved animals). The owner or operator should assess the risk and potential for this type of damage. A solution may be to construct a security fence to prevent unauthorized landfill access.

4 DESIGN METHODS

4.1 Introduction

In this section, design methods that can be used to address hail damage and wind uplift are presented. When using these methods, site-specific conditions must be considered, as described hereafter.

4.2 Hail Damage

To calculate the potential for damage to the exposed geomembrane by hail, a comparison must be made between the impact energy of a hail stone and the impact resistance of the exposed geomembrane. The impact energy of a hail stone is equivalent to its kinetic energy given by:

$$I_e = 0.5\, M\, v_t^{\,2} \tag{1}$$

where: I_e = impact energy of the hail stone (N·m); M = mass of the hail stone (kg); and v_t = terminal velocity of the hail stone (m/s). Therefore, the mass and terminal velocity of the hail stone must be calculated. The mass of the hail stone is a function of the hail stone density, ρ_h (kg/m^3), and volume, V (m^3):

$$M = \rho_h V \tag{2}$$

The volume is a function of the diameter, d (m):

$$V = \pi d^3/6 \tag{3}$$

hence,

$$M = \pi \rho_h d^3/6 \tag{4}$$

Now, the velocity of the hail stone is calculated. The driving force, F_g (N), on the hail stone is due to gravity:

$$F_g = M g \tag{5}$$

hence,

$$F_g = \pi \rho_h g d^3/6 \tag{6}$$

This force being constant, the hail stone tends to accelerate. However, this force is resisted by the drag force exerted by air, F_d (N), which is proportional to the square of velocity:

$$F_d = (1/2)\, \rho_a v^2 A\, c_d \tag{7}$$

where: ρ_a = density of air (1.225 kg/m^3); c_d = dimensionless drag coefficient (range is typically 0.45 to 0.60); v = velocity of hail stone (m/s); and A = cross section of hail stone perpendicular to velocity (m^2):

$$A = \pi d^2/4 \tag{8}$$

hence,

$$F_d = \pi \rho_a v^2 d^2 c_d / 8 \tag{9}$$

As the hail stone accelerates, F_d increases until it becomes equal to F_g:

$$F_d = F_g \tag{10}$$

At this point, the resulting force applied to the hail stone is zero and the velocity of the hail stone becomes constant (i.e., $v = v_t$). This constant velocity is calculated by combining equations 1, 2, and, 3 (Straka, 1995):

$$v_t = [(4/3)(\rho_h/\rho_a)(gd/c_d)]^{0.5} \tag{11}$$

Finally, the impact energy of the hail stone is calculated by combining the derived Equations 1, 4 and 11;

$$I_e = (\pi \rho_h^{\,2} g\, d^4)/(9\, \rho_a c_d) \tag{12}$$

Equation 12 gives the impact energy for the case where hail falls in a direction perpendicular to the geomembrane. This is conservative because the impact energy is less if hail does not fall in a direction perpendicular to the geomembrane. One may be even more conservative by calculating the impact energy using Equation 1 with a value of v_t that is greater than that given by Equation 11 to account for an increase in the terminal velocity of the hail stone due to wind.

The factor of safety against puncture of the geomembrane by a hail stone must be greater than a specified value, e.g., 1.0. This factor of safety is calculated using the following equation:

$$\text{Factor of Safety} = I_r / I_e \tag{13}$$

where I_r is the impact resistance of the geomembrane measured in a test.

Because the hail stone impacts the geomembrane in the cross-plane direction, standard impact resistance tests that simulate in-plane impact are not appropriate. Rollin (1991, 1993) and Kilius (1993) present cross-plane geomembrane impact resistance data obtained from tests that used a large-scale dynamic testing apparatus. The apparatus is described as a "modified drop-weight apparatus" in which the specimen is held taut while a mass is dropped from a fixed height. Using a different test method, Koerner et al. (1986) evaluated the cross-plane impact resistance of geomembranes with a floor-mounted pendulum device. For either of these test methods, the shape of the impact apparatus should be spherical in order to simulate the assumed shape of a hail stone. Impact resistance of the geomembrane is a function of the geomembrane material properties and the thickness of the geomembrane, and is reported in terms of energy.

4.3 Wind Damage

The resistance to wind uplift of the exposed geomembrane is a function of the tensile characteristics of the geomembrane, the landfill geometry, and the design wind velocity. The analyses for geomembrane wind uplift presented in this paper are based on the procedures developed by Giroud et al. (1995), extended by Zornberg and Giroud (1997). For a detailed design, these references should be reviewed. The analyses are organized into two criteria: (i) resistance of the exposed geomembrane to tensile failure caused by wind uplift; and (ii) resistance of the geomembrane anchor to the tensile forces caused by wind uplift on the geomembrane. The forces acting on the geomembrane that cause geomembrane uplift, geomembrane tension, and tensile forces at the geomembrane anchors are a function of the wind velocity and the exposed length of the geomembrane. The wind velocity may be selected based on the local building codes or other appropriate guidelines.

For the selected wind velocity, the wind uplift pressure (i.e., suction) on the geomembrane at or near sea level is given by the following equation (Giroud et al., 1995):

$$S = (0.05)\,\lambda\, v_w^2 \qquad (14)$$

where: S = suction (Pa); λ = suction factor (dimensionless); and v_w = design wind speed (km/hr).

The recommended values for suction factor, λ, vary according to the location along the landfill slope, as indicated in Figure 3. The suction decreases slightly with increasing elevation above sea level (Giroud et al., 1995); this effect is conservatively ignored herein. Also, the suction given by Equation 14 can be slightly decreased to account for the weight of the geomembrane (Zornberg and Giroud, 1997); however, this effect is generally not significant and is also conservatively ignored herein. As a result, the effective suction, S_e (defined by Giroud et al., (1995) as the suction corrected for the site elevation and the geomembrane weight) is considered in this paper as equal to the suction expressed by Equation 14.

The effect of wind suction on the exposed geomembrane is characterized by the term S_eL, where L is the length of exposed geomembrane. L is calculated using Equation 15 as follows:

$$L = h/\sin\beta \qquad (15)$$

where: β = slope angle (degree); and h = vertical distance between geomembrane anchors (m).

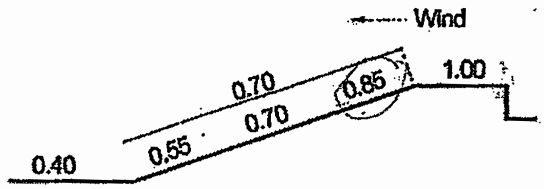

Figure 3. Recommended Values of the suction factor, λ (Giroud et al., 1995).

To evaluate the potential for tensile failure caused by wind uplift, the suction force acting over the length of geomembrane (i.e., S_eL) is compared to the ability of the geomembrane to resist this force. The properties of the geomembrane required for this analysis can be obtained from the stress-strain curve of the geomembrane, which may be established by performing American Society for Testing and Materials (ASTM) test method D 4885 (i.e., "Standard Test Method for Determining Performance Strength of Geomembranes by the Wide Strip Tensile Method"). The properties to be obtained from the stress-strain relationship are: (i) the allowable tensile strain, ε_a (tensile strain at break for the reinforcing component of a reinforced geomembrane, or tensile strain at yield for unreinforced geomembranes); and (ii) the tensile stiffness, J, of the geomembrane.

The first part of the analysis involves calculation of the factor of safety for the geomembrane to resist rupture when subjected to the design wind event. Using the values obtained for S_eL and J, the normalized tensile stiffness for the geomembrane, J/S_eL, is calculated. Referring to Table 4 in the paper by Giroud et al. (1995) and using the calculated value of J/S_eL, the geomembrane strain, ε_c, can be calculated. The factor of safety against geomembrane rupture (recommended to be a minimum of 1.5) is calculated by dividing the allowable geomembrane strain, ε_a, by the strain calculated for the design wind speed, ε_c:

$$FS_r = \varepsilon_a / \varepsilon_c \qquad (16)$$

The second part of the analysis involves calculating the uplift force exerted on the geomembrane anchors. The required weight (hence the cross-sectional area) of the geomembrane anchor to resist the calculated uplift force can then be calculated. The geomembrane tension, T, is calculated using Equation 17:

$$T = J\,\varepsilon_c \qquad (17)$$

where: T = tension in the exposed geomembrane (kN/m); J = geomembrane tensile stiffness (kN/m); and ε_c = calculated strain (%). Using the strain calculated as indicated, the values for uplift distance, u, uplift angle, θ, and normalized tension, T/S_cL, can be found from Table 2 of Giroud et al., (1995). These parameters are identified in Figure 4. The value of T calculated using Equation 17 may be confirmed by multiplying T/S_cL (obtained in Table 2 of Giroud et al., 1995) by S_cL to give T.

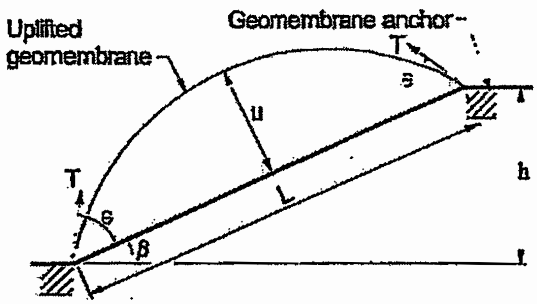

Figure 4. Exposed Geomembrane Uplift

A geomembrane anchor located on a slope between two portions of exposed geomembrane is subjected to the forces shown in Figure 5. The vertical component of these forces is a function of the uplift angle, θ (identified in Table 2 of Giroud et al., (1995) and Figure 4 of this paper), the slope angle, β, and the tension, T, calculated in Equation 17. The weight of the geomembrane anchor required to resist the vertical components of the tensile forces acting on the geomembrane can be calculated using Equation 18.

$$W = T_d \sin(\theta_d - \beta) + T_u \sin(\theta_u + \beta) \qquad (18)$$

where: W = weight per unit length of anchor trench (kN/m); T_d, T_u = tension on geomembrane at the downslope and upslope side of the geomembrane anchor, respectively (kN/m); θ_d, θ_u = uplift angle on the downslope and upslope side of the geomembrane anchor, respectively (degree); and β = slope angle (degree).

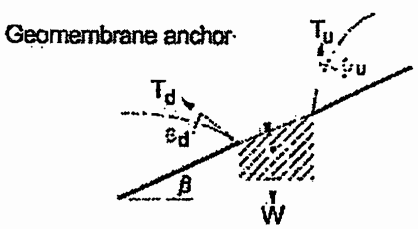

Figure 5. Tensions Acting on a Geomembrane Anchor

Assuming a continuous geomembrane anchor, the calculated anchor weight can be translated into a volume and a corresponding required area per unit width. For a geomembrane anchor consisting of soil, the required area per unit width is a function of the calculated vertical force, W, and the unit weight of the anchor soil, γ, and is calculated using Equation 19:

$$A_{required} = W/\gamma \qquad (19)$$

The value for $A_{required}$ is calculated assuming that the geomembrane is continuous through the cover system anchor. The calculation applies to uplift of the geomembrane anchor and does not apply to pullout of the geomembrane from the anchor. If the geomembrane is not continuous through the anchor or if the seam strength of the geomembrane is less than the geomembrane strength, then a geomembrane pullout calculation would be required. For this calculation, the soil/geomembrane interaction and/or the geomembrane seam strength would be required. These calculations are not provided in this paper.

5 CASE STUDY

5.1 Introduction

Use of the design equations and analyses presented in the previous sections is illustrated in the following case study, in which the impact of hail and wind uplift on an exposed geomembrane cover system is evaluated. The conditions presented in the case study are based on the design of an exposed geomembrane cover system for the DSWA's Cell 1&2 landfill. The geomembrane used for the design is a 0.9-mm thick green polypropylene geomembrane with a polyester scrim reinforcement. The following data are used for the analyses: (i) based on discussions with DSWA, a maximum hail stone diameter of 0.05 m was selected; and (ii) based on the local building code for structures in the area, the design wind velocity was 130 km/hr. The landfill has 4H:1V slopes (i.e., slope angle, β = 14°) and will have cover benches with corresponding drainage swales and geomembrane anchors spaced at 12 m vertical intervals (i.e., h = 12 m) (Figure 6).

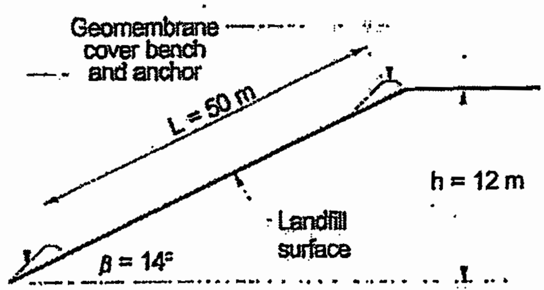

Figure 6. Case Study Landfill Slope Geometry

Using these data, the following analyses were performed: (i) calculation of the impact energy of the hail stone on the exposed geomembrane; and (ii) calculation of the total strain and tension in the geomembrane, and the minimum geomembrane anchor cross section required to resist the calculated uplift force. The analyses are described in the following two subsections.

5.2 Hail Impact

The impact energy, I_e, for a 0.05 m diameter hail stone assuming, $g = 9.81\ m/s^2$, $d = 0.05$ m, $\rho_h = 900\ kg/m^3$, $\rho_a = 1.225\ kg/m^3$, and $c_d = 0.45$ is calculated using Equation 12 as follows:

$$I_e = [(\pi\,(900)^2(9.81)(0.05)^4]\,/\,[(9)(1.225)(0.45)]$$
$$= 31.4\ N{\cdot}m$$

Therefore, to resist puncture by hail stones, the impact resistance, I_r, of the geomembrane must be greater than 31.4 N·m. The impact resistance is a function of the geomembrane polymer and thickness. The properties of the material underlying the geomembrane also affect the impact resistance (Koerner et al., 1986). The test results reported by Rollin (1991, 1993), Kilius (1993), and Koerner et al. (1986) were reviewed during the selection process of the geomembrane. As indicated from the published test results, the selected geomembrane has an impact resistance greater than the calculated impact energy, such that the factor of safety calculated from Equation 13 is greater than 1.0.

5.3 Wind Uplift

5.3.1 Introduction

Several geomembranes were considered for the design of the exposed geomembrane cover system. Calculations for the selected geomembrane are presented in this section. A reinforced geomembrane with a linear stress-strain curve characterized by a tensile stiffness, J=165 kN/m, and a strain at break (i.e., of the reinforcement), ε_b=27 %, was selected for the design.

5.3.2 Analysis for Geomembrane Rupture

First, the factor of safety against tensile failure for the design wind speed is calculated. From Figure 3, the suction factor near the top of the slope is, λ=0.85. Ignoring the elevation factor and the mass of the geomembrane, the effective suction force, S_e, for a wind velocity, v_w, of 130 km/hr is calculated using Equation 14, as follows:

$$S_e = (0.05)(0.85)(130)^2 = 720\ Pa$$

Using Equation 15, the length of exposed geomembrane between the geomembrane anchors is:

$$L = 12 / \sin(14°) = 50\ m$$

The suction force acting on this length is:

$$S_eL = (720)(50) = 36{,}000\ N/m = 36\ kN/m$$

And the normalized tensile stiffness is:

$$J/S_eL = (165\ kN/m) / (36\ kN/m) = 4.6$$

For $J/S_eL = 4.6$, Table 4 by Giroud et al. (1995) gives the calculated strain, ε_c = 14.1%. Using Equation 16, the factor of safety against geomembrane tensile failure is calculated, which is greater than the recommended minimum value of 1.5:

$$FS_r = (27\%) / (14.1\%) = 1.9$$

5.3.3 Geomembrane Anchor Analysis

Next, using the parameters obtained in the previous subsection, the tension caused by uplift and the required anchor area per unit width for the geomembrane is calculated. First, the uplift of the geomembrane is calculated. For the calculated strain, ε_c = 14.1% (obtained in subsection 5.3.2), Table 2 by Giroud et al. (1995) gives θ = 50.3° and u/L = 0.235. For an exposed geomembrane length, L = 50 m, the total uplift, u, of the geomembrane is 11.75 m (Figure 4).

The wind generated tension, T, on the geomembrane is calculated from the normalized tension, T/S_eL. From Table 2 by Giroud et al., (1995), T/S_eL = 0.648; multiplying this value by S_eL = 36 kN/m gives T = 23.3 kN/m. To confirm this value, T is also calculated using Equation 17:

$$T = J\,\varepsilon_c = (165)(14.1\%) = 23.3\ kN/m$$

On either side of the geomembrane anchor it is assumed that the length of exposed geomembrane, L, and the suction factor, λ, for the slope are equivalent. Therefore, $T_u = T_d$, and $\theta_u = \theta_d$ (Figure 5). For $\theta_u = \theta_d$ = 50.3°, $T_u = T_d$ = 23.3 kN/m, and β = 14°, the vertical force, W, required to resist uplift of the geomembrane anchor is calculated using Equation 18, as follows:

$$W = (23.3)\sin(50.3°\text{-}14°) + (23.3)\sin(50.3°+14°) = 35\ kN/m$$

Assuming that the anchor consists of soil with a unit weight of 18 kN/m³, the required cross-sectional area of the geomembrane anchor is calculated using Equation 19, as follows:

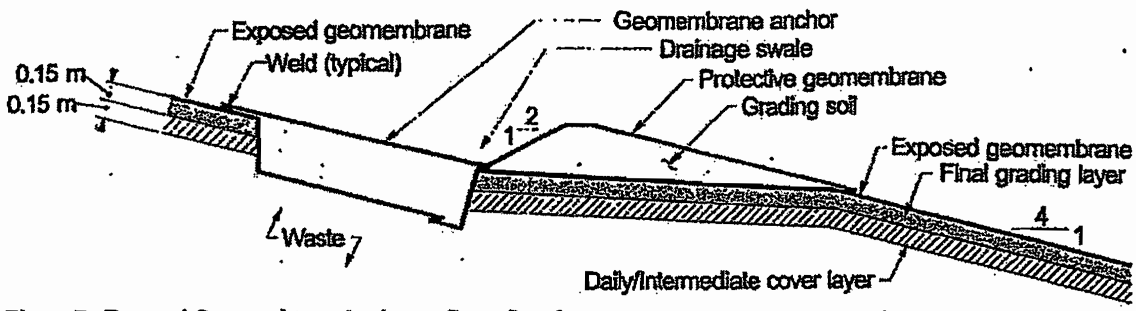

Figure 7. Exposed Geomembrane Anchor at Cover Benches

$A_{required} = (35 \text{ kN/m}) / (18 \text{ kN/m}^3) = 1.95 \text{ m}^2$

At the case study site, the geomembrane anchors on the cover system were designed to include a swale that conveys storm-water runoff from the landfill in a non-erosive manner. As indicated in Figure 7, the soils in the anchor trench and the soils that form the drainage swale are covered by a protective geomembrane that is welded to the exposed geomembrane in order to eliminate the potential for soil erosion at these locations.

6 CONCLUSION

An exposed geomembrane cover system may be appropriate at landfill sites when the design life of the cover system is relatively short or when overfilling or landfill reclamation are future possibilities. Sites that are considered for this application should also have adequate landfill gas collection systems and storm-water management controls. To design an exposed geomembrane cover system, a number of issues must be addressed. These issues are reviewed in this paper, and guidance is provided. Furthermore, design methods for two key issues, hail damage and wind uplift, are described and are illustrated using a case history. Considering the available design tools and the example provided by the case history, it is possible to safely design an exposed geomembrane cover system that can be constructed at a lower cost than a typical final cover system.

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REFERENCES

Giroud, J.P., and Morel, N., (1992) "Analysis of Geomembrane Wrinkles", *Geotextiles and Geomembranes*, Vol. 11, No. 3, pp. 255-276. (Erratum: 1993, Vol. 12, No. 4, p. 378.)

Giroud, J.P., (1994), "Determination of Geomembrane Shattering Cracks", *Geosynthetics International*, Industrial Fabrics Association International, Vol. 1, No. 2, pp. 149-180.

Giroud, J.P., Pelte, T., and Bathurst, R.J., (1995) "Uplift of Geomembranes by Wind", *Geosynthetics International*, Special Issue on Design of Geomembrane Applications, Industrial Fabrics Association International, Vol. 2, No. 6, pp. 897-952.

Kilius, D.E., (1993) "Cold Temperature Performance of Polypropylene Geomembranes and Seams", *Geosynthetic Liner System: Innovations, Concerns, and Designs*, Koerner, R.M., and Wilson-Fahmy, R.F., Editors, Proceedings of 1993 GRI Conference, Industrial Fabrics Association International, pp. 197-207.

Koerner, G.R., and Koerner, R.M., (1995) "Temperature Behavior of Field Deployed HDPE Geomembranes", *Proceedings, Geosynthetics '95 Conference*, Nashville, Tennessee, USA, pp. 921-937.

Koerner, R.M., Monteleone, M.J., Schmidt, J.R., and Roethe, A.T., (1986) "Puncture and Impact Resistance of Geosynthetics", *Proceedings, Third International Conference on Geotextiles and Geomembranes*, Vienna, Austria, pp. 677-682.

Rollin, A.L., Lefebvre, M., Lafleur, J., and Marcotte, M., (1991) "Evaluation of Field Seam Quality by the Impact Test Procedure", *Proceedings, Geosynthetics '91 Conference*, Atlanta, Georgia, USA, pp. 223-237.

Rollin, A.L., Lefebvre, M., Lafleur, J., and Mlynarek, J., (1993) "The use of Impact Test Procedure to Assess Seam's Brittleness", *Proceedings, Geosynthetics '93 Conference*, Vancouver, Canada, pp. 1559-1573.

Straka, J., (1995) University of Oklahoma Meteorology Department, written communication with C. Furst of GeoSyntec.

Zornberg, J.G., and Giroud, J.P., (1997) "Uplift of Geomembranes by Wind - Extension of Equations", *Geosynthetics International*, Industrial Fabrics Association International, Vol. 4, No. 2, pp. 187-207.

REFERENCE 5
TECHNICAL NOTE – UPLIFT OF GEOMEMBRANES BY WIND –EXTENSION OF EQUATIONS

Technical Note by J.G. Zornberg and J.P. Giroud

UPLIFT OF GEOMEMBRANES BY WIND - EXTENSION OF EQUATIONS

ABSTRACT: This technical note presents an extension of earlier analytical methods published in 1995 by Giroud et al. for evaluating the uplift of geomembranes by wind. The extension incorporates: (i) the influence on wind uplift of the slope inclination of an exposed geomembrane; and (ii) a more accurate expression of the tension-strain relationship in a wind uplifted geomembrane. Use of the revised methods is particularly relevant for projects in which the exposed geomembrane mass per unit area is high, the slope inclination of the exposed geomembrane is steep, and the exposed geomembrane is subjected to strains due to mechanisms other than the wind (e.g. gravity, temperature) prior to wind uplift. Also, the revised equations are particularly appropriate for dimensioning a protective layer placed on top of the geomembrane to prevent wind uplift. The information provided in this technical note may be of particular significance for projects in which an exposed geomembrane is contemplated as the final cover for waste containment systems with steep slope configurations.

KEYWORDS: Geomembrane, Wind, Uplift, Design method, Steep slope.

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1 INTRODUCTION

A thorough evaluation of the uplift of geomembranes by wind is presented in a paper by Giroud et al. (1995). The paper presents approaches to assess the maximum wind velocity that an exposed geomembrane can withstand without being uplifted, the required thickness of a protective layer that would prevent the geomembrane from being uplifted, the tension and strain induced in the geomembrane by wind loads, and the geometry of the uplifted geomembrane. The evaluation of the uplift of geomembranes by wind is a design issue that deserves consideration not only for applications in which geomembranes are temporarily exposed (e.g. during construction of conventional landfill cover and liner systems), but also for challenging projects in which an exposed geomembrane without any protective layer is contemplated for final closure of a waste containment system.

This technical note presents revisions and extensions of the work by Giroud et al. (1995), including: (i) revision of a number of the original equations to account for the influence on wind uplift of the slope inclination of an exposed geomembrane; (ii) revision of the wind uplift tension-strain relationship to facilitate calculations and graphical applications in cases where the geomembrane is already subjected to an initial strain when wind uplifting begins; and (iii) methods for evaluating the geomembrane wind uplift under initial strain induced by gravity and temperature.

The revised equations may be of particular relevance when an exposed geomembrane is considered as the final cover for a waste containment landfill with steep slopes. An example of such an application is given in Section 5. This example is inspired by the feasibility evaluation of the use of an exposed geomembrane as the final cover for the Operating Industries, Inc. (OII) landfill located in southern California, which is in an area of high seismicity. The landfill slopes are up to 80 m high, with intermediate slopes between benches as steep as 1V:1.5H and up to 28 m high. The main reason for having considered an exposed geomembrane cover as a potential alternative for final closure of the landfill was the difficulty in demonstrating adequate slope stability, under static and seismic conditions, in the case of conventional covers where geosynthetics are overlain by soil layers. In contrast, an exposed geomembrane cover would be stable under both static and seismic conditions. Evaluation of the uplift by wind of the geomembrane becomes, however, a key consideration in the assessment of an exposed geomembrane as a final cover alternative.

2 INFLUENCE OF SLOPE INCLINATION ON GEOMEMBRANE UPLIFT BY WIND

The forces per unit area acting on a geomembrane exposed on a slope and subjected to wind-generated suction are shown in Figure 1. The suction, S, induced by the wind is normal to the exposed geomembrane and, therefore, its average direction is normal to the slope. A geomembrane exposed on a slope with inclination β will resist wind uplift by itself if the component of the geomembrane weight per unit area in the direction normal to the slope is greater than or equal to the suction S. Therefore, in order to prevent wind uplift, it should be verified that:

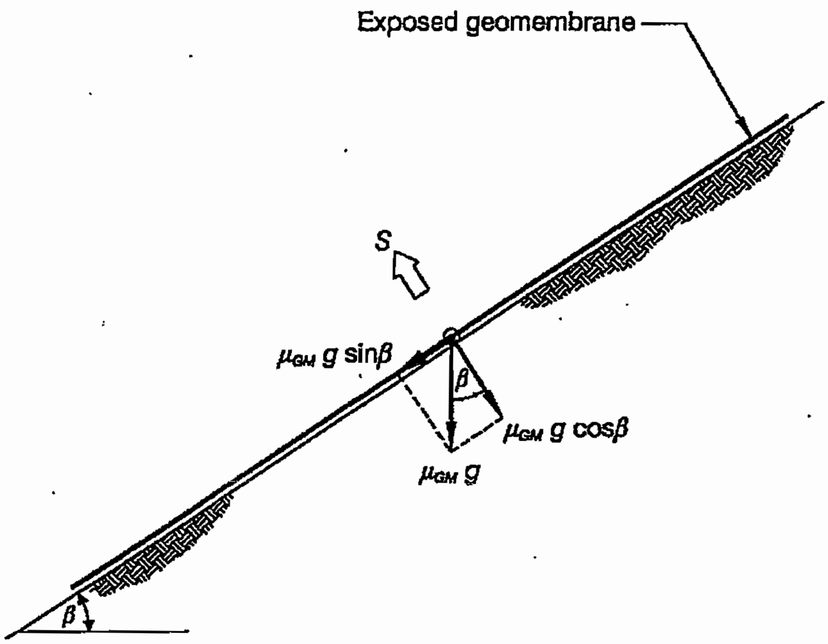

Figure 1. **Geomembrane exposed on a slope of inclination β and subjected to wind-induced suction.**

$$\mu_{GM}\, g \cos\beta \geq S \tag{1}$$

where: μ_{GM} = mass per unit area of the geomembrane; and g = acceleration due to gravity.

The earlier equations (Giroud et al. 1995) do not include the term $\cos\beta$ in Equation 1. Although these earlier equations would rigorously be valid only for exposed horizontal geomembranes ($\cos\beta = 1$), they would be appropriate for practical purposes in many cases because: (i) many structures in which geomembrane uplift by wind is an issue of concern have slopes that are not steep ($\cos\beta \sim 1$); and (ii) the geomembrane weight per unit area is generally much smaller than the wind-generated suction and, therefore, an error on the weight would have no significant impact on the calculated value of the effective suction. However, using $\cos\beta = 1$ would not be appropriate in cases where the slope of the exposed geomembrane is steep or in cases where the mass per unit area of the geomembrane is comparatively high (e.g. if bituminous geomembranes are used). The effect of the $\cos\beta$ term is particularly significant when calculating the thickness of the protective layer on top of the geomembrane which is required to prevent wind uplift.

A revised version of the earlier equations, which incorporates the effect of the slope inclination β, is presented in the Appendix. The revised equations can be used to estimate, as a function of the slope inclination, the mass per unit area of geomembrane required to resist wind uplift, the threshold wind velocity below which a geomembrane should not be uplifted by wind, the required thickness of a protective layer that would prevent wind uplift, and the effective suction acting on an exposed geomembrane. The revised equations in the Appendix supersede the original equations (Giroud et al. 1995) and, to facilitate cross-referencing, the same numbering sequence is used for the revised and original equations (e.g. Equation A-14 in the Appendix is the revised version of the original Equation 14).

3 UPLIFT OF GEOMEMBRANES WITH INITIAL WRINKLES OR TENSION

3.1 Uplift Tension-Strain Relationship

The fundamental relationship for the geomembrane uplift problem is the "uplift tension-strain relationship" defined by Equation 47 in the paper by Giroud et al. (1995). In this relationship, the only strain component is the strain induced by the wind. Therefore, it is proposed to use the notation ε_w to distinguish this strain component from the total strain in the geomembrane, ε, which may result from multiple causes (e.g. wind, temperature, gravity). As the only cause of strain considered in the relationship presented by Giroud et al. (1995) is the wind, the notation ε is used in Equation 47 of the original paper. However, this notation becomes confusing when multiple causes of strain are considered in the analysis.

The new version of the original Equation 47 resulting from the use of the notation ε_w is:

$$\varepsilon_w = \frac{2T}{S_e L} \sin^{-1}\left[\frac{S_e L}{2T}\right] - 1 \qquad \text{(A-47)}$$

where: ε_w = geomembrane strain component induced by wind uplift; T = total geomembrane tension; S_e = effective suction; and L = length of geomembrane subjected to suction.

It is important to emphasize that the uplift tension-strain relationship (Equation A-47) relates the strain induced only by the wind, ε_w, with the total tension in the geomembrane, T, induced also by sources other than wind such as temperature or gravity. In other words, it should be noted that Equation A-47 is *not* a relationship between the wind-induced strain, ε_w, and the wind-induced tension, T_w. This is because, while the geometry of the uplifted geomembrane is governed by the wind-induced strain, ε_w, the effective suction acting over a length L is resisted by the total tension, T, in the geomembrane (Figure 2).

Equations A-45, A-46, A-51 and A-57 presented in the Appendix were also revised to explicitly use ε_w. The uplift tension-strain relationship expressed by Equation A-47 is represented by the curve in Figure 3. Note that the horizontal axis of the graph presented in Figure 3 corresponds to the wind-induced component of the geomembrane strain, ε_w.

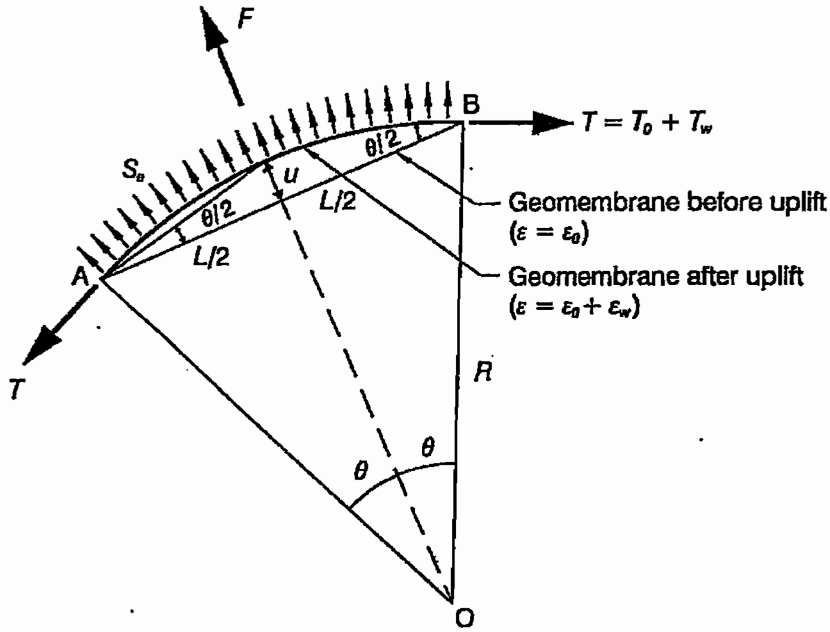

Figure 2. Schematic representation of an uplifted geomembrane (based on Figure 9 from Giroud et al. 1995).

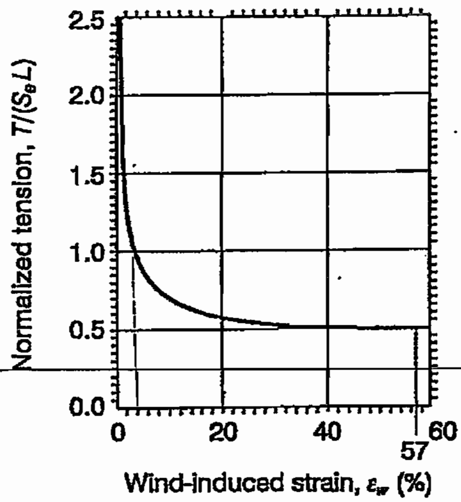

Figure 3. Normalized uplift tension-strain relationship.

Notes: This curve was established using Equation A-47. This is a revised version of Figure 10 presented by Giroud et al. (1995) in which the horizontal axis is the wind-induced component of the geomembrane strain, ε_w, instead of the total geomembrane strain, ε, used in the original figure.

3.2 Graphical Application

The representation of the uplift tension-strain relationship expressed by Equation A-47 and shown in Figure 3, where the initial horizontal axis is ε_w instead of ε, is useful in the evaluation of the effect of initial wrinkles or initial tension on the uplift by wind of geomembranes. A graphical determination of the total strain, ε, and total tension, T, in a geomembrane after wind uplift, for the case of a geomembrane with initial wrinkles or initial tension, is shown in Figure 4. For the purposes of the discussion presented herein, the initial strains in the geomembrane analyzed in Figure 4 are assumed to be induced by temperature changes. However, the procedure illustrated in Figure 4 can be equally used to evaluate the total tension and strain in the geomembrane if the initial strains are induced by other mechanisms.

Figure 4a shows a typical geomembrane tension-strain curve. The tension-strain behavior of the geomembrane shown in Figure 4 was extended to the "negative strain" portion of the curve in order to illustrate the behavior of a geomembrane with wrinkles. The axes of the geomembrane tension-strain curve are the total tension, T, and the total strain, ε, in the geomembrane. Since geomembranes do not sustain compression, the tension is zero on the negative side of the ε axis. Points A_0, B_0, and C_0 represent different possible initial state conditions of a geomembrane before it is subjected to wind-induced suction. State A_0 represents a geomembrane that has not undergone strains (neither positive nor negative) due to temperature changes, state B_0 represents a geomembrane with initial wrinkles due to thermal expansion (high temperature when uplifting begins), and state C_0 represents a geomembrane under initial tension due to thermal contraction (low temperature when uplifting begins).

Figure 4b illustrates the uplift tension-strain relationship for a specific value of $S_e L$, which is defined by the geometry of the exposed geomembrane and the design wind velocity. As discussed in Section 3.1, the axes of this uplift tension-strain relationship are the total tension, T, and the wind-induced component, ε_w, of the geomembrane strain.

Figure 4c illustrates how to estimate the final tension and strain in a geomembrane subjected to wind-induced suction for three cases representing possible initial states of a geomembrane when uplifting begins. The elements relevant for design provided by the graphical analysis illustrated in Figure 4c are the total tension, T, in the geomembrane, which should be less than the allowable tension, and the wind-induced strain component, ε_w, which defines the geometry of the uplifted geomembrane.

The three cases illustrated in Figure 4c are discussed below.

Case A. In this case, the geomembrane has no wrinkles or tension when uplifting begins. Points A_0 and A_1 along the geomembrane tension-strain curve represent the states before and after wind uplift and can be used to define the total tension, T_A, and the wind-induced strain, ε_{wA}, in the geomembrane. Point A_1 is the intersection of the geomembrane tension strain-curve, $T - \varepsilon$, with the uplift tension-strain curve, $T - \varepsilon_w$. The origin, O, of the uplift curve for this case (Curve A) is Point A_0, which represents the initial state in the tension-strain curve of the geomembrane.

Case B. In this case, due to thermal expansion prior to wind action, the geomembrane has wrinkles when uplifting begins, which are characterized by a "negative strain".

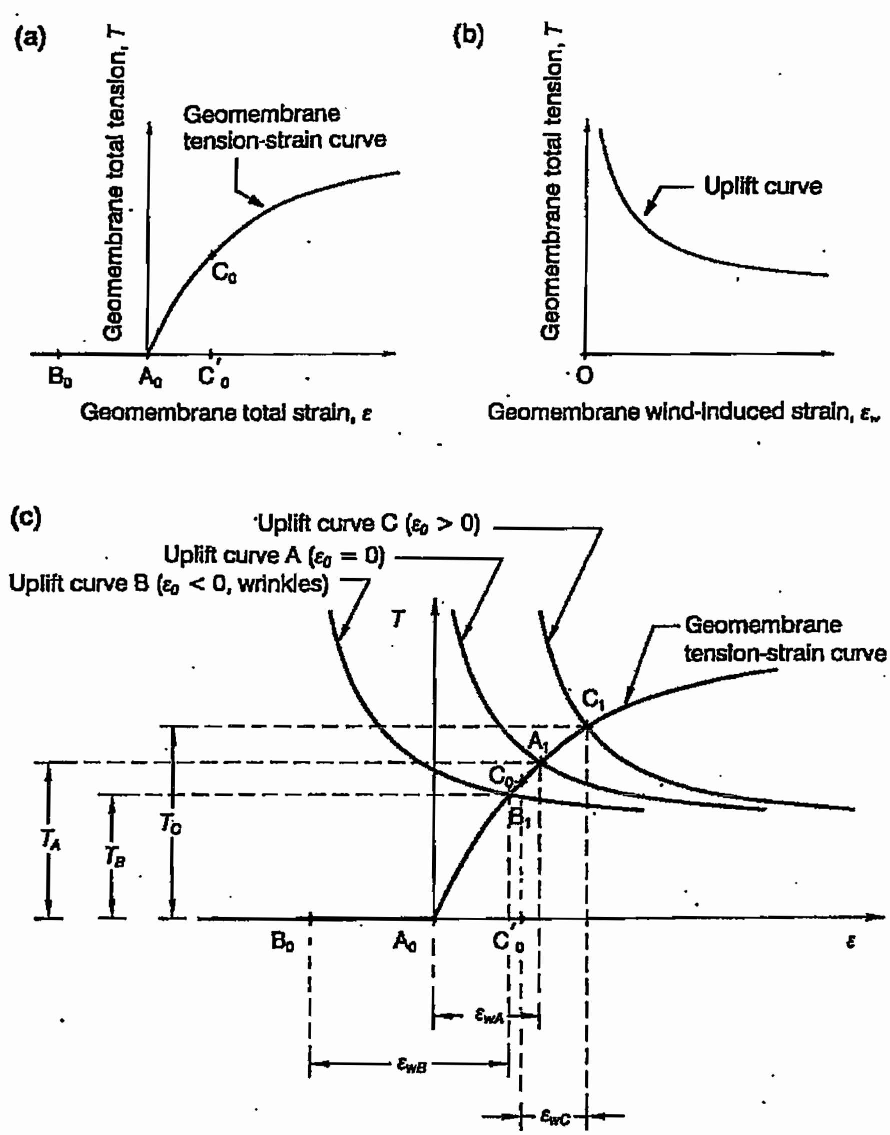

Figure 4. **Uplift by wind of a geomembrane under initial strains: (a) schematic geomembrane tension-strain (T - ε) curve; (b) schematic geomembrane uplift tension-strain (T - ε_w) relationship; (c) uplift by wind of a geomembrane under no initial strain (from A_0 to A_1), with initial wrinkles (from B_0 to B_1), and under initial tension (from C_0 to C_1).**

Points B_0 and B_1 along the geomembrane tension-strain curve represent the states before and after wind uplift and can be used to define the total tension, T_B, and the wind-induced strain, ε_{wB}. Point B_1 is the intersection of the geomembrane tension-strain curve,

T - ε, with the uplift tension-strain curve, T - ε_w. The origin, O, of the uplift curve for this case (Curve B) is Point B_0, which represents the initial state in the tension-strain curve of the geomembrane. Figure 4c shows that the total tension, T_B, in the uplifted geomembrane is smaller than the total tension, T_A, in Case A and that the wind-induced strain, ε_{wB}, in the uplifted geomembrane is greater than the wind-induced strain, ε_{wA}, in Case A. In summary, as stated by Giroud et al. (1995), "if a geomembrane has wrinkles when uplifting begins, it is uplifted more, but with a smaller tension than if the geomembrane has no wrinkles when uplifting begins.".

Case C. In this case, due to thermal contraction prior to wind action, the geomembrane is under tension when uplifting begins. Points C_0 and C_1 along the geomembrane tension-strain curve represent the states before and after wind uplift and can be used to define the total tension, T_C, and the wind-induced strain, ε_{wC}, after wind uplift. Point C_1 is the intersection of the geomembrane tension-strain curve, T - ε, with the uplift tension-strain curve, T - ε_w. The origin, O, of the uplift curve, T - ε_w, for this case (Curve C) is point C'_0, the projection on the ε axis of Point C_0, which represents the initial state in the tension-strain curve of the geomembrane. Figure 4c shows that the total tension, T_C, in the uplifted geomembrane is greater than the total tension, T_A, in Case A and that the wind-induced strain, ε_{wC}, in the uplifted geomembrane is smaller than the strain, ε_{wA}, in Case A. In summary, as stated by Giroud et al. (1995), "if a geomembrane is under tension when uplifting begins, it is uplifted less, but with a greater tension than if the geomembrane has no wrinkles when uplifting begins.".

worst case for tension.

3.3 Discussion

Figure 4c of this technical note should be compared with Figure 25 in the paper by Giroud et al. (1995). Both figures illustrate the same approach, which consists of translating parallel to the strain axis one of the following two curves: the geomembrane tension-strain curve (Figure 4a) or the uplift tension-strain curve ("uplift curve") (Figure 4b). In Figure 4c, the uplift curve is translated, whereas in Figure 25 of the original paper the geomembrane tension-strain curve is translated. The conclusions drawn from Figure 4c in Section 3.2 are identical to those drawn by Giroud et al. (1995) from Figure 25. Experience has shown that some engineers prefer the approach in Figure 4c, whereas other engineers prefer the approach in Figure 25 (with the horizontal axis labeled ε_w instead of ε, as pointed out in Section 3.1). Therefore, it appears useful to have both approaches available. However, regardless of the approach selected, it is important that the horizontal axis of Figure 4b be labeled ε_w.

4 WIND UPLIFT OF GEOMEMBRANES UNDER INITIAL STRAINS INDUCED BY GRAVITY AND TEMPERATURE

The analysis presented in Section 3 regarding the uplift by the wind of a geomembrane under initial tension due to thermal contraction can also be applied for the case of a geomembrane under initial tension induced by other sources (e.g. gravity forces, seismic forces, tractive forces caused by surface water flow). Similarly, the analysis presented in Section 3 for wind uplift of a geomembrane initially with wrinkles due to thermal expansion can also be applied to the case of a geomembrane initially with wrinkles caused by other reasons (e.g. induced during construction).

Section 4 discusses the particular case of an exposed geomembrane under initial tension induced both by thermal contraction and gravity forces. These two sources of initial tension in geomembranes may be particularly relevant when evaluating the performance of geomembranes exposed on steep slopes. Geomembrane tensions induced by seismic forces and tractive water forces are not considered herein as it appears unreasonable, for design purposes, to consider that the design wind would occur simultaneously with a seismic event or with the design storm.

The initial strain, ε_0, and initial tension, T_0, in the geomembrane before uplifting begins can be estimated from:

$$\varepsilon_0 = \varepsilon_T + \varepsilon_g \tag{2}$$

$$T_0 = T_T + T_g \tag{3}$$

where: ε_T = geomembrane strain component induced by thermal contraction; ε_g = geomembrane strain component induced by gravity; T_T = geomembrane tension component induced by thermal contraction; and T_g = geomembrane tension component induced by gravity.

The strain component induced by thermal contraction can be calculated using the following equation, which is identical to Equation 58 in the paper by Giroud et al. (1995):

$$\varepsilon_T = \alpha \, (\Gamma - \Gamma_{base}) \tag{4}$$

do the design for the worst case. i.e instability at highest temperature & uplift at lowest temperature

over

where: α = coefficient of thermal contraction of the geomembrane; Γ = temperature of the geomembrane when uplift occurs; and Γ_{base} = temperature of the geomembrane when it rests on the supporting ground without wrinkles and without tension. After determining the strain component induced by thermal contraction, ε_T, the corresponding tension component, T_T, can be obtained using the nonlinear tension-strain curve of the geomembrane as shown in Figure 5.

If the geomembrane tension-strain curve, or a portion of it, can be assumed to be linear, determination of T_T does not require a graphical solution, but it can be estimated using the geomembrane tensile stiffness, J, as follows:

$$T_T = J \, \varepsilon_T \tag{5}$$

The tension component induced by gravity, T_g, is the component of the weight of the geomembrane and of the geomembrane protection layer, if any, in the direction of the slope (see Figure 1). Assuming that a geomembrane is properly anchored at the crest of the slope, the tension component induced by gravity increases from zero at the toe of the slope to a maximum tension at the crest of the slope. In the case of a

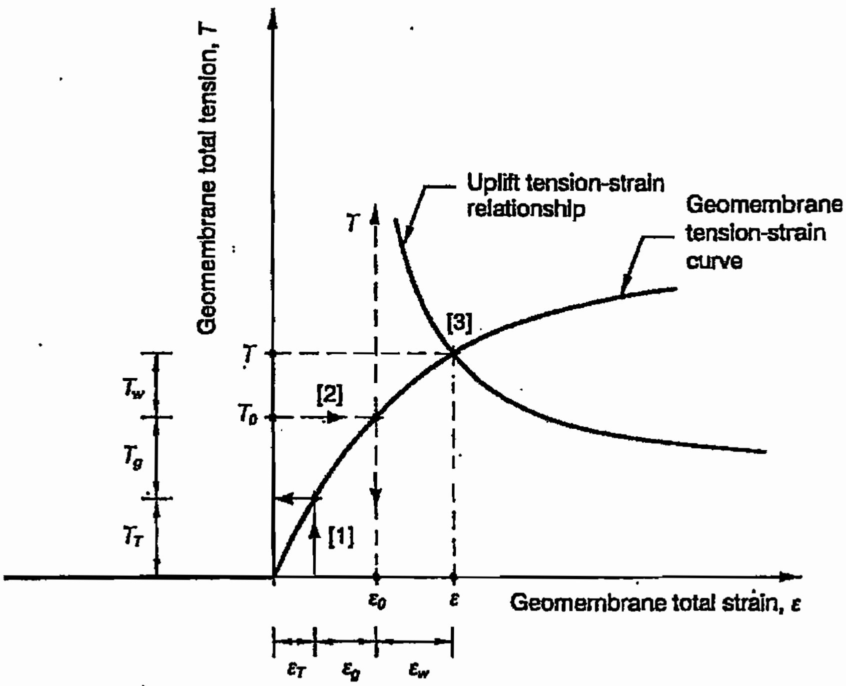

Figure 5. Uplift by wind of a geomembrane with nonlinear tension-strain behavior under initial tension induced by both thermal and gravity sources.

Notes: The nonlinear tension-strain curve is used to graphically define: T_T from the estimated ε_T (see [1] in figure); ε_g from the estimated value of T_g (see [2] in figure); and both T_w and ε_w from superimposing the geomembrane tension-strain curve on the uplift tension-strain curve (see [3] in figure).

geomembrane without a protection layer, the tension component induced by gravity at the crest of a slope of length L is:

$$T_g = \mu_{GM}\, g\, L\, \sin\beta \tag{6}$$

Since the tension component induced by gravity is not uniform along the geomembrane length, the average tension (i.e. half of the tension estimated using Equation 6) would be representative of the average condition of the geomembrane. However, the tension estimated using Equation 6 better represents the most critical section in the geomembrane. After determining the tension component induced by gravity, T_g, the corresponding strain component, ε_g, can be obtained from the nonlinear tension-strain curve of the geomembrane as shown in Figure 5. If the geomembrane tension-strain curve, or a portion of it, can be assumed to be linear, the strain component, ε_g, can be estimated using the geomembrane tensile stiffness, J, as follows:

$$\varepsilon_g = T_g / J \tag{7}$$

The procedure illustrated in Figure 5 assumes that thermal strains occur before the gravity-induced strains. It should be noted, however, that for the case of a geomembrane with a nonlinear tension-strain behavior, a different initial condition (i.e. ε_0 and T_0) would be obtained if the gravity-induced strains were assumed to occur before the thermal strains. The sequence illustrated in Figure 5 implies that gravity-induced strains occur at the moment wind uplift begins (i.e. after the thermal strains) and that, before wind uplift, the component of the geomembrane weight parallel to the slope was carried by shear stresses developed at the interface between the geomembrane and the side slope. A different assumption would be to consider that gravity-induced strains occur during placement of the geomembrane (i.e. before the thermal strains) and that shear stresses between the geomembrane and the side slope were not mobilized after construction. Nevertheless, the same initial condition (i.e. ε_0 and T_0) would be obtained, independently of the sequence in which thermal and gravity-induced strains are assumed to occur, if the geomembrane has a linear tension-strain relationship.

Once the initial state of the geomembrane before uplifting begins (i.e. ε_0 and T_0) has been defined, the geomembrane strain and tension components induced by wind uplift (ε_w and T_w, respectively) can be determined following the procedure described previously in Figure 4. These wind-induced strain and tension components should be obtained graphically if the geomembrane has a nonlinear tension-strain behavior.

If the geomembrane tension-strain curve, or a portion of it, can be assumed to be linear, determination of ε_w does not require a graphical solution, but it can be estimated using the geomembrane tensile stiffness J, the initial tension T_0, the effective suction S_e, and the geomembrane length L by solving the following equation, which is adapted from Equation 57 by Giroud et al. (1995):

$$\frac{S_e L}{2\,(T_0 + J\,\varepsilon_w)} = \sin\left[\frac{S_e L}{2\,(T_0 + J\,\varepsilon_w)}\,(1 + \varepsilon_w)\right] \tag{A-57a}$$

The wind-induced strain component, ε_w, can also be estimated using the geomembrane tensile stiffness J, the initial strain ε_0, and the term $S_e L$ by solving the following equivalent equation:

$$\frac{S_e L}{2J\,(\varepsilon_0 + \varepsilon_w)} = \sin\left[\frac{S_e L}{2J\,(\varepsilon_0 + \varepsilon_w)}\,(1 + \varepsilon_w)\right] \tag{A-57b}$$

Expressions A-57a or A-57b may be solved by trial and error in order to determine ε_w. An initial trial value can be defined using Table 4 from Giroud et al. (1995), which provides ε_w for the case of a geomembrane with a linear tension-strain behavior, but with no wrinkles or tension when uplifting begins ($\varepsilon_0 = 0$ and $T_0 = 0$).

After determining the wind-induced strain component, ε_w, the tension component, T_w, can also be estimated using the geomembrane tensile stiffness, J:

$$T_w = J\,\varepsilon_w \tag{8}$$

Finally, the total strain, ε, and total tension, T, in the geomembrane after wind uplift can be defined from:

$$\varepsilon = \varepsilon_0 + \varepsilon_w \tag{9}$$

$$T = T_0 + T_w \tag{10}$$

5 DESIGN EXAMPLE

Use of the equations presented in this technical note is illustrated in the following example, which evaluates the wind uplift of a geomembrane that is exposed on a steep landfill slope and which is initially under tension induced by both gravity and temperature before uplifting begins. These conditions are based on those considered in the feasibility evaluation of the use of an exposed geomembrane as a final cover for the OII landfill mentioned in Section 1.

Example. A reinforced geomembrane has a linear tension-strain curve characterized by a tensile stiffness of 310 kN/m and a strain at break of 23%. This geomembrane is installed and left exposed as part of the final cover system for a landfill site located 150 m above sea level, in an area where, during a certain season, winds with velocities up to 115 km/h can be expected. The geomembrane is exposed on a steep (1V:1.5H) slope, which is 28 m high between benches. The geomembrane has a mass per unit area of 1.41 kg/m^2 and a coefficient of thermal expansion of $1.2 \times 10^{-4}\ °C^{-1}$. In order to have a factor of safety of 2, the allowable strain is 11.5%. Consider that the geomembrane is under initial tension when uplifting begins due to its own weight and to thermal contraction induced by a temperature change of 50°C. Assuming that the geomembrane is properly anchored at the crest of the slope and that no protective layer is used on top of the geomembrane, predict the total strain and tension in the geomembrane when it is uplifted by the considered wind. Calculate the thickness of a protective layer, with a density of 1600 kg/m^3, which would be required to prevent the uplift of the geomembrane.

The length of geomembrane subjected to wind-generated suction is the length of the slope, which is:

$$L = \sqrt{28^2 + (1.5 \times 28)^2} = 50.5\ \text{m}$$

The slope inclination is:

$$\beta = \tan^{-1}(1/1.5) = 33.69°$$

The initial strain component induced by thermal contraction can be estimated using Equation 4 as follows:

$$\varepsilon_T = (1.2 \times 10^{-4})(50) = 0.0060 = 0.60\%$$

From the estimated strain component, the corresponding tension component induced by thermal contraction can be determined for a geomembrane with a linear tension-strain curve using Equation 5 as follows:

$$T_T = (310)(0.006) = 1.86 \text{ kN/m}$$

The initial tension component induced by gravity at the top of the side slope of length L can be estimated using Equation 6 as follows:

$$T_g = (1.41)(9.81)(50.5) \sin(33.69°) = 387 \text{ N/m} = 0.387 \text{ kN/m}$$

From the estimated tension component, the corresponding strain component induced by gravity can then be determined using Equation 7 as follows:

$$\varepsilon_g = 0.387/310 = 0.00125 = 0.125\%$$

The initial strain and tension in the geomembrane before uplifting begins can be estimated from Equations 2 and 3, respectively, as follows:

$$\varepsilon_0 = 0.600 + 0.125 = 0.73\%$$

$$T_0 = 1.860 + 0.387 = 2.25 \text{ kN/m}$$

use $\lambda = 0.7$
bcs entire slope is considered

A value $\lambda = 0.7$ is recommended by Giroud et al. (1995) for the suction factor if the entire slope is considered, which is the case in this example. Using Equation A-41 presented in the Appendix, the effective suction on the side slope is calculated as follows:

$$S_e = (0.050)(0.7)(115)^2 e^{-(1.252\times10^{-4})(150)} - (9.81)(1.41)\cos(33.69°)$$
$$= 454.26 - 11.51 = 442.75 \text{ Pa}$$

It should be noted that, with $\cos\beta = 1$ instead of $\cos(33.69°) = 0.83$, the error on S_e is only 0.5%. This confirms a comment made in Section 2 that, when the geomembrane weight per unit area is much smaller than the wind generated suction (which is often the case), using $\cos\beta = 1$ does not have a significant impact on the calculated value of the effective suction.

Next, $S_e L$ is calculated as follows:

$$S_e L = (442.75)(50.5) = 22{,}359 \text{ N/m} = 22.36 \text{ kN/m}$$

The strain component induced by wind-generated suction can be calculated using Equation A-57a as follows:

0.01

$$\frac{22.36}{2\,(2.25 + 310\,\varepsilon_w)} = \sin\left[\frac{22.36}{2\,(2.25 + 310\,\varepsilon_w)}\,(1 + \varepsilon_w)\right]$$

0.5494

The equation above must be solved by trial and error in order to obtain ε_w. An initial trial can be defined using Table 4 from Giroud et al. (1995), which solves the wind uplift problem for a geomembrane with a linear tension-strain relationship, but with no wrinkles or tension when uplifting begins. Using a normalized tensile stiffness $(J/S_e L) = (310/22.36) = 13.86$, the initial trial value defined using Table 4 is 6.4%. This initial trial value corresponds to the upper bound of the wind-induced strain on the considered geomembrane, which is under tension when uplifting begins (see Section 3.2). The solution obtained after solving Equation A-57a by trial and error is $\varepsilon_w = 0.0585 = 5.85\%$.

The wind-generated tension component, T_w, can then be estimated using Equation 8 as follows:

$$T_w = (310)(0.0585) = 18.14 \text{ kN/m}$$

Finally, the total tension and strain in the geomembrane when it is uplifted by the considered wind can be estimated using Equations 9 and 10, respectively, as follows:

$$\varepsilon = 0.73 + 5.85 = 6.58\%$$

$$T = 2.25 + 18.14 = 20.39 \text{ kN/m}$$

The total strain in the geomembrane after it has been subjected to wind-generated suction is 6.58%, which is less than the allowable strain of 11.5%. Therefore the geomembrane should not fail in tension when it is uplifted by the wind. Although the total tension, T, in the geomembrane after wind uplift is lower than the allowable tension of the reinforced geomembrane, it is considerably higher than the allowable tensile strength of typical nonreinforced geomembranes. The initial tension, T_0, in the exposed geomembrane before uplifting begins represents 11% of the total tension, T, in the uplifted geomembrane.

The thickness of the protective layer required to prevent uplift by wind of the geomembrane can be calculated using Equation A-33. Considering $\varrho_p = 1600$ kg/m^3, $\mu_{GM} = 1.41$ kg/m^2, $\lambda = 0.7$, $V = 115$ km/h, $\beta = 33.69°$, and $z = 150$ m, the required thickness, t_{req}, is calculated as follows:

$$t_{req} = \frac{1}{1600}\left[-1.41 + 0.005085\ \frac{(0.7)(115)^2}{\cos(33.69°)}\ e^{-1.252\times10^{-4}(150)}\right]$$

hence:

$$t_{req} = \frac{1}{1600}(-1.41 + 55.52) = 0.034\ \text{m} = 34\ \text{mm}$$

It should be noted that, with $\cos\beta = 1$ instead of $\cos(33.69°) = 0.83$, an unconservative value of 28 mm would have been obtained for the required thickness of the protective layer, hence an 18% error. This confirms the comment made in Section 2 that the effect of $\cos\beta$ is particularly significant when calculating the thickness of the protective layer.

Finally, although the static and seismic stability of the 34 mm-thick protective layer on such a steep slope is not addressed herein, it should be recognized as an important design consideration.

END OF EXAMPLE

6 CONCLUSIONS

This technical note presents a revised version of equations as well as an extension of discussions initially presented by Giroud et al. (1995) which analyzes the phenomenon of uplift of geomembranes by wind. The following conclusions are drawn:

- The uplift effect of wind on geomembranes depends on the inclination of the side slope on which the geomembrane is exposed. The effect of the slope inclination is particularly relevant if the slope of the exposed geomembrane is steep and if heavy geomembranes are used. Also, the effect of slope inclination is significant for the calculation of the required thickness of a protective layer on top of the geomembrane to prevent wind uplift. Revised equations are provided to estimate, as a function of the slope inclination, the mass per unit area of geomembrane required to resist wind uplift, the threshold wind velocity below which a geomembrane should not be uplifted by wind, the required thickness of a protective layer that would prevent wind uplift, and the effective suction acting on an exposed geomembrane.
- The "uplift tension-strain relationship" (Equation A-47) that governs the uplift problem relates the geomembrane strain induced exclusively by wind action (and not the total geomembrane strain) to the total tension in the geomembrane induced not only by the wind but also by other sources such as temperature or gravity. Taking into account that the uplift relationship does not refer to the total geomembrane strain, a consistent approach is presented to assess the wind uplift phenomenon accounting for the effect of initial wrinkles or initial tension in the geomembrane.

- The effect of initial strains induced by multiple sources (e.g. temperature, gravity) on the uplift of geomembranes by wind can be evaluated either graphically, if the geomembrane has a nonlinear tension-strain relationship, or analytically, if the geomembrane tension-strain curve can be assumed to be linear. Methods are presented to evaluate the uplift of geomembranes under initial strains induced by multiple sources when uplifting begins.

ACKNOWLEDGMENTS

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REFERENCE

Giroud, J.P., Pelte, T. and Bathurst, R.J., 1995, "Uplift of Geomembranes by Wind", *Geosynthetics International*, Vol. 2, No. 6, pp. 897-952.

NOTATIONS

Basic SI units are given in parentheses.

A	=	area of geomembrane (m^2)
F	=	force applied on geomembrane by uplift suction, defined by Equation 42 of the paper by Giroud et al. (1995) (N/m)
g	=	acceleration due to gravity (m/s^2)
J	=	geomembrane tensile stiffness (N/m)
L	=	length of geomembrane subjected to suction (m)
p_0	=	atmospheric pressure at sea level (Pa)
R	=	radius of circular-shaped uplifted geomembrane (m)
S	=	suction (Pa)
S_e	=	"effective suction" defined by Equation A-35 (Pa)
T	=	total geomembrane tension (N/m)
T_A	=	total tension in uplifted geomembrane for base case (Case A) where geomembrane has no wrinkles and no tension when uplifting begins (N/m)
T_B	=	total tension in uplifted geomembrane that has wrinkles when uplifting begins (Case B) (N/m)

T_C = total tension in uplifted geomembrane that is under tension when uplifting begins (Case C) (N/m)

T_w = geomembrane tension component induced by wind uplift (N/m)

T_g = geomembrane initial tension induced by gravity (N/m)

T_T = geomembrane initial tension induced by temperature changes (N/m)

T_0 = geomembrane initial tension (N/m)

t_{req} = required thickness of protective layer (m)

u = geomembrane uplift (m)

V = wind velocity (m/s)

V_{up} = wind velocity that causes geomembrane uplift (m/s)

W = weight of geomembrane (N)

z = altitude above sea level (m)

α = coefficient of thermal expansion-contraction of geomembrane (°C^{-1})

β = slope inclination (°)

Γ = temperature of geomembrane when uplift occurs (°C)

Γ_{base} = temperature of geomembrane when it rests on supporting ground without wrinkles and without tension (°C)

ε = total geomembrane strain (dimensionless)

ε_T = geomembrane initial strain induced by temperature changes (dimensionless)

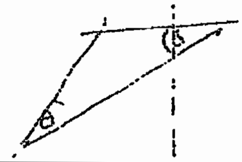
ε_g = geomembrane initial strain induced by gravity forces (dimensionless)

ε_w = geomembrane strain component induced by wind uplift (dimensionless)

ε_{wA} = strain component in uplifted geomembrane for base case (Case A) where geomembrane has no wrinkles and no tension when uplifting begins (dimensionless)

ε_{wB} = strain component in an uplifted geomembrane that has wrinkles when uplifting begins (Case B) (dimensionless)

ε_{wC} = strain component in an uplifted geomembrane that is under tension when uplifting begins (Case C) (dimensionless)



ε_0 = geomembrane initial strain (dimensionless)

θ = angle between extremities of uplifted geomembrane and straight line passing through these extremities (°)

~~λ = suction factor, defined by Equation 13 of the paper by Giroud et al. (1995)~~ (dimensionless)

μ_{GM} = mass per unit area of geomembrane (kg/m^2)

μ_{GMreq} = mass per unit area of geomembrane required to resist wind uplift (kg/m^2)

ρ = air density (kg/m^3)

ρ_P = density of protective layer material (kg/m^3)

ρ_0 = air density at sea level (kg/m^3)

Appendix

The following are revised equations for the evaluation of wind uplift. In order to facilitate cross-referencing between the revised equations in this Appendix and the original equations presented by Giroud et al. (1995), the same numbering sequence is used in the revised and original sets of equations (e.g. Equation A-14 in this Appendix is the revised version of the original Equation 14). Equations presented by Giroud et al. (1995) which have not been revised are not repeated in this Appendix.

A-1 GEOMEMBRANE SENSITIVITY TO WIND UPLIFT(1)

$$(W/A)\cos\beta \geq S \tag{A-14}$$

$$\mu_{GM} \geq \mu_{GMreq} = \lambda \frac{\varrho_o V^2}{2g} e^{-\varrho_o g z/p_o} \frac{1}{\cos\beta} \tag{A-17}$$

$$\mu_{GM} \geq \mu_{GMreq} = 0.0659 \frac{\lambda V^2}{\cos\beta} \tag{A-18}$$

with μ_{GMreq} (kg/m^2) and V(km/h)

$$\mu_{GM} \geq \mu_{GMreq} = 0.005085 \frac{\lambda V^2}{\cos\beta} \tag{A-19}$$

with μ_{GMreq} (kg/m^2) and V(km/h)

$$\mu_{GM} \geq \mu_{GMreq} = 0.0659 \frac{\lambda V^2}{\cos\beta} e^{-(1.252 \times 10^{-4})z} \tag{A-20}$$

with μ_{GMreq}(kg/m^2), V(km/h) and z(m)

$$\mu_{GM} \geq \mu_{GMreq} = 0.005085 \frac{\lambda V^2}{\cos\beta} e^{-(1.252 \times 10^{-4})z} \tag{A-21}$$

with μ_{GMreq}(kg/m^2), V(km/h) and z(m)

$$V \leq V_{up} = \left[\frac{2g\mu_{GM}\cos\beta}{\lambda\, \varrho_o\, e^{-\varrho_o g z/p_o}}\right]^{1/2} \tag{A-22}$$

(Note: Equation 22 in the original paper contained a typographical error, p_o was used instead of ρ_o after λ in the denominator.)

$$V \leq V_{up} = 3.895\sqrt{\mu_{GM}\ \cos\beta/\lambda} \tag{A-23}$$

with V_{up} (m/s) and μ_{GM} (kg/m²)

$$V \leq V_{up} = 14.023\sqrt{\mu_{GM}\ \cos\beta/\lambda} \tag{A-24}$$

with V_{up} (m/s) and μ_{GM} (kg/m²)

$$V \leq V_{up} = 3.895\, e^{(6.259\ \times\ 10^{-5})\, z}\sqrt{\mu_{GM}\ \cos\beta/\lambda} \tag{A-25}$$

with V_{up}(m/s), z(m) and μ_{GM} (kg/m²)

$$V \leq V_{up} = 14.023\, e^{(6.259\ \times\ 10^{-5})\, z}\sqrt{\mu_{GM}\ \cos\beta/\lambda} \tag{A-26}$$

with V_{up}(m/s), z (m) and μ_{GM} (kg/m²)

A-2 REQUIRED UNIFORM PRESSURE TO COUNTERACT WIND UPLIFT[1]

$$(\varrho_P\, g\, t_{req} + \mu_{GM}\, g)\ \cos\beta \geq S \tag{A-28}$$

$$t_{req} \geq \frac{1}{\varrho_P}\left(-\mu_{GM} + \frac{\varrho_o\,\lambda\, V^2}{2g\ \cos\beta}\, e^{-\varrho_o g z/p_o}\right) \tag{A-29}$$

$$t_{req} = \frac{1}{\varrho_P}\left(-\mu_{GM} + 0.0659\,\frac{\lambda V^2}{\cos\beta}\right) \tag{A-30}$$

with t_{req} (m), ϱ_P (kg/m³), μ_{GM} (kg/m²) and V (m/s)

$$t_{req} = \frac{1}{\varrho_P}\left(-\mu_{GM} + 0.005085\,\frac{\lambda V^2}{\cos\beta}\right) \tag{A-31}$$

with t_{req} (m), ϱ_P (kg/m³), μ_{GM} (kg/m²) and V (km/h)

$$t_{req} = \frac{1}{\varrho_P}\left(-\mu_{GM} + 0.0659\,\frac{\lambda V^2}{\cos\beta}\, e^{-(1.252\ \times\ 10^{-4})z}\right) \tag{A-32}$$

with t_{req} (m), ϱ_P (kg/m³), μ_{GM} (kg/m²), V (m/s) and z (m)

$$t_{req} = \frac{1}{\varrho_P}\left(-\mu_{GM} + 0.005085\,\frac{\lambda V^2}{\cos\beta}\, e^{-(1.252\ \times\ 10^{-4})z}\right) \tag{A-33}$$

with t_{req} (m), ϱ_P (kg/m³), μ_{GM} (kg/m²), V (km/h) and z (m)

A-3 EVALUATION OF EFFECTIVE SUCTION(1)

$$S_e = S - \mu_{GM}\, g \cos\beta \tag{A-35}$$

$$S_e = \lambda \varrho (V^2/2) - \mu_{GM}\, g \cos\beta \tag{A-36}$$

$$S_e = \lambda \varrho_o (V^2/2) e^{-\varrho_o g z / p_o} - \mu_{GM}\, g \cos\beta \tag{A-37}$$

$$S_e = 0.6465 \lambda V^2 - 9.81 \mu_{GM} \cos\beta \tag{A-38}$$
with S_e(Pa), V(m/s) and μ_{GM}(kg/m²)

$$S_e = 0.050 \lambda V^2 - 9.81 \mu_{GM} \cos\beta \tag{A-39}$$
with S_e(Pa), V(km/h) and μ_{GM}(kg/m²)

$$S_e = 0.6465 \lambda V^2 e^{-(1.252 \times 10^{-4})z} - 9.81 \mu_{GM} \cos\beta \tag{A-40}$$
with S_e(Pa), V(m/s), z(m) and μ_{GM}(kg/m²)

$$S_e = 0.050 \lambda V^2 e^{-(1.252 \times 10^{-4})z} - 9.81 \mu_{GM} \cos\beta \tag{A-41}$$
with S_e(Pa), V(km/h), z(m) and μ_{GM}(kg/m²)

A-4 DETERMINATION OF GEOMEMBRANE TENSION AND STRAIN(2)

$$1 + \varepsilon_w = \frac{\text{arc AB}}{L} = \frac{2R\theta}{2R\sin\theta} \tag{A-45}$$

$$\varepsilon_w = \frac{\theta}{\sin\theta} - 1 \tag{A-46}$$

$$\varepsilon_w = \frac{2T}{S_e L} \sin^{-1}\left[\frac{S_e L}{2T}\right] - 1 \tag{A-47}$$
with $T = T_0 + T_w$

$$\varepsilon_w = \frac{1}{2}\left(\frac{2u}{L} + \frac{L}{2u}\right) \sin^{-1}\left[\frac{2}{\frac{2u}{L} + \frac{L}{2u}}\right] - 1 \tag{A-51}$$

$$\frac{S_e L}{2(T_o + J\varepsilon_w)} = \sin\left[\frac{S_e L}{2(T_o + J\varepsilon_w)}(1 + \varepsilon_w)\right] \qquad \text{(A-57a)}$$

$$\frac{S_e L}{2J(\varepsilon_o + \varepsilon_w)} = \sin\left[\frac{S_e L}{2J(\varepsilon_o + \varepsilon_w)}(1 + \varepsilon_w)\right] \qquad \text{(A-57b)}$$

Notes: (1) The revised equations incorporate the effect of slope inclination β through a term $\cos\beta$ that did not exist in the original equations. Also, the notation t_{req} is used, instead of D_{req} in the original paper, to make it clear that the dimension of the protective layer that is being calculated is the thickness (measured perpendicularly to the slope), whereas the notation D is commonly used for the depth (measured vertically). For horizontal slopes ($\beta = 0$) the revised equations are the same as those presented by Giroud et al. (1995).

(2) The revised equations incorporate considerations discussed in Section 3.1 of this technical note regarding the "uplift tension-strain" relationship, which relates the wind-induced strain component, ε_w, to the total tension, T, in the geomembrane ($T = T_o + T_w$). If the initial strain, ε_o, and initial tension, T_o, in the geomembrane are zero (i.e. if the total strain, $\varepsilon = \varepsilon_w$, and the total tension, $T = T_w$), the revised equations are the same as those presented by Giroud et al. (1995).

REFERENCE 6
STORMWATER ANALYSIS

Project: Sarasota Phase I Closure	Computed: CAR	Date: 2/9/09
Subject: Stormwater Analysis	Checked: IRF	Date: 2/18/10
Task: Drainage Terrace Capacity (EGC)	Page: 1	of:
Job #:	No:	

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Purpose: Verify proposed terrace for temporary final cover is adequate to contain 25 yr design storm.

Assumptions: - Largest contributing area = 1.2 acre (attachment A)
- Use procedures in FDOT manual
- Design for 25 yr storm.

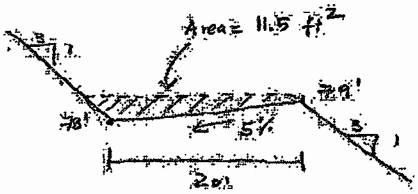
1. Determine max. flow rate terrace:
Use rational formula to determine 25 yr design rate terrace
$Q = CIA$.

Q = peak runoff, cfs
C: runoff coefficient → 0.95 max. steep slope (attachment B)
adjust by 1.1 for 25 yr return period (attachment C)
$C = 0.95(1.1) = 1.045$
I = rainfall intensity = 9.0 in/hr (25 yr return period) (attachment D-1/D-2)

$Q_{25} = 1.045(9)(1.2) = 11.3$ cfs

2. Determine capacity of drainage terrace:
Use manning equation $Q = \frac{1.49}{n} A R_h^{2/3} S^{1/2}$

Q = flow rate, cfs
n = roughness coefficient = 0.020 (use concrete paved) (attachment E)
A = flow area of terrace (assume flowing full)



R_h = hydraulic radius = $\frac{A}{W}$

W = wetted perimeter

$W = 23.2$ ft

$R_h = \frac{11.5}{23.2} = 0.5$ ft

$S = 2\%$ (along terrace)

Project: Sarasota Phase I Closure	Computed: CAR	Date: 2/9/09
Subject: Stormwater Analysis	Checked:	Date:
Task: Drainage Terrace Capacity (E&C)	Page: 2	of:
Job #:	No:	

HDR | ONE COMPANY *Many Solutions*

$$Q = \frac{1.49}{0.020} \times 11.5 \times 0.5^{2/3} \times 0.02^{1/2}$$

$Q = 76.3$ cfs

3. Check flow velocity in terrace

$V = Q/A = 76.3/11.5 = 6.6$ fps

Geomembrane is not erodible, therefore a max. velocity is not a limiting factor.

4. Verify 18" dia. ADS inlet have sufficient capacity

Conservatively assume inlet characteristics are similar to concrete pipe with groove end with headwall. Since pipe slopes steeply after inlet, Inlet controls flow. Assume headwater (HW) is allowed to come to top of pipe. (HW/D = 1)

Q_{pipe} = 7 cfs for 18" dia and HW/D = 1 attachment F

Q_{25} = 12.42 cfs

Factor of Safety = 14/11.3 = 1.2

18" dia. pipes at the terrace will discharge into a 24" dia pipe. Therefore proposed design is adequate. attachment G

T:\Documents and Settings\crestrep\Desktop\FCO Sarasota Phase I Closure\HDR REVISED SEQUENCING FINAL BUILDOUT CONTOURS AND ROA

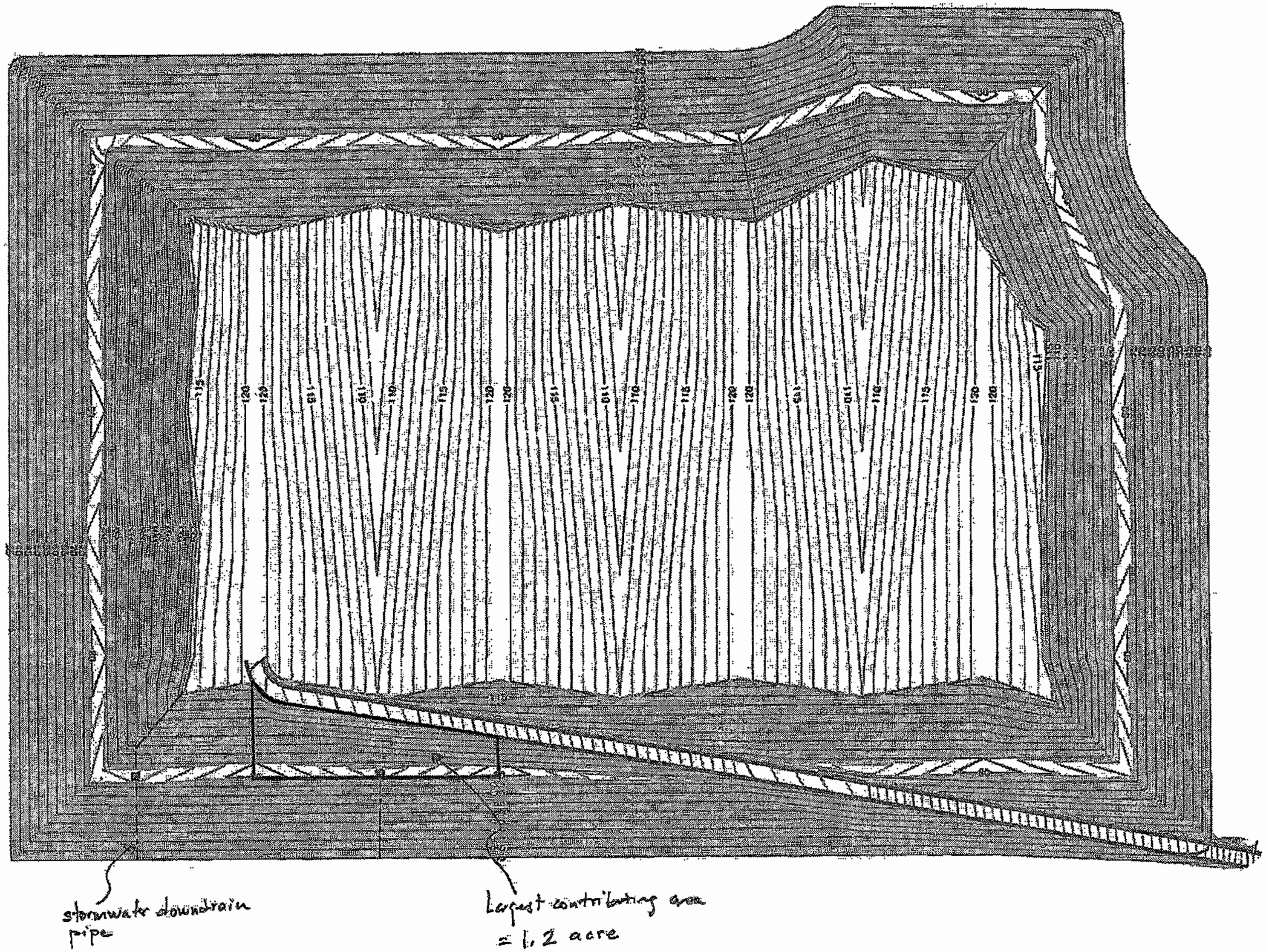


Table 5-5
RUNOFF COEFFICIENTS[a] FOR A DESIGN STORM RETURN
PERIOD OF 10 YEARS OR LESS

Slope	Land Use	Sandy Soils Min.	Sandy Soils Max.	Clay Soils Min.	Clay Soils Max.
Flat (0-2%)	Woodlands	0.10	0.15	0.15	0.20
	Pasture, grass, and farmland[b]	0.15	0.20	0.20	0.25
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements[c]	0.75	0.95	0.90	0.95
	SFR: ½-acre lots and larger	0.30	0.35	0.35	0.45
	Smaller lots	0.35	0.45	0.40	0.50
	Duplexes	0.35	0.45	0.40	0.50
	MFR: Apartments, townhouses, and condominiums	0.45	0.60	0.50	0.70
	Commercial and Industrial	0.50	0.95	0.50	0.95
Rolling (2-7%)	Woodlands	0.15	0.20	0.20	0.25
	Pasture, grass, and farmland[b]	0.20	0.25	0.25	0.30
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements[c]	0.80	0.95	0.90	0.95
	SFR: ½-acre lots and larger	0.35	0.50	0.40	0.55
	Smaller lots	0.40	0.55	0.45	0.60
	Duplexes	0.40	0.55	0.45	0.60
	MFR: Apartments, townhouses, and condominiums	0.50	0.70	0.60	0.80
	Commercial and Industrial	0.50	0.95	0.60	0.95
Steep (7%+)	Woodlands	0.20	0.25	0.25	0.30
	Pasture, grass, and farmland[b]	0.25	0.35	0.30	0.40
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements[c]	0.85	0.95	0.90	0.95
	SFR: ½-acre lots and larger	0.40	0.55	0.50	0.65
	Smaller lots	0.45	0.60	0.55	0.70
	Duplexes	0.45	0.60	0.55	0.70
	MFR: Apartments, townhouses, and condominiums	0.60	0.75	0.65	0.85
	Commercial and Industrial	0.60	0.95	0.65	0.95

[a] Weighted coefficient based on percentage of impervious surfaces and green areas must be selected for each site.

[b] Coefficients assume good ground cover and conservation treatment.

[c] Depends on depth and degree of permeability of underlying strata.

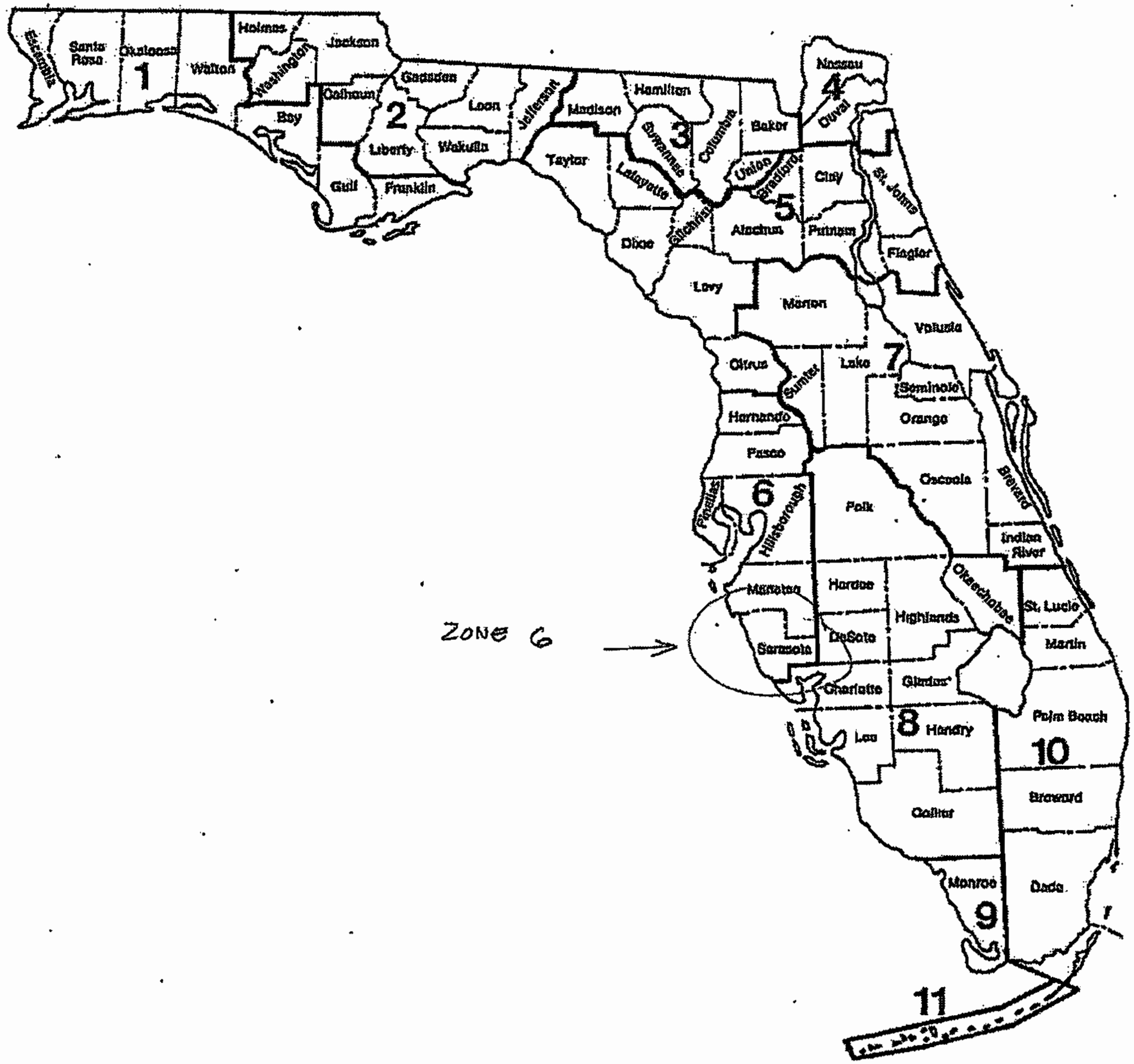
Note: SFR = Single Family Residential
MFR = Multi-Family Residential

(c)

Table 5-6
DESIGN STORM FREQUENCY FACTORS
FOR PERVIOUS AREA RUNOFF COEFFICIENTS

Return Period (years)	Design Storm Frequency Factor, X_T
2 to 10	1.0
25	1.1
50	1.2
100	1.25

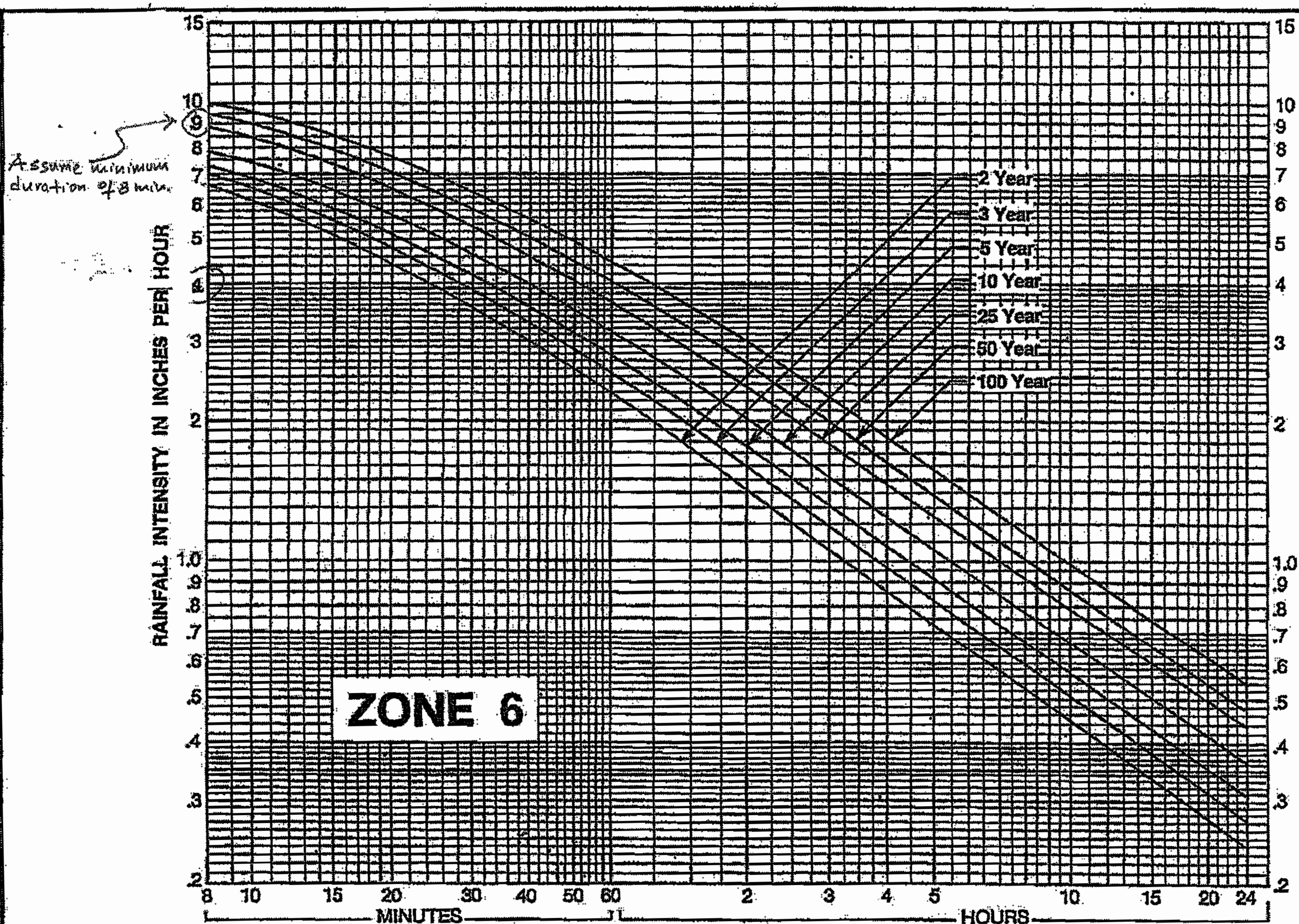
Reference: Wright-McLaughlin Engineers (1969).



ZONE 6 →

FIGURE 5-1
Zones for Precipitation Intensity-Duration-Frequency (IDF) Curves Developed by the Department

D-1



DURATION

FIGURE 5-7
Rainfall Intensity-Duration-Frequency Curves for Zone 6

Table 7-3
RECOMMENDED MANNING'S n VALUES FOR ARTIFICIAL CHANNELS
WITH BARE SOIL AND VEGETATIVE LININGS

Channel Lining	Description	Design Manning's n Value
Bare Earth, Fairly Uniform	Clean, recently completed	0.022
Bare Earth, Fairly Uniform	Short grass and some weeds	0.028
Dragline Excavated	No vegetation	0.030
Dragline Excavated	Light brush	0.040
Channels not Maintained	Dense weeds to flow depth	0.10
Channels not Maintained	Clear bottom, brush sides	0.08
Maintained Grass or Sodded Ditches	Good stand, well maintained 2" - 6"	0.06*
Maintained Grass or Sodded Ditches	Fair strand, length 12" - 24"	0.20*

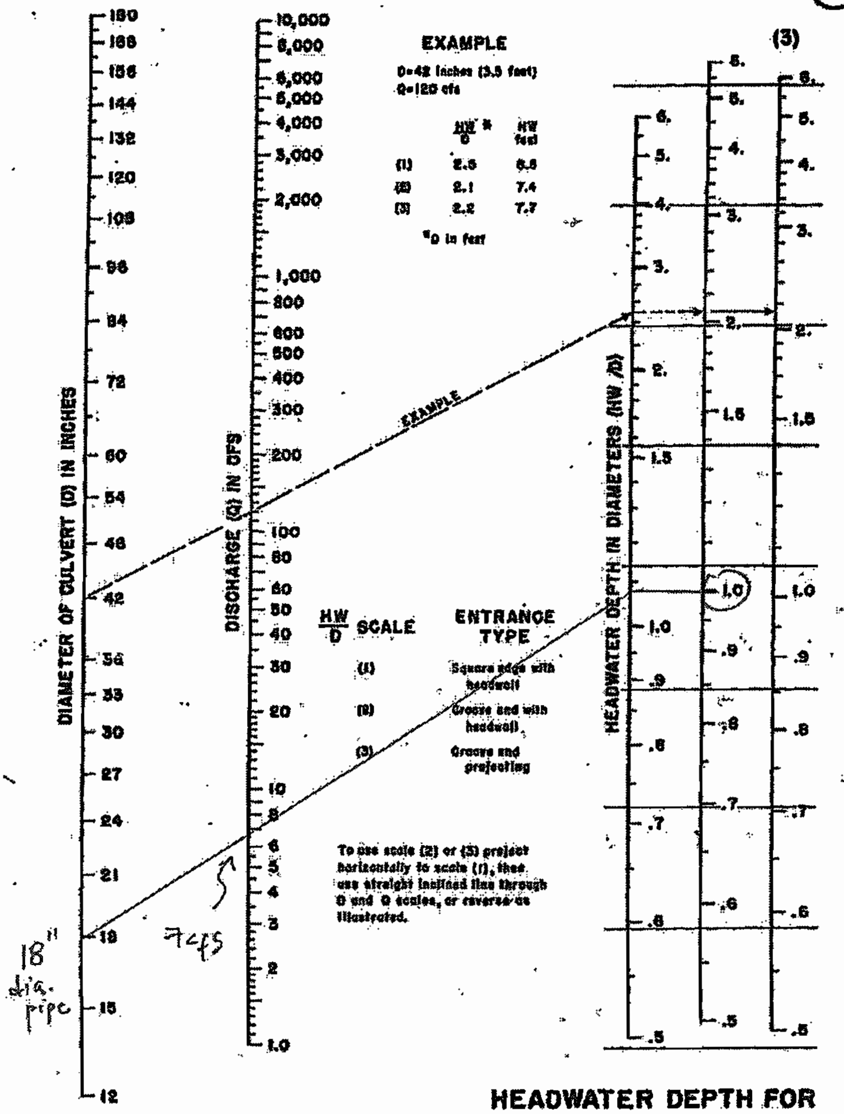
*Decrease 30 percent for flows >0.7' depth (maximum flow depth 1.5').

Table 7-4
RECOMMENDED MANNING'S n VALUES FOR
ARTIFICIAL CHANNELS WITH RIGID LININGS

Channel Lining	Finish Description	Design Manning's n Value
Concrete Paved	Broomed*	0.016
Concrete Paved	"Roughened" - Standard	0.020
Concrete Paved	Gunite	0.020
Concrete Paved	Over rubble	0.023
Asphalt Concrete	Smooth	0.013
Asphalt Concrete	Rough	0.016

*Because this is not the standard finish, it must be specified (see Section 5.24-7 of Standard Specifications).

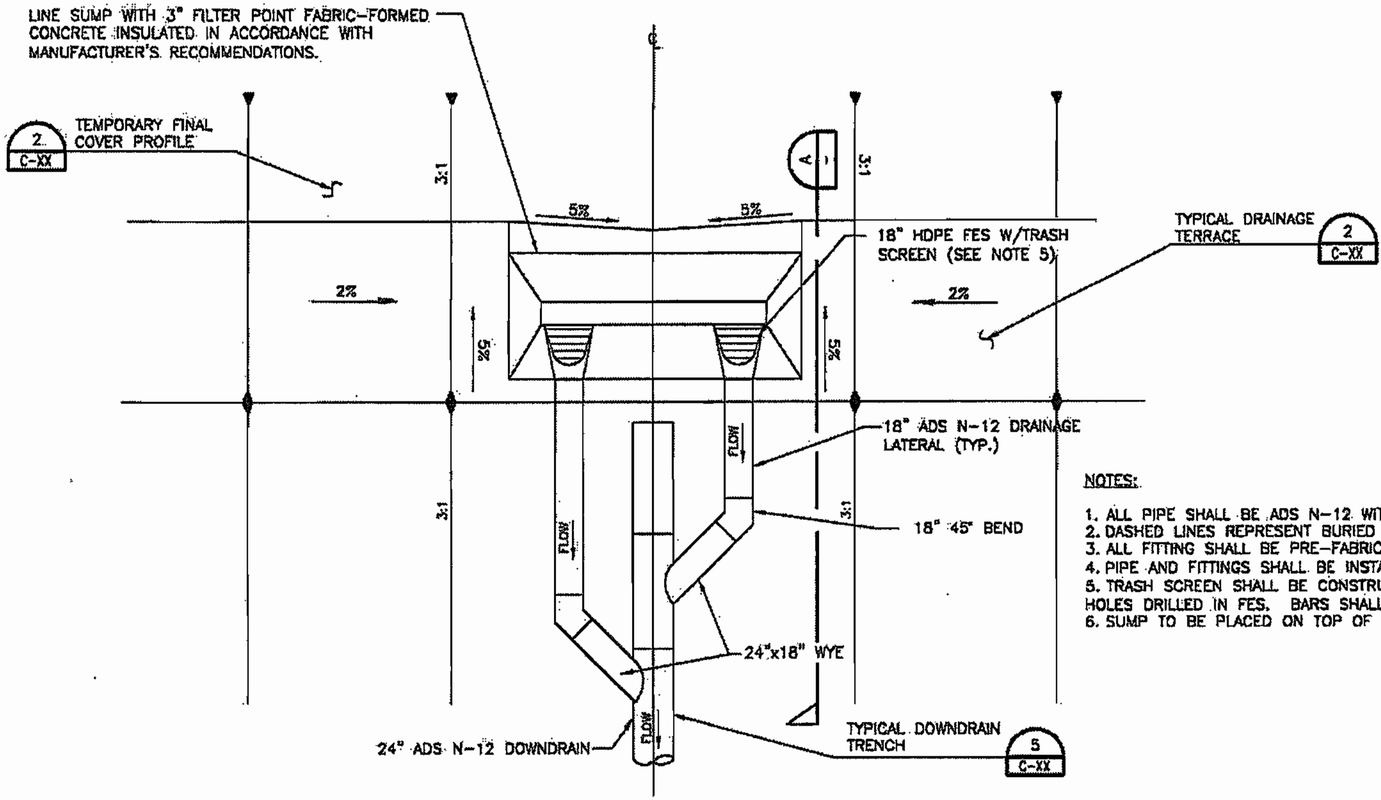
CHART 1B



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL



NOTES:

1. ALL PIPE SHALL BE ADS N-12 WITH WATER TIGHT JOINTS.
2. DASHED LINES REPRESENT BURIED PIPE.
3. ALL FITTING SHALL BE PRE-FABRICATED.
4. PIPE AND FITTINGS SHALL BE INSTALLED TO MANUFACTURER'S RECOMMENDATIONS.
5. TRASH SCREEN SHALL BE CONSTRUCTED FROM 1/2" DIA REBAR INSERTED THROUGH HOLES DRILLED IN FES. BARS SHALL BE 6" OC AND HELD IN PLACE WITH LOCKNUTS.
6. SUMP TO BE PLACED ON TOP OF TEMPORARY FINAL COVER LINER.

PLAN VIEW

TERRACE / DOWNDRAIN INTERSECTION (SOUTH SLOPE)

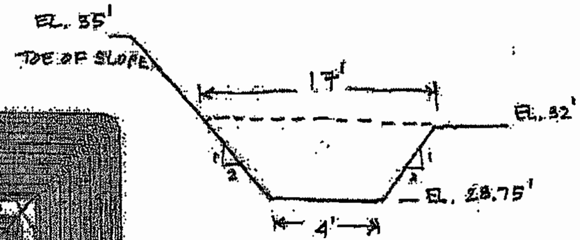
NOT TO SCALE

2
C-XX

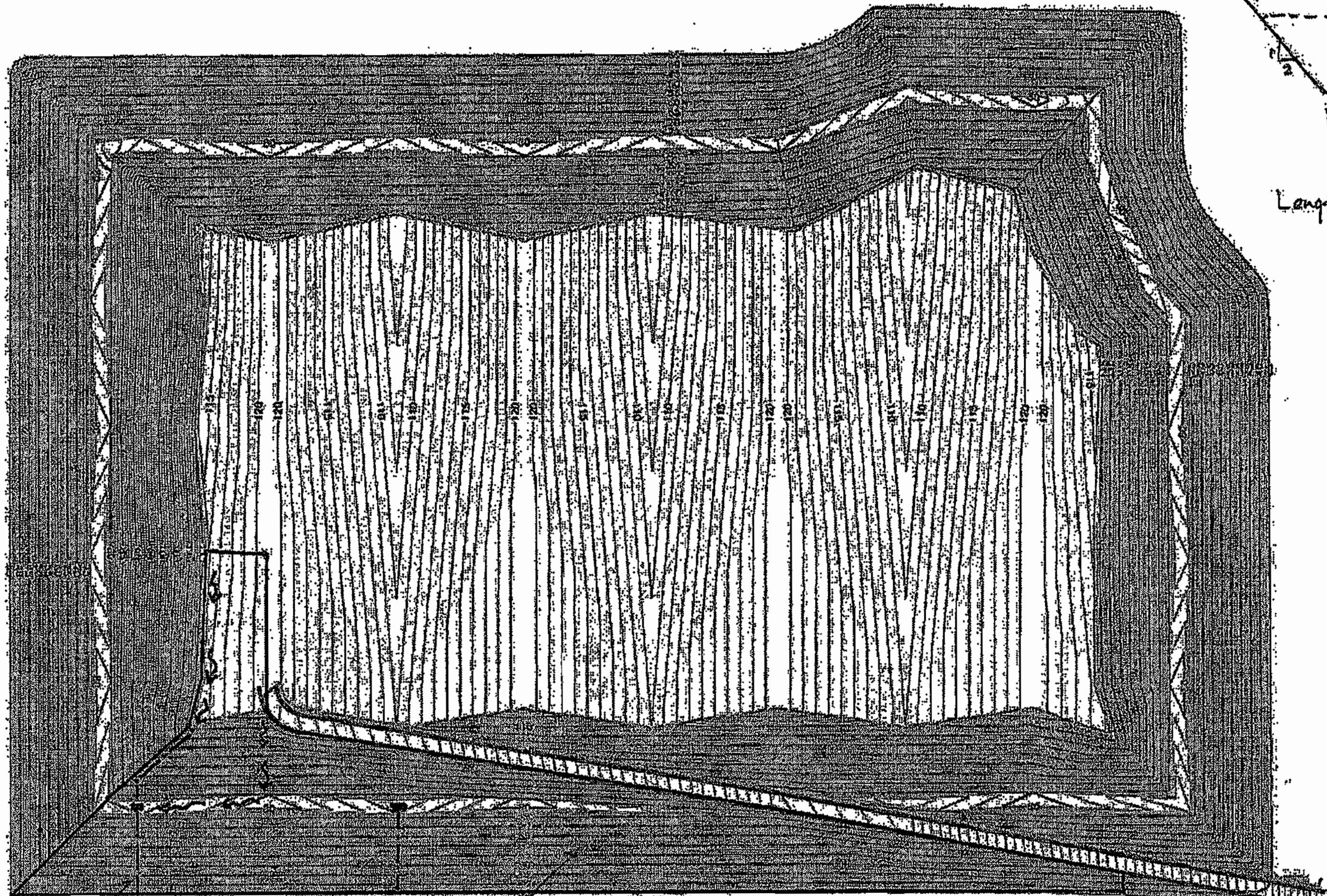
G:\Solid Waste\Sarasota CC SWDC\Phase I Closure\CAD Drawings\Sheets\EGC sheets\00C-09.dwg, 2/16/2009 10:32:58 AM, crestrep, 1:1.07

REFERENCE 7
STORMWATER SWALE ANALYSIS

SOUTH PERIMETER SWALE
CROSS SECTION



Length of swale = 1670 ft.



Stormwater downdrain

Contributing area to
south perimeter swale
= 7.5 acre

Pervious area = 0.65 acre (top of landfill) CN = 79
Impervious area = 6.85 acre (Liner). CN = 98

7.5 acre

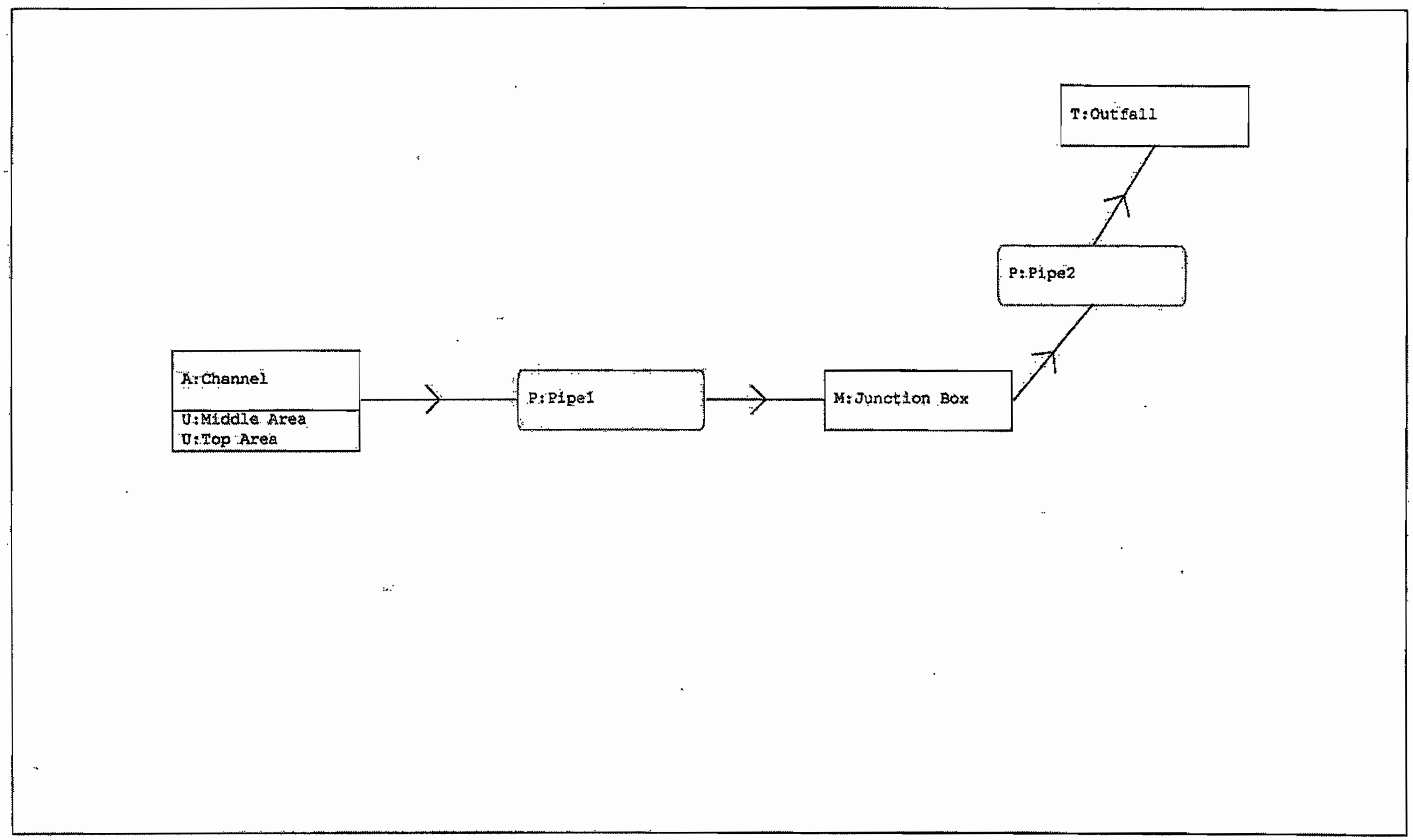
QC JRF 2/19/10

C:\Documents and Settings\...\Desktop\EEC Sarasota Phase I Closure\HDR REVISED SEQUENCING FINAL BUILDOUT CONTOURS AND RDA

Nodes
A Stage/Area
V Stage/Volume
T Time/Stage
M Manhole

Basins
O Overland Flow
U SCS Unit CN
S SBUH CN
Y SCS Unit GA
Z SBUH GA

Links
P Pipe
W Weir
C Channel
D Drop Structure
B Bridge
R Rating Curve
H Breach
E Percolation
F Filter
X Exfil Trench



CAR

Sarasota Phase I Closure
South Perimeter Swale
Sarasota County, Florida

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n		End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)	
Top Area									
SHEET	100	0.0038	0.150	← grass-range short				0.280	
SHALLOW	163	0.0038	0.050	← unpaved				0.046	
SHALLOW	308	0.3300	0.025	← paved				0.007	
					Time of Concentration			0.333	← 19.98 min.
Mid Area									
SHEET	100	0.3300	0.011	← smooth surface				0.006	
SHALLOW	42	0.3300	0.025	← paved				0.001	
SHALLOW	200	0.0200	0.025	← paved				0.019	
CHANNEL	140	0.3300							
					Time of Concentration			0.100	← 6 min.

Basins

Name: Middle Area
Group: BASE
Node: Channel
Type: SCS Unit Hydrograph CN
Status: Onsite

Unit Hydrograph:	Uh484	Peaking Factor:	484.0
Rainfall File:	Flmod	Storm Duration(hrs):	24.00
Rainfall Amount(in):	8.000	Time of Conc(min):	6.00
Area(ac):	6.850	Time Shift(hrs):	0.00
Curve Number:	98.00	Max Allowable Q(cfs):	999999.000
DCIA(%):	0.00		

contributing area to south channel (area covered with 60 mil HDPE geomembrane liner)

Name: Top Area
Group: BASE
Node: Channel
Type: SCS Unit Hydrograph CN
Status: Onsite

Unit Hydrograph:	Uh256	Peaking Factor:	256.0
Rainfall File:	Flmod	Storm Duration(hrs):	24.00
Rainfall Amount(in):	8.000	Time of Conc(min):	19.98
Area(ac):	0.650	Time Shift(hrs):	0.00
Curve Number:	79.00	Max Allowable Q(cfs):	999999.000
DCIA(%):	0.00		

contributing area to south channel (area top of landfill with typical cover)

Nodes

Name: Channel
Group: BASE
Type: Stage/Area
Base Flow(cfs): 0.000
Init Stage(ft): 28.750
Warn Stage(ft): 32.000

South Channel with 2:1 slopes.
Bottom elevation at 28.75 ft.
Maximum Elevation at 32 ft.

Stage(ft)	Area(ac)
28.750	0.1530
32.000	0.6520

Name: Junction Box
Group: BASE
Type: Manhole, Flat Floor
Base Flow(cfs): 0.000
Plunge Factor: 1.00
Init Stage(ft): 26.500
Warn Stage(ft): 32.000

Junction Box - 8ft diameter
Bottom elevation at 26 ft (26.5 ft inside bottom)
Maximum elevation at 32 ft

Stage(ft)	Area(ac)
26.500	0.0012
32.000	0.0012

Name: Outfall
Group: BASE
Type: Time/Stage
Base Flow(cfs): 0.000
Init Stage(ft): 21.000
Warn Stage(ft): 32.000

East channel
Bottom Elevation at 21 ft
Maximum Elevation at 32 ft.

Time(hrs)	Stage(ft)
0.00	21.000
24.00	32.000

Pipes

Name: Pipe1
Group: BASE
From Node: Channel
To Node: Junction Box
Length(ft): 163.00
Count: 2
Friction Equation: Automatic
Solution Algorithm: Most Restrictive
Flow: Both
Entrance Loss Coef: 0.00
Exit Loss Coef: 1.00
Bend Loss Coef: 0.00

	UPSTREAM	DOWNSTREAM
Geometry:	Circular	Circular
Span(in):	24.00	24.00
Rise(in):	24.00	24.00
Invert(ft):	28.750	26.500

```
 Manning's N: 0.013000        0.013000                 Outlet Ctrl Spec: Use dc or tw
Top Clip(in): 0.000           0.000                     Inlet Ctrl Spec: Use dc
Bot Clip(in): 0.000           0.000                   Stabilizer Option: None
```

Upstream FHWA Inlet Edge Description:
Circular Concrete: Square edge w/ headwall

Downstream FHWA Inlet Edge Description:
Circular Concrete: Square edge w/ headwall

FDOT Index 250 - Straight Concrete Endwalls - 2 x 24" Concrete Pipes
Connecting South Channel to Concrete Junction Box

```
         Name: Pipe2              From Node: Junction Box       Length(ft): 90.00
        Group: BASE                 To Node: Outfall                 Count: 2
                                                          Friction Equation: Automatic
               UPSTREAM         DOWNSTREAM               Solution Algorithm: Most Restrictive
     Geometry: Circular         Circular                               Flow: Both
     Span(in): 24.00            24.00                    Entrance Loss Coef: 0.20
     Rise(in): 24.00            24.00                        Exit Loss Coef: 1.00
   Invert(ft): 26.500           24.000                       Bend Loss Coef: 0.22
  Manning's N: 0.013000         0.013000                   Outlet Ctrl Spec: Use dc or tw
 Top Clip(in): 0.000            0.000                       Inlet Ctrl Spec: Use dc
 Bot Clip(in): 0.000            0.000                     Stabilizer Option: None
```

Upstream FHWA Inlet Edge Description:
Circular Concrete: Groove end projecting

Downstream FHWA Inlet Edge Description:
Circular Concrete: Square edge w/ headwall

2 x 24" RCP connecting junction box to east channel.
FDOT Index 250 - straight concrete endwalls

==== Hydrology Simulations ====

```
         Name: channel
     Filename: C:\Program Files\Icpr3\Sarasota Phase I Closure - South Swale\channel.R32

      Override Defaults: Yes
    Storm Duration(hrs): 24.00
         Rainfall File: Flmod
    Rainfall Amount(in): 8.00
```

Time(hrs)	Print Inc(min)
24.000	5.00

==== Routing Simulations ====

```
         Name: channel             Hydrology Sim: channel
     Filename: C:\Program Files\Icpr3\Sarasota Phase I Closure - South Swale\channel.I32

      Execute: Yes          Restart: No           Patch: No
  Alternative: No

       Max Delta Z(ft): 1.00                       Delta Z Factor: 0.00500
    Time Step Optimizer: 10.000
        Start Time(hrs): 0.000                      End Time(hrs): 24.00
     Min Calc Time(sec): 0.5000                Max Calc Time(sec): 24.0000
        Boundary Stages:                           Boundary Flows:
```

Time(hrs)	Print Inc(min)
24.000	15.000

Group	Run
BASE	Yes

Simulation	Basin	Group	Time Max hrs	Flow Max cfs	Volume in	Volume ft3
channel	Middle Area	BASE	12.00	41.16	7.750	192704
channel	Top Area	BASE	12.12	1.84	5.504	12987

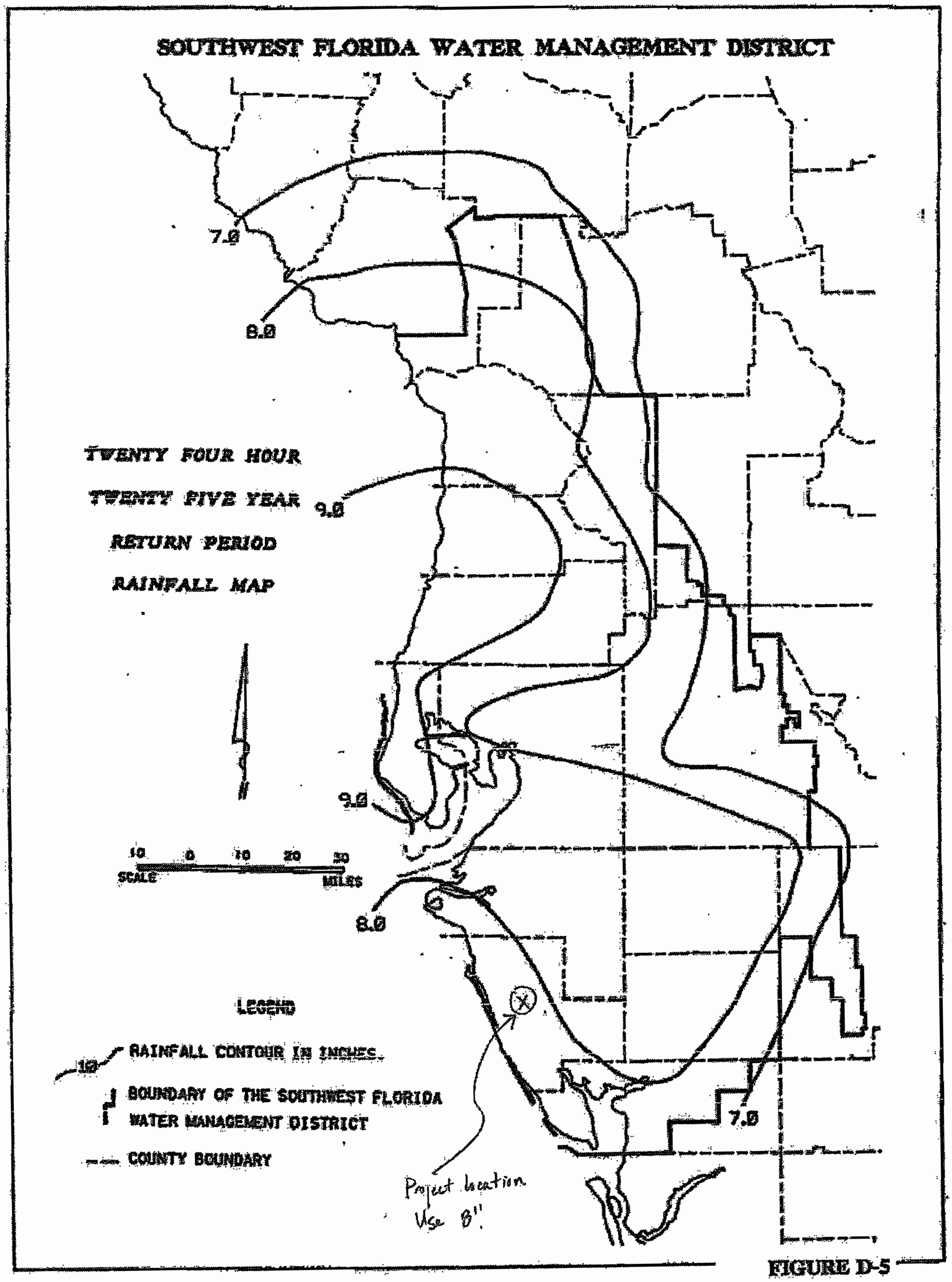
Name	Group	Simulation	Max Time Flow hrs	Max Flow cfs	Max Delta Q cfs	Max Time US Stage hrs	Max US Stage ft	Max Time DS Stage hrs	Max DS Stage ft
Pipe1	BASE	channel	12.07	29.78	-3.266	24.00	31.98	24.00	31.99
Pipe2	BASE	channel	12.08	29.77	4.836	24.00	31.99	24.00	32.00

Name	Group	Simulation	Max Time Stage hrs	Max Stage ft	Warning Stage ft	Max Delta Stage ft	Max Surf Area ft2	Max Time Inflow hrs	Max Inflow cfs	Max Ou
Channel	BASE	channel	24.00	31.98	32.00	0.0050	28294	12.00	42.70	
Outfall	BASE	channel	24.00	32.00	32.00	0.0031	9	12.08	29.77	

MAX. WATER ELEVATION ≤ 32 FT.

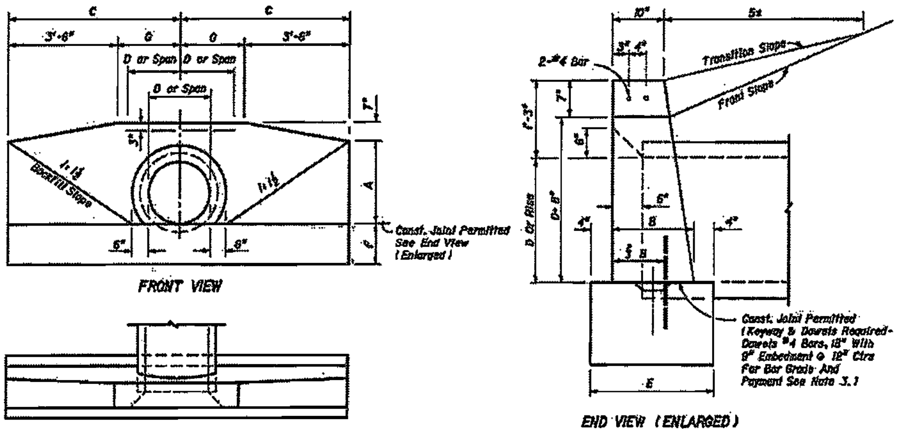
ROAD ELEVATION AT 32 FT.

DESIGN ADEQUATE FOR 25 YR-24 HR STORM.

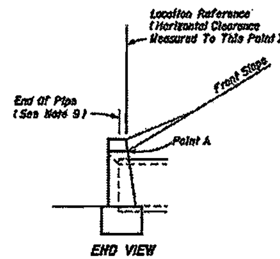


SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
7.0
8.0
TWENTY FOUR HOUR
TWENTY FIVE YEAR
RETURN PERIOD
RAINFALL MAP
9.0
9.0
10 0 10 20 30
SCALE
MILES
8.0
LEGEND
10 RAINFALL CONTOUR IN INCHES.
BOUNDARY OF THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
COUNTY BOUNDARY
7.0
Project location
Use 8"

FIGURE D-5



ENDWALL DIMENSIONS (EXCLUSIVE OF MULTIPLE PIPE SPACING)



1. Position is set by the intersection of the front slope and Point A where this intersection falls outside the clear zone.

2. Where the front slope and Point A intersects inside the clear zone, the endwall is positioned so the location reference point is at the clear zone limit. The front slope is transitioned to the endwall as shown in Index No. 280.

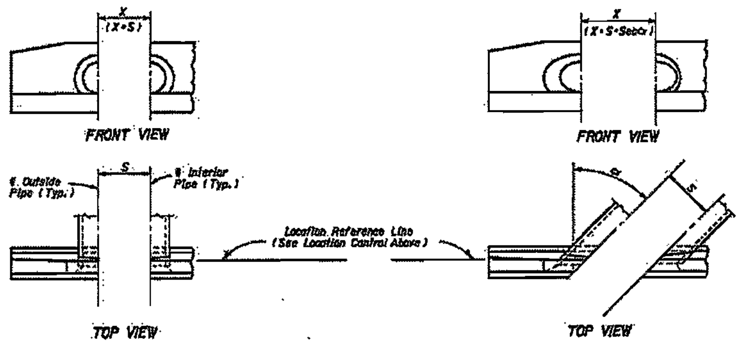
STANDARD LOCATION CONTROL

GENERAL NOTES

1. Endwall dimensions, locations and positions are for round and elliptical concrete pipe and for round and pipe-arch corrugated metal pipe. Round concrete pipe shown.
2. Front slope and ditch transitions shall be in accordance with Index No. 280.
3. Endwalls may be cast in place or precast concrete. Reinforcing steel shall be Grades 40 or 60. Additional reinforcement necessary for handling precast units shall be determined by the Contractor or the supplier. Cost of reinforcement shall be included in the contract unit price for concrete, (endwalls).
4. All exposed corners and edges of concrete are to be chamfered [illegible].
5. Concrete meeting the requirements of ASTM C478 (4000 psi) may be used in lieu of Class I concrete in precast items manufactured in plants which are under the Standard Operating Procedures for the Inspection of precast drainage products.
6. On outfall ditches with side slopes flatter than 1:1½ provide 20' transitions from the endwall to the flatter side slopes, right of way permitting.
7. For sodding around endwalls see Index No. 281.
8. Payment for concrete quantities for endwalls skewed to the pipe shall be made on the following basis:

Endwall Skew To Pipe	Use Tabulated Value
0° to 5°	0°
6° to 15°	15°
16° to 30°	30°
31° or over	45°

9. Pipe length plan quantities shall be based on the pipe end locations shown in the standard location control end view, or lengths based on special endwall locations called for in the plans.
10. Payment for pipe in pipe culverts shall be based on plan quantities, adjusted for endwall locations subsequently established by the Engineer.
11. Endwalls to be paid for under the contract unit price for Class I Concrete (Endwalls), CY.



NORMAL PIPE

SKEWED PIPE

LEGEND

- α Pipe Skew
- S Center To Center Pipe Spacing
- X Centerline To Centerline Dimension At Face Of Headwall

ENDWALL POSITIONS FOR SINGLE AND MULTIPLE PIPE AND SPACING FOR MULTIPLE PIPE

2006 FDOT Design Standards	Last Revision	Sheet No.
STRAIGHT CONCRETE ENDWALLS SINGLE AND MULTIPLE PIPE	04	1 of 2
	Index No.	250

DATA AND ESTIMATED QUANTITIES FOR ONE ENDWALL

ROUND CONCRETE AND CORRUGATED METAL PIPE

D	Opening Area (SF) Number Of Pipes 1	2	3	4	Dimensions A	B	C	E	F	G	S	X 0°	15°	30°	45°
15"	1.23	2.46	3.69	4.92	1'-8"	1'-2"	4'-0"	1'-10"	1'-2"	0'-6"	2'-7"	2'-7"	2'-8"	3'-0"	3'-8"
18"	1.77	3.54	5.31	7.08	2'-2"	1'-3"	4'-6"	1'-8"	1'-3"	1'-0"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"
21"	2.41	4.82	7.23	9.64	2'-5"	1'-4"	5'-0"	2'-0"	1'-4"	1'-6"	3'-2"	3'-2"	3'-3"	3'-8"	4'-6"
24"	3.14	6.28	9.42	12.56	2'-8"	1'-4"	5'-6"	2'-0"	1'-4"	2'-0"	3'-3"	3'-5"	3'-6"	3'-11"	4'-10"
27"	3.98	7.96	11.94	15.92	2'-11"	1'-5"	6'-0"	2'-1"	1'-5"	2'-6"	3'-10"	3'-10"	4'-0"	4'-5"	5'-3"
30"	4.91	9.82	14.73	19.64	3'-2"	1'-6"	6'-6"	2'-2"	1'-6"	3'-0"	4'-3"	4'-3"	4'-5"	4'-11"	6'-0"
36"	7.07	14.14	21.21	28.28	3'-8"	1'-8"	7'-6"	2'-4"	1'-8"	4'-0"	5'-1"	5'-1"	5'-3"	5'-10"	7'-2"
42"	9.62	19.24	28.86	38.48	4'-2"	1'-10"	8'-6"	2'-6"	2'-0"	5'-0"	6'-0"	6'-0"	6'-3"	6'-11"	8'-6"
48"	12.57	25.14	37.71	50.28	4'-8"	2'-1"	9'-6"	2'-9"	2'-0"	6'-0"	6'-9"	6'-9"	7'-0"	7'-10"	9'-7"
54"	15.90	31.80	47.70	63.60	5'-2"	2'-6"	10'-6"	3'-2"	2'-3"	7'-0"	7'-8"	7'-8"	7'-11"	8'-10"	10'-10"

D	Class I Concrete (CY) — Number And Type Of Pipe And Skew Angle Of Pipe: Single Concrete 0°	Single Metal 0°	Double Concrete 0°	15°	30°	45°	Double Metal 0°	15°	30°	45°	Triple Concrete 0°	15°	30°	45°	Triple Metal 0°	15°	30°	45°	Quadruple Concrete 0°	15°	30°	45°	Quadruple Metal 0°	15°	30°	45°	D
15"	1.23	1.24	1.59	1.60	1.65	1.74	1.62	1.63	1.68	1.78	1.94	1.98	2.05	2.23	1.99	2.02	2.11	2.30	2.30	2.34	2.47	2.74	2.37	2.41	2.75	2.84	15"
18"	1.56	1.59	1.99	2.01	2.06	2.17	2.04	2.06	2.11	2.23	2.43	2.46	2.56	2.78	2.51	2.54	2.68	2.89	2.88	2.91	3.06	3.40	2.96	3.01	3.17	3.53	18"
21"	1.87																										21"
24"	2.24	2.29	2.82	2.84	2.91	3.06	2.91	2.93	3.01	3.17	3.39	3.43	3.57	3.87	3.52	3.56	3.71	4.03	3.97	4.03	4.24	4.69	4.14	4.20	4.43	4.91	24"
27"	2.73																										27"
30"	3.26	3.34	4.13	4.16	4.26	4.49	4.28	4.31	4.43	4.67	4.98	5.04	5.25	5.69	5.20	5.27	5.49	5.97	5.84	5.93	6.24	6.91	6.13	6.23	6.56	7.29	30"
36"	4.53	4.64	5.73	5.77	5.92	6.23	5.95	6.00	6.15	6.49	6.92	7.00	7.29	7.91	7.25	7.34	7.65	8.33	8.13	8.26	8.69	9.62	8.57	8.71	9.18	10.20	36"
42"	6.33	6.49	8.11	8.17	8.39	8.85	8.43	8.50	8.73	9.23	9.90	10.02	10.45	11.38	10.38	10.52	10.98	11.99	11.68	11.87	12.51	13.89	12.32	12.52	13.22	14.73	42"
48"	8.15	8.39	10.40	10.48	10.75	11.33	10.85	10.94	11.25	11.87	12.64	12.80	13.34	14.50	13.34	13.51	14.11	15.39	14.89	15.13	15.93	17.68	15.82	16.08	16.97	18.90	48"
54"	11.71	11.77	15.23	15.35	15.78	16.69	15.35	15.48	15.90	16.83	18.77	19.02	19.86	21.69	18.93	19.18	20.04	21.89	22.29	22.66	23.93	26.67	22.51	22.89	24.17	26.96	54"

CORRUGATED METAL PIPE ARCH

Span	Rise	Opening Area (SF) Number Of Pipes 1	2	3	4	Dimensions A	B	C	E	F	G	S	X 0°	15°	30°	45°
17"	13"	1.1	2.2	3.3	4.4	1'-9"	1'-2"	3'-10"	1'-10"	1'-2"	0'-4"	2'-6"	2'-6"	2'-7"	2'-11"	3'-8"
21"	15"	1.6	3.2	4.8	6.4	1'-11"	1'-2"	4'-3"	1'-10"	1'-2"	0'-8"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"
28"	20"	2.8	5.6	8.4	11.2	2'-4"	1'-3"	5'-2"	1'-11"	1'-3"	1'-8"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"
35"	24"	4.3	8.6	12.9	17.2	2'-8"	1'-4"	5'-4½"	2'-0"	1'-4"	2'-5½"	4'-0"	4'-0"	4'-2"	4'-7"	5'-8"
42"	29"	5.9	11.8	17.7	23.6	3'-1"	1'-5"	6'-10½"	2'-1"	1'-5"	3'-4½"	4'-9"	4'-9"	4'-11"	5'-6"	6'-9"
49"	33"	8.4	16.8	25.2	33.6	3'-5"	1'-6"	7'-8"	2'-2"	1'-6"	4'-2"	5'-6"	5'-6"	5'-8"	6'-4"	7'-9"
57"	38"	10.6	21.2	31.8	42.4	3'-10"	1'-7"	8'-7½"	2'-3"	1'-7"	5'-1½"	6'-4"	6'-4"	6'-7"	7'-4"	8'-11"
64"	43"	13.2	26.4	39.6	52.8	4'-3"	1'-8"	9'-6½"	2'-4"	1'-8"	6'-0½"	7'-1"	7'-1"	7'-4"	8'-2"	10'-0"
71"	47"	16.9	33.8	50.7	67.6	4'-7"	1'-10"	10'-4"	2'-6"	2'-0"	6'-10"	7'-10"	7'-10"	8'-1"	9'-1"	11'-1"

Span	Class I Concrete (CY) — Number Of Pipe And Skew Angle Of Pipe: Single 0°	Double 0°	15°	30°	45°	Triple 0°	15°	30°	45°	Quadruple 0°	15°	30°	45°	Span	Rise	Approx. Equiv. Round Pipe
17"	1.18	1.47	1.48	1.52	1.60	1.78	1.80	1.83	2.04	2.09	2.12	2.23	2.48	17"	13"	15"
21"	1.33	1.69	1.70	1.75	1.84	2.04	2.06	2.15	2.33	2.40	2.44	2.57	2.84	21"	15"	18"
28"	1.78	2.31	2.33	2.39	2.53	2.83	2.87	2.99	3.26	3.38	3.42	3.60	4.01	28"	20"	24"
35"	2.34	3.03	3.05	3.14	3.32	3.72	3.77	3.93	4.29	4.40	4.47	4.72	5.25	35"	24"	30"
42"	3.13	4.06	4.09	4.20	4.45	4.99	5.06	5.29	5.76	5.93	6.03	6.36	7.09	42"	29"	36"
49"	3.83	5.00	5.04	5.18	5.48	6.15	6.24	6.52	7.12	7.32	7.44	7.86	8.76	49"	33"	42"
57"	4.87	6.31	6.36	6.53	6.91	7.74	7.84	8.18	8.93	9.18	9.33	9.85	10.96	57"	38"	48"
64"	5.88	7.64	7.70	7.91	8.37	9.40	9.52	9.94	10.83	11.15	11.33	11.97	13.33	64"	43"	54"
71"	7.80	10.15	10.23	10.51	11.12	12.49	12.65	13.22	14.43	14.85	15.10	15.94	17.77	71"	47"	60"

Note: Use the guidelines of General Note No. 8 for selecting tabular quantities.

CONCRETE ELLIPTICAL PIPE

Rise	Span	Opening Area (SF) Number Of Pipes 1	2	3	4	Dimensions A	B	C	E	F	G	S	X 0°	15°	30°	45°
12"	18"	1.3	2.6	3.9	5.2	1'-8"	1'-2"	3'-9"	1'-10"	1'-2"	0'-3"	2'-10"	2'-10"	2'-11"	3'-3"	4'-0"
14"	23"	1.8	3.6	5.4	7.2	1'-10"	1'-3"	4'-2½"	1'-11"	1'-3"	8½"	3'-5"	3'-5"	3'-6"	3'-11"	4'-10"
19"	30"	3.3	6.6	9.9	13.2	2'-3"	1'-4"	5'-1½"	2'-0"	1'-4"	1'-7½"	4'-2"	4'-2"	4'-4"	4'-10"	5'-11"
24"	38"	5.1	10.2	15.3	20.4	2'-8"	1'-5"	6'-3"	2'-1"	1'-5"	2'-9"	5'-2"	5'-2"	5'-4"	6'-0"	7'-4"
29"	45"	7.4	14.8	22.2	29.6	3'-1"	1'-6"	7'-0"	2'-2"	1'-6"	3'-6"	6'-0"	6'-0"	6'-3"	6'-11"	8'-6"
34"	53"	10.2	20.4	30.6	40.8	3'-6"	1'-7"	7'-11½"	2'-3"	1'-7"	4'-5½"	7'-1"	7'-1"	7'-4"	8'-2"	10'-0"
38"	60"	12.9	25.8	38.7	51.6	3'-10"	1'-8"	8'-9"	2'-4"	1'-8"	5'-3"	7'-11"	7'-11"	8'-2"	9'-2"	11'-2"
43"	68"	16.6	33.2	49.8	66.4	4'-3"	1'-10"	9'-8½"	2'-6"	1'-10"	6'-2½"	8'-10"	8'-10"	9'-2"	10'-2"	12'-6"
48"	76"	20.5	41.0	61.5	82.0	4'-8"	2'-1"	10'-8"	2'-9"	2'-0"	7'-2"	9'-9"	9'-9"	10'-1"	11'-3"	13'-9"
53"	83"	24.8	49.6	74.4	99.2	5'-1"	2'-6"	11'-7"	3'-2"	2'-6"	8'-1"	10'-7"	10'-7"	10'-11"	12'-3"	15'-0"
58"	91"	29.5	59.0	88.5	118.0	5'-6"	2'-10"	12'-6½"	3'-6"	2'-10"	9'-0½"	11'-4"	11'-4"	11'-9"	13'-1"	16'-0"

Rise	Class I Concrete (CY) — Number Of Pipe And Skew Angle Of Pipe: Single 0°	Double 0°	15°	30°	45°	Triple 0°	15°	30°	45°	Quadruple 0°	15°	30°	45°	Rise	Span	Approx. Equiv. Round Pipe
12"	1.09	1.45	1.46	1.51	1.60	1.80	1.82	1.91	2.09	2.16	2.20	2.33	2.60	12"	18"	15"
14"	1.38	1.82	1.84	1.89	2.01	2.29	2.32	2.43	2.68	2.75	2.80	2.97	3.33	14"	23"	18"
19"	1.89	2.55	2.57	2.65	2.88	3.26	3.37	3.43	3.77	3.88	3.95	4.19	4.70	19"	30"	24"
24"	2.64	3.55	3.58	3.69	3.93	4.49	4.54	4.77	5.24	5.39	5.49	5.82	6.53	24"	38"	30"
29"	3.32	4.48	4.52	4.66	4.96	5.64	5.72	6.00	6.60	6.80	6.92	7.34	8.24	29"	45"	36"
34"	4.24	5.76	5.81	6.00	6.39	7.29	7.40	7.76	8.55	8.81	8.97	9.52	10.70	34"	53"	42"
38"	5.22	7.16	7.23	7.46	7.96	9.10	9.24	9.70	10.71	11.05	11.25	11.95	13.48	38"	60"	48"
43"	6.63	9.01	9.09	9.38	10.00	11.39	11.56	12.13	13.36	13.77	14.02	14.88	16.73	43"	68"	54"
48"	8.66	11.74	11.85	12.22	13.02	14.82	15.04	15.77	17.37	17.91	18.23	19.34	21.74	48"	76"	60"
53"	12.50	16.98	16.93	17.67	18.63	21.47	21.78	22.86	25.18	25.97	26.44	28.06	31.55	53"	83"	66"
58"	16.46	22.26	22.45	23.16	24.66	28.05	28.46	29.65	32.65	33.85	34.46	36.55	41.05	58"	91"	72"

ATTACHMENT O.4
TPO SUPPORT DOCUMENTS

HDR | ONE COMPANY *Many Solutions*℠

Technical Memo

From: Mark Roberts, PE	Project: Sarasota County Phase I Closure
Date: April 16, 2010	Job No: 000000000125174-002

RE: Exposed Geomembrane Materials

Linear low density polyethylene (LLDPE) and High Density Polyethylene (HDPE), and high performance scrim reinforced flexible polypropylene (FPP) geomembranes have been most commonly used in previous EGC designs over the last 10+ years. Textured 60-mil HDPE has been used in EGC designs at Florida landfills in Marion County and Polk County. 35-mil FPP has been used in the Delaware Solid Waste Authority Landfill in Sussex County. **The proposed Sarasota Central Landfill EGC TPO is a 60-mil FPP product with nylon scrim reinforcement (designed and fabricated by Firestone or similar).** A comparison of the three most common types of solid waste liner systems is presented in Table 1:

TABLE 1
Flexible Membrane Liner Comparison

ATTRIBUTE	LLDPE	PVC	FPP
General Chemical Exposure	good	fair	excellent
Hydrocarbon Exposure	good	fair	good
Weathering (UV Exposure)	fair	poor	excellent
Thermal Stability	poor	good	excellent (reinforced)
Tensile Performance	good	good	excellent (reinforced)
Uni-Axial Elongation Performance	excellent	good	excellent
Multi-Axial Elongation Performance	excellent	excellent	excellent
Puncture Performance	excellent	excellent	good
Installation Damage Resistance	fair	excellent	excellent
Seaming Methods	thermal/excellent	thermal or solvent bonding/good	thermal/excellent
Repair in Service	good	good	excellent
Stress Cracking	good	does not occur	does not occur
Flexibility in Detailing	excellent	good	excellent

Source: M. Sadlier and R. Frobel (1997)

Standard oxidative induction time and high pressure oxidative induction time tests were performed to determine the antioxidant properties of the exposed LLDPE geomembrane. LLDPE relies on antioxidants for their resistance to UV radiation. The nature of the LLDPE resin and its formulation is very similar to HDPE. Because LLDPE has a lower density, hence lower crystallinity, than HDPE, it has the effect of allowing oxygen to diffuse into the polymer structure more quickly and therefore reduce its lifetime when compared to HDPE (Koerner, Hsuan, Koerner, 2005). The loss of antioxidants leaves the geomembrane vulnerable to oxidative degradation as described by Grassie and Scott (1985).

Exposed Geomembrane Selection for the Sarasota County Central Landfill EGC System

The required performance characteristics of the exposed geomembrane include UV resistance, seamability, seam durability, chemical resistance, puncture resistance, stress-strain characteristics, and interface friction. Richardson, Peggs, Barton (1994) performed an evaluation of different possible geomembrane materials similar to that presented in Table 1 as reported by Sadlier and Frobel (1997). In this study, a ranking program was set up based on the performance of different materials and the difficulty of repairing the failure. Based on this ranking program, a polypropylene-based geomembrane, green in color, that is fused together using double-track fusion seams allowing for periodic seam integrity testing was selected as the highest ranked material.

For the Central Landfill project, the selected geomembrane is a green polypropylene-based material similar to the highest ranked material discussed by Richardson, Peggs, and Barton (1994). However, it also has additional strength and thickness qualities greater than those commonly referenced in previous exposed liner applications. The Central Landfill uses a 60-mil fiber reinforced TPO (thermoplastic polyolefin) product with a 20-year prorated manufacturer guarantee on its outdoor performance. Firestone initially designed this material for use as an exposed roof surface. However, it outperforms the geomembrane materials used in previous EGC designs due to its material flexibility, high strength reinforcement, and thickness.

The 60-mil fiber reinforced TPO proposed for the Central Landfill addresses the design criteria for EGCs as set forth by Gleason, Houlihan, and Giroud (1998). These criteria are:

- Resist damage caused by exposure to sunlight
- Resist damage caused by low temperatures
- Resist damage caused by tensile strain due to downslope creep
- Resist puncture damage caused by hail stones
- Resist damage from wind

Resistance to Sunlight:
The geoemembrane must not be adversely affected by long-term exposure to sunlight, which generates heat and contains ultra-violet radiation. The Central Landfill EGC TPO has been designed for long-term outdoor use and does not contain plasticizers and other components that could degrade during long-term exposure to ultra-violet radiation. The TPO material's exposure to UV was tested using ASTM G154. The results indicated no visual damages and 90% of tensile strength and breaking strength was retained after the test.

Resistance to Low Temperatures:
Geomembranes must not become brittle when subjected low temperatures. Based on manufacturer test data for low temperature brittleness per ASTM 746, the test specimen passed the brittleness test in both machine direction and transverse direction at -60^{0}C. The manufacturer recommended lowest temperature for the TPO material is -46^{0}C.

Resistance to Downslope Creep:
The combined action of gravity and thermal expansion/contraction of the geomembrane over long periods of time can lead to the downslope creep of the geomembrane and create additional stresses at the anchors. The Central Landfill EGC TPO has a low coefficient of expansion/contraction relative to many other geomembrane materials. Also, because of its scrim reinforcement the Central Landfill EGC TPO meets both the low bending modulus and the high tensile modulus requirements that also minimize creep.

Resistance to puncture from Hail Stones:
The exposed geomembrane can be susceptible to damage caused by extreme weather, including hail. The Central Landfill EGC TPO has a high resistance to puncture due to its polymer type and its thickness. It has been documented that increasing the thickness increases both the puncture and impact resistances of geomembranes (Koerner, Moneteleone, Schmidt, and Roethe, 1986). The TPO geomembrane will withstand a 1.75-inch hail storm event.

Resistance to Wind Damage:
In an EGC design, it is important for the geomembrane to have sufficient tensile strength with a corresponding distance between anchors to resist the tensile stresses caused by wind uplift. A cost effective design to protect the EGC from wind uplift damage involves selecting a geomembrane exhibiting both high flexibility as well as high tensile strength, and then constructing it on the landfill with geomembrane anchors at relatively widely spaced vertical intervals (i.e. 10 to 12m) (Gleason, Houlihan, Giroud, 1998).

The Central Landfill EGC wind uplift design considerations involved an assessment of the maximum recorded local wind velocity with the strength and thickness of the TPO and the geometry of the uplifted geomembrane. Figure 1 shows a schematic representation of an uplifted geomembrane where T = total geomembrane tension, ε = geomembrane strain, S_e = effective wind suction, and L = the length of geomembrane subjected to suction.

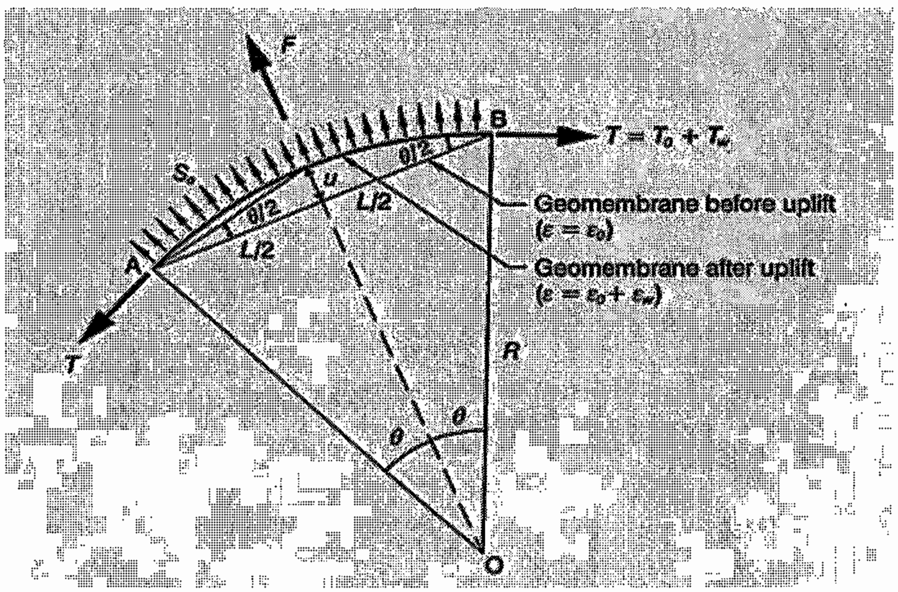


FIGURE 1 – Schematic representation of an uplifted geomembrane (Source: Zornburg & Giroud 1997)

Recommendations

After review of the documentation and industry information for the proposed EGC TPO for the Central County Landfill, HDR has found that a TPO material is equivalent to a LLDPE material for this application and is an excellent material to use as an EGC for the temporary closure of the south slope of Phase I.

References

Sadlier, M. & Frobel, R. 1997. "Geomembrane Properties – A Comparative Perspective". Proceedings from the Geoenvironmental Conference, Melbourne, November, 2007.

Bouazza, A., Zornberg, J.G., & Adam, D, 2002. "Geosynthetics in Waste Containment Facilities: Recent Advances". Geosynthetics – 7th ICG – Delmas, Gourc & Girard (eds) 2002 Swets & Zeitlinger, Lisse ISBN 90 5809 523 1

Koerner, Robert M., Hsuan, Grace Y., & Koerner, George R.. "Geosynthetic Institute. Geomembrane Lifetime Prediction: Unexposed and Exposed Conditions". Pg 10. June, 2005.

Grassie, N., & Scott, G. (1985). "Polymer Degradation and Stabilization", Cambridge University Press, New York.

Richardson, G.N., Peggs, I.D., Barton, W., "30 Year Lifetime Landfill Exposed Geomembrane Cover: Performance Criteria, Material Selection, and Design Features", ibid. pp 1097 – 1100

Gleason, M.H., Houlihan, M.F., and Giroud, J.P. 1998. "An Exposed Geomembrane Cover System for a Landfill". Sixth International Conference on Geosynthetics, IFAI. Atlanta, GA.

Koerner, R.M., Monetelone, M.J., Schmidt, J.R., & Rothe, A.T., 1986. "Puncture and Impact Resistance of Geosynthetics." Third International Conference on Geotextiles and Geomembranes. Vienna, Austria.

Zornberg, J.G. & Giroud, J.P. 1997. "Uplift of Geomembranes by Wind – Extension of Equations". Geosynthetics International 4(2): 187-207

Giroud, J.P., Pelte, T., & Bathhurst, R.J. 1995. "Uplift of Geomembranes by Wind", Geosynthetics International, Vol 2, No. 6.

Dedrick, A.R., 1975. "Air Pressures over Surfaces Exposed to Wind. Transactions of ASAE, Volume 18, No. 3.

Florida Department of
Environmental Protection
Northwest District
160 Governmental Center, Suite 308
Pensacola, Florida 32502-5794

NOTICE OF PERMIT MODIFICATION

March 15, 2010

Sent via e-mail to:
jjones@co.bay.fl.us

In the matter of an
Application for Permit by:

DEP File No. 0007875-007-SF
Bay County

Mr. Jamie Jones
Director of Utility Services
Bay County Board of County Commissioners
Bay County Utility Services Department
Solid Waste Division
3410 Transmitter Road
Panama City, Florida 32404

Enclosed is the Modified Permit to operate a Class I Landfill and closure of a Class III Landfill known as Steelfield Road Landfill (DEP Permit Nos. 0007875-005-SO and 0007875-006-SF; Facility Identification No.: 16) located on 11411 Landfill Road, West Bay, Bay County, Florida, issued pursuant to **Section 403.707, Florida Statutes (F.S.)**

The modification consists of construction of an exposed geomembrane liner to substitute as interim cover for parts of Cells A, Aa, and B in the Class III Landfill, and an approximately one-acre section of Cell 1 of the Class I Landfill. The exposed geomembrane liner will cover a 10.3-acre area, which includes a stormwater and erosion control area that will also be covered. Additionally, the purpose of this modification is to implement the applicable provisions of **Chapter 62-701, F.A.C.; effective January 6, 2010** (Enclosed) for landfill construction or operation facilities in your permit.

Rule 62-701.330(1) (b), F.A.C. requires "...All holders of landfill construction or operation permits issued prior to January 6, 2010 which contain conditions not in conformance with this chapter shall apply for modification of the permit to conform to this chapter to the District Office of the Department which issued the permit. The submission shall occur at the time of application for renewal of an existing permit, or before July 5, 2010..."

Please submit your permit modification as required by **Rule 62-701.330(1) (b), F.A.C.** on or before July 5, 2010. The permit modification documentation should address all applicable changes made to **Chapter 62-701, F.A.C.; effective January 6, 2010.**

A person whose substantial interests are affected by this permit may petition for an administrative proceeding (hearing) in accordance with **Section 120.57, F.S**. The petition must contain the information set forth below and must be filed (received) in the Office of General Counsel of the Department at 2600 Blair Stone Road, Tallahassee 32399-2400, within 14 days of receipt of this Permit. Petitioner shall mail a copy of the petition to the applicant at the address indicated above at the time of filing. Failure to file a petition within this time period shall constitute a waiver of any right such person may have to request an administrative determination (hearing) under **Section 120.57, F.S.**

The Petition shall contain the following information;

(a) The name, address, and telephone number of each petitioner, the applicant's name and address, the Department Permit File Number and the county in which the project is proposed;
(b) A statement of how and when each petitioner received notice of the Department's action or proposed action;
(c) A statement of how each petitioner's substantial interests are affected by the Department's action or proposed action;
(d) A statement of the material facts disputed by petitioner, if any;
(e) A statement of facts which petitioner contends warrant reversal or modification of the Department's action or proposed action;
(f) A statement of which rules or statutes petitioner contends require reversal or modification of the Department's action or proposed action; and
(g) A statement of the relief sought by petitioner, stating precisely the action petitioner wants the Department to take with respect to the Department's action or proposed action.

If a petition is filed, the administrative hearing process is designed to formulate agency action. Accordingly, the Department's final action may be different from the position taken by it in this permit. Persons whose substantial interests will be affected by any decision of the Department with regard to the application have the right to petition to become a party to the proceeding. The petition must conform to the requirements specified above and be filed (received) within 14 days of receipt of this notice in the Office of General Counsel at the above address of the Department. Failure to petition within the allowed time frame constitutes a waiver of any right such person has to request a hearing under Section 120.57, Florida Statutes, and to participate as a party to this proceeding. Any subsequent intervention will only be at the approval of the presiding officer upon motion filed pursuant to Rule 28-5.207, F.A.C.

This permit is final and effective on the date filed with the Clerk of the Department unless a petition is filed in accordance with the above paragraphs or unless a request for extension of time in which to file a petition is filed within the time specified for filing a petition and conforms to Rule 62-103.070, F.A.C. Upon timely filing of a petition or a request for an extension of time this permit will not be effective until further Order of the Department.

When the Order (Permit) is final, any party to the Order has the right to seek judicial review of the Order pursuant to Section 120.68, Florida Statutes, by the filing of a Notice of Appeal pursuant to Rule 9.110, Florida Rules of Appellate Procedure, with the Clerk of the Department in the Office of General Counsel, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400; and by filing a copy of the Notice of Appeal accompanied by the applicable filing fees with the appropriate District Court of Appeal. The Notice of Appeal must be filed within 30 days from the date the Final Order is filed with the Clerk of the Department.

Executed in Pensacola, Florida.

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION

Michael S. Kennedy

Michael S. Kennedy, P.G.
Waste Program Administrator

160 Governmental Center
Pensacola, Florida 32502-5794
(850) 595-8360

FILED, on this date, pursuant to §120.52(9),
Florida Statutes, with the designated Department clerk,
receipt of which is hereby acknowledged.

Barbara Edwards

Clerk

03/15/2010
Date

c: Lee Martin, Solid Waste Management, Tallahassee, lee.martin@dep.state.fl.us
Mike Stephen, Solid Waste Section, mike.stephen@dep.state.fl.us
Carlos Reyes, Solid Waste Section, carlos.reyes@dep.state.fl.us
Dawn Templin P.E., Solid Waste Section, dawn.templin@dep.state.fl.us
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Daniel K. Shaw, AICP, Bay County, dshaw@co.bay.fl.us
Kathleen M. McDonald, Bay County Utility Services, kmcdonald@co.bay.fl.us
Fred Wick, Solid Waste Management, Tallahassee, FA, fred.wick@dep.state.fl.us

You can view this and other documents for this facility at the following internet link:

http://appprod.dep.state.fl.us/WWW_WACS/REPORTS/SW_Facility_Docs.asp?wacsid=16

Florida Department of
Environmental Protection
Northwest District
160 Governmental Center, Suite 308
Pensacola, Florida 32502-5794

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

1.0 Permitted Facility Information

Applicant/Permittee:	Bay County Utility Services Department Solid Waste Division
Facility Identification Number:	16
Date of Issue:	**September 17, 2009**
Modification Date:	**March 15, 2010**
Expiration Date:	**September 17, 2014**
County (No.):	Bay(03)
Latitude/Longitude:	30° 21′ 36″ N/85° 55′ 01″ W
Section-Township-Range:	35-1S-17W
Project/Facility Name:	Steelfield Road Landfill

1.1 Type of Permitted Facility

Type Solid Waste Management Facility	DEP File No.
Class I Landfill	0007875-005-SO
Class III Landfill- Closed	0007875-006-SF
Modification-Class III-Closed	0007875-007-SF

1.2 Permitted Facility Description

Issuance of this permit is under the provisions of **Chapter 403, Florida Statutes (F.S.),** and **Chapter 62-701, Florida Administrative Code (F.A.C.).** The above named applicant is hereby authorized to perform the work or operate the facility as submitted and shown in the application, drawing(s), plans, and other documents attached hereto and made a part hereof and specifically described as follows:

- Operate a 39.7-acre Class I Landfill, and 17.4-acre closed Class III Landfill, having approximately a 57-acre total disposal area. The facility also includes six (6) future Class I landfill cells consisting of approximately 106 acres.

- The active disposal area consist of a 19-acre Class I Landfill (Cells 3 & 4 double synthetic liner) and an inactive 8.3-acre Class III Landfill (Cells Aa & B unlined) to be closed.

- Provide maintenance for a 20-acre Closed Class I Landfill (Cells 1 & 2 single liner) and a 9.1-acre Closed Class III Landfill.

- <u>The modification to the permit consists of construction of an exposed geomembrane liner to substitute as interim cover for parts of Cells A, Aa, and B in the Class III Landfill, and an approximately one-acre section of Cell 1 of the Class I Landfill. The exposed geomembrane liner will cover a 10.3-acre area, which includes a stormwater and erosion control area that will also be covered.</u>

This facility is located on 11411 Landfill Road, West Bay, Bay County, Florida 32437.

This facility was first permitted in May 1987.

The total area of the facility is 156.95 Acres.

1.3 Construction and Operation

A. Operation and construction of the solid waste management facilities shall be in accordance with application received December 31, 2007, subsequent incompleteness information, permit modification application received January 25, 2010, and applicable regulations in **Chapter 62-701, F.A.C.** and conditions of this permit.

2.0 General Conditions

General Conditions are in **Attachment 1.**

3.0 Specific Conditions:

3.1 <u>General</u>

The Department may modify these conditions or impose new conditions, as it deems necessary to assure compliance with the provisions of **Chapter 403, F.S., Chapter 62-701, F.A.C.**, and other applicable regulations. **[Rule 62-4.070(1), F.A.C.]**

3.2 Construction

The Department shall be notified and prior approval shall be obtained of any changes or revisions proposed during operation or construction under this permit. **[Rule 62-4.070(1), F.A.C.]**

A. Construction of all disposal units and modifications to existing disposal units shall be in accordance with the methods and plans as approved by the Department.

B. Solid waste disposal units which have been filled to design dimensions shall receive final cover within 180 days after attaining final elevation or in accordance with the closure plan for the landfill. **[Rule 62-701.500(7) (g), F.A.C.]**

3.3 Operations

A. This facility shall be operated in accordance with the Operation Plan submitted with the permit application received December 31, 2007, subsequent incompleteness information, and the permit modification application received January 25, 2010. The Operation Plan shall be kept at or near the facility and shall be accessible to facility operators. Substantially comply with the operation plan at all times, and shall be revised if operational procedures change. **[Rule 62-701.500(2), F.A.C.]**

B. **Control of access.** To prevent unauthorized waste disposal, access to and use of the facility shall be controlled by fencing, gates, or other barriers, as well as signs and facility personnel. Public access and receipt of wastes shall occur only when an attendant is on duty. **[Rule 62-701.500(5), F.A.C.]**

C. Stormwater shall be controlled and maintained during operation under this permit in accordance with permit application received December 31, 2007, subsequent incompleteness information, the permit modification application received January 25, 2010, and meet the requirements of **Rule 62-701.400(9), F.A.C. [Rule 62-701.500(10), F.A.C.]**

D. No person shall store or dispose of solid waste in any natural or artificial body of water, including ground water and wetlands within the jurisdiction of the Department. This prohibition does not apply to areas of standing water that exist only after storm events, provided that the storage or disposal does not result in objectionable odors or sanitary nuisances. **[Rule 62-701.300(2) (d), F.A.C.]**

E. Fuels, solvents, lubricants and other maintenance materials shall be stored in secure areas separate from the disposal or sorting areas.

F. **Operator and spotter training and special criteria**. The owner or operator of a landfill, or other solid waste management facility required by this chapter to have trained operators or spotters, shall not employ a person to perform, nor may any person perform the duties of an operator or spotter at such facility unless that person is a trained operator or trained spotter. A facility may employ interim spotters, but only if they work under the direct supervision of a trained spotter or trained operator. A facility may employ an interim operator in lieu of a trained operator for no more than three consecutive months. The training plans submitted as part of the application received December 31, 2007, subsequent incompleteness information, and the permit modification application received January 25, 2010, shall be adhered to and comply with the requirements of **Rule 62-701.320(15), F.A.C.**

1. Owners and operators of facilities shall ensure that operators employed at the facility are properly trained to operate the facility, and that spotters are properly trained to identify and properly manage any unauthorized waste which is received at the facility. The training plan, along with records documenting how the training plan is being implemented, shall be kept at the facility at all times and be made available for inspection by Department staff.
   a. In order to be considered trained, operators of:

      (1) Landfills shall complete 24 hours of initial training, and shall pass an examination as part of that training. Within three years after passing the examination, and every three years thereafter, operators shall complete an additional 16 hours of continued training.

      (2) Waste processing facilities shall complete 16 hours of initial training, and shall pass an examination as part of that training. Within three years after passing the examination, and every three years thereafter, operators shall complete an additional 8 hours of continued training.

   b. In order to be considered trained, spotters shall:

      (1) Complete 8 hours of initial training at courses described in the facility's operating plan. Within three years after attending the initial training, and every three years thereafter, spotters shall complete an additional 4 hours of continued training.

2. The training plan, along with records documenting how the training plan is being implemented, shall be kept at the facility at all times and be made available for inspection by Department staff.

[Rule 62-701.320(15), F.A.C.; Rule 62-701.500(3), F.A.C.]

G. **Equipment and Operational Features.** The facility shall have:

1. Sufficient equipment to ensure proper operation and for excavating, spreading, compacting, and covering waste;

2. Sufficient reserve equipment or arrangement to obtain additional equipment within 24 hours of equipment breakdown;

3. Communications equipment for emergency and routine communications;

4. Dust control methods;

5. Fire protection and fire-fighting capabilities adequate to control accidental burning of solid waste. Fire protection includes procedures for notification of local fire protection agencies for assistance in emergencies;

6. Litter control devices, portable fences, or other suitable devices; and

7. Signs indicating the name of the operating authority, traffic flow, hours of operations and restrictions or conditions of disposal.

[Rule 62-701.500(11), F.A.C.]

H. Monitoring of waste.

1. The owner or operator shall implement a load-checking program to detect and discourage attempts to dispose of unauthorized wastes at the landfill. The load-checking program shall consist of the following minimum requirements:
   a. The landfill operator shall examine at least three random loads of solid waste delivered to the landfill each week. The waste collection vehicle drivers selected by the inspector shall be directed to discharge their loads at a designated location within the landfill. A detailed inspection of the discharged material shall be made for any unauthorized wastes. If the landfill owner or operator also owns or operates a transfer station, this inspection may be carried out at that transfer station before delivery of the waste to the landfill.
   b. If unauthorized wastes are found, the facility shall contact the generator, hauler, or other party responsible for shipping the waste to the landfill to determine the identity of the waste sources.

2. Handling hazardous wastes.
   a. If any regulated hazardous wastes are identified by random load checking, or are otherwise discovered to be improperly deposited at the landfill, the landfill operator shall promptly notify the Department, the person responsible for shipping the wastes to the landfill, and the generator of the wastes, if known. The area where the wastes are deposited shall immediately be cordoned off

from public access. If the generator or hauler cannot be identified, the landfill operator shall assure the cleanup, transportation, and disposal of the waste at a permitted hazardous waste management facility.

b. Subsequent shipments from sources found or suspected to be previously responsible for shipping regulated hazardous waste shall be subject to precautionary measures prior to the solid waste management facility accepting wastes.

3. **Recording inspection results**. Information and observations resulting from each random inspection shall be recorded in writing and retained at the landfill for at least three years. The recorded information shall include, at a minimum:

   (a) The date and time of the inspection;
   (b) The names of the hauling firm and the driver of the vehicle;
   (c) The vehicle license plate number;
   (d) The source of the waste, as stated by the driver; and
   (e) Observations made by the inspector during the detailed inspection.

   The written record shall be signed by the inspector.

4. **Temporary storage**. The owner or operator shall make arrangements or shall have equipment for temporary storage, handling and transport to an authorized disposal or recycling facility for unauthorized waste which is inadvertently accepted by the facility. Unless an alternate schedule is included in an operation plan submitted with the permit application, which provides for the control of odors and vectors, putrescible waste shall not be stored for longer than 48 hours and non-putrescible waste shall not be stored for longer than 30 days.

[Rule 62-701.500(6), F.A.C.]

I. Solid Waste Disposal:

1. In no event shall any solid waste or other materials be disposed of on the site other than in areas specifically designated in permit application received **December 31, 2007**, subsequent incompleteness information, and the permit modification application received **January 25, 2010**.

2. The disposal of the following **Special Wastes** is not allowed:
   a. Used Oil
   b. Lead Acid Batteries
   c. Yard Trash in a Class I landfill
   c. Whole Waste Tires
   d. White Goods

3. **Asbestos-containing waste materials** may be accepted at a Class I and Class III landfill. Each designated active disposal area that receives asbestos-containing waste material from a source covered under the National Emission Standards for Asbestos, **40 CFR Part 61, Subpart M**, shall meet the requirements of **40 CFR Part 61.154**.

   a. The waste generator shall make arrangements with the landfill operator before disposal of such regulated asbestos-containing waste materials, and inform the operator of the quantity of the waste and the scheduled date the shipment will arrive at the landfill.

   b. The landfill operator shall direct the waste transporter to the designated disposal location.

   c. Each designated disposal area shall:

      (1) Have fencing to deter general public access;
      (2) Have signs identifying the areas as an active "**Asbestos Containing Waste Material Disposal Area**"; and
      (3) Be covered with six inches of initial cover as defined in **Rule 62-701.200(53), F.A.C.**, at the end of each day or every 24 hours of continuous operation.

   d. As a minimum, record and maintain the following:

      (1) The name, mailing address, phone number and email address of the generator and transporter;
      (2) Date and quantity of disposed **Asbestos-containing waste materials**; and
      (3) Map or diagram indicating the location (Latitude and Longitude) and depth (North American Vertical Datum in feet) of disposed **Asbestos-containing waste materials**.

   [Rule 62-701.520(3), F.A.C.]

5. Hazardous waste as defined in **Rule 62-701.200(47), F.A.C.**, shall not be accepted or disposed at the facility.

   [Rule 62-701.300(4), F.A.C.]

J. Waste Handling:

1. All solid waste at Class I landfills shall be spread in layers of approximately two feet in thickness and compacted to approximately one foot in thickness or as thin a layer as practical before the next layer is applied. Solid waste at all Class III sites shall be spread in layers and compacted once every week using suitable heavy

equipment. Bulky materials which are not easily compacted should be worked into other materials as much as practical.

2. Solid waste shall be formed into cells to construct horizontal lifts. The working of the cell, and side grades above land surface, shall be at a slope no greater than three feet horizontal to one-foot vertical rise.
3. The working face shall be only wide enough to accommodate vehicles discharging waste, and to minimize the exposed area and unnecessary use of cover material.
4. The minimum frequency for applying initial cover is:
   a. **Class I area**: At the end of each working day.
   b. **Class III area:** At the end of each workweek.
5. An intermediate cover in addition to the six-inch initial cover shall be applied and maintained within seven days of cell completion if additional solid waste will not be deposited within 180 days of cell completion. The landfill operator may remove all or part of the intermediate cover before placing additional waste or installing final cover.
6. Solid waste disposal units which have been filled to design dimensions shall receive final cover within 180 days after attaining final elevation.
7. A litter policing operation shall be employed to keep litter from leaving the working area of the landfill. Litter outside the working area shall be picked up within 24 hours.
8. Erosion control measures shall be employed to correct any erosion which exposes waste or causes malfunction of the storm water management system. Such measures shall be implemented within three days of occurrence. If the erosion cannot be corrected within seven days of occurrence the landfill operator shall notify the Department and propose a correction schedule.

[Rule 62-701.500(7), F.A.C.]

K. Waste Records

1. Landfill Facility

   a. The facility operator shall weigh all solid waste as it is received. Landfill operators shall record, in tons per day, the amount of solid waste received and shall estimate the amount of wastes listed in **Rule 62-701.500(4)(b), F.A.C.,** and **Specific Condition 3.3.K.1.b.** Waste reports shall be compiled monthly, and copies shall be provided to the Department annually.

   b. Types of waste received:
      1. Municipal Solid Waste
      2. Class III Waste
      3. Ash Residue
      4. Other Wastes

[Rule 62-701.500(4), F.A.C.]

L. Landfill Leachate Management

1. The landfill operator is responsible for leachate level monitoring, sampling, analysis of the landfill leachate, and for providing copies of the leachate analysis to the Department.
2. The landfill operator is responsible for the operation of the leachate collection and removal system and for maintaining the system as designed for the design period. Leachate shall be collected and treated as necessary so that water quality standards and criteria are not violated.
3. Leachate may be discharged to an off-site treatment plant. The landfill operator is responsible for having a written contract or agreement with the off-site treatment plant to discharge leachate to the plant.
4. On-site leachate treatment or pretreatment systems are part of the leachate collection and removal system and shall be designed according to the expected characteristics of the leachate.
5. Quantities of leachate collected by the leachate collection and removal system shall be recorded in gallons per day before on-site treatment or transport off-site, and shall be included with the operating record.
6. A recording rain gauge shall be installed, operated, and maintained to record precipitation at the landfill. Precipitation records shall be included with the operating record and shall be maintained and used by the permittee to compare with leachate generation rates.
7. New leachate collection systems shall be water pressure cleaned or inspected by video recording after construction but prior to initial placement of wastes. Existing leachate collection systems shall be water pressure cleaned or inspected by video recording at the time of permit renewal. Results of the collection system cleanings or inspections shall be available to the Department upon request.

[Rule 62-701.500(8), F.A.C.]

M. Emergency preparedness and response.

1. Every permitted solid waste management facility shall have, as part of its operation plan, a contingency plan appropriate for the type of facility to cover operational interruptions and emergencies such as fires, explosions, or natural disasters. The contingency plan shall be kept at the facility at all times and shall be accessible to facility operators. The contingency plan shall include:

   a. Designation of persons responsible for implementation of the contingency plan.
   b. Procedures for notification of appropriate emergency response persons, including the department, the local government, and local fire protection agencies.

c. A description of emergency procedures to be followed, including the location of fire-fighting equipment and explanations of how to use this equipment;
d. Provisions for the immediate shutting down of those parts of the facility affected by the emergency and notification to customers of the closure of the facility.
e. Procedures for notification of neighbors and local government officials of the potential impacts of the emergency, and provisions to minimize those impacts.

2. Every solid waste disposal facility shall have:

   a. Sufficient equipment to implement the contingency plan, including equipment for excavating, spreading, compacting, and covering waste;
   b. Sufficient reserve equipment or arrangement to obtain additional equipment within 24 hours of equipment breakdown;
   c. Communications equipment for emergency and routine communications; and
   d. Fire protection and fire-fighting capabilities adequate to control accidental burning of solid waste in the facility. Fire protection includes procedures for notification of local fire protection agencies for assistance in emergencies.

3. In the case of a fire within the waste pile at a solid waste management facility, all reasonable efforts shall be made to immediately extinguish or control the fire. If the fire cannot be extinguished or controlled within an hour, the owner or operator shall immediately:

   a. Implement the contingency plan which is included as part of its operation plan;
   b. Cease accepting waste for disposal in those areas of the facility impacted by the fire; and
   c. Notify the Department and the local government having jurisdiction over the facility of the fire and of the fire control plan being implemented by the owner or operator.

4. If the fire cannot be extinguished or controlled within 48 hours, the owner or operator shall notify the local fire protection agency and seek its assistance, and shall also notify the local government and any neighbors likely to be affected by the fire.

[Rule 62-701.320(16), F.A.C.]

<u>N. Yard Trash Processing Facility</u>

<u>1. Yard Trash as defined by **Rule 62-701.200(135), F.A.C.**, shall be managed in accordance with **Rule 62-709.320, F.A.C.**, and **Rule 62-709.330, F.A.C.**</u>

2. Design and operating requirements.

a. The facility shall have the operational features and equipment necessary to maintain a clean and orderly operation and shall include:
   (1) An effective barrier to prevent unauthorized entry and dumping into the facility site;
   (2) Dust and litter control methods; and
   (3) Fire protection and control provisions to deal with accidental burning of solid waste, including:
      (a) There shall be an all-weather access road, at least 20 feet wide, all around the perimeter of the site;
      (b) None of the processed or unprocessed material shall be mechanically compacted; and
      (c) None of the processed or unprocessed material shall be more than 50 feet from access by motorized firefighting equipment.

b. The facility shall be operated in a manner to control vectors.

c. The facility shall be operated in a manner to control objectionable odors in accordance with **Rule 62-296.320(2), F.A.C.**

d. Any drains and leachate or condensate conveyances that have been installed shall be kept clean so that flow is not impeded.

e. Solid waste received at a registered facility must be processed timely as follows:
   (1) Any yard trash received at the facility shall be size-reduced or removed within 6 months, or within the period required to receive 3,000 tons or 12,000 cubic yards, whichever is greater. However, logs with a diameter of 6 inches or greater may be stored for up to 12 months before they are size-reduced or removed, provided the logs are separated and stored apart from other materials on site.

f. If any of the following materials are discovered, they shall be immediately containerized and removed from the facility: treated or untreated biomedical waste; hazardous waste; or any materials containing a polychlorinated biphenyl (PCB) concentration of 50 parts per million or greater.

g. If the Yard Processing Facility ceases operation, all residuals, solid waste, and recyclable materials shall be removed from the site and recycled, or disposed of pursuant to the requirements of **Chapter 62-701, F.A.C.** Any remaining processed material shall be used in accordance with the requirements of this rule or disposed of pursuant to the requirements of **Chapter 62-701, F.A.C.**

3. Record Keeping and Annual Report

a. Monthly records of incoming and outgoing material shall be kept on site for least three years. The values may be in cubic yards or tonnage, but the same unit of measurement shall be used to record both incoming and outgoing material. An annual report, based on the preceding calendar year, shall summarize the monthly records and shall be submitted by **July 1** to the Department using **DEP Form 62-709.901(2)**, Annual Report for Solid Waste Management Facility Producing Compost Made from Solid Waste (Attachment 8).

b. The annual report shall be submitted to:

Department of Environmental Protection
Bob Martinez Center
Solid Waste Section, MS 4565
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

O. The owner or operator of an unlined Class III landfill shall submit and comply with a CCA management plan that complies with **Rule 62-701.730(20), F.A.C. [Guidance for the Management and Disposal of CCA Treated Wood]**

P. Ash residue from the Bay County Waste-to-Energy facility is allowed to be disposed in the lined Class I disposal cells at this facility.

3.4 Alternate Initial Covers

A. Alternative initial cover materials of an alternative thickness (other than at least six inches of earthen material) may be used upon approval by the Department. To obtain approval, documentation should be submitted demonstrating that the alternative material and thickness control disease vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment. As a minimum the alternative initial cover documentation should provide performance criteria indicated in **ASTM D 6523-00** "Standard Guide for Evaluation and Selection of Alternative Daily Covers for Sanitary Landfills."

B. This facility may utilize chipped clean wood debris as initial cover.

C. This facility may use recycled latex paint(s) as an alternate daily cover.

D. This facility may use an exposed geomembrane liner as described in the permit modification application received **January 25, 2010**, to substitute as interim cover fo parts of Cells A, Aa, and B in the Class III Landfill, and an approximately one-acre section of Cell 1 of the Class I Landfill.

3.5 Air Quality

A. Open burning of solid waste is prohibited except in accordance with **Chapter 62-256, F.A.C.** Controlled burning of solid waste is prohibited except in a permitted incinerator, or in a facility in which the burning of solid waste is authorized by a site certification order issued under **Chapter 403, Part II, F.S.** **[Rule 62-701.300(3), F.A.C.]**

   1. Open burning in connection with industrial, commercial, institutional, or governmental operations is allowed as provided in **Chapter 62-256, F.A.C.** or when:
      a. Open burning is determined by the Department to be the only available method of disposal and is authorized by an air permit.
      b. Such open burning does not involve any material prohibited from being burned at **Rule 62-256.300, F.A.C.**

B. The owner or operator of a solid waste management facility shall not allow the unconfined emissions of particulate matter in violation of **Rule 62-296.320(4) (c), F.A.C.** **[Rule 62-701.300(15), F.A.C.]**

   1. No person shall cause, let, permit, suffer or allow the emissions of unconfined particulate matter from any activity, including vehicular movement; transportation of materials; construction, alteration, demolition or wrecking; or industrially related activities such as loading, unloading, storing or handling; without taking reasonable precautions to prevent such emissions.

   2. Any permit issued to a facility with emissions of unconfined particulate matter shall specify the reasonable precautions to be taken by that facility to control the emissions of unconfined particulate matter.

   3. Reasonable precautions include the following:
      a. Paving and maintenance of roads, parking areas and yards.
      b. Application of water or chemicals to control emissions from such activities as demolition of buildings, grading roads, construction, and land clearing.
      c. Application of asphalt, water, oil, chemicals or other dust suppressants to unpaved roads, yards, open stock piles and similar activities.
      d. Removal of particulate matter from roads and other paved areas under the control of the owner or operator of the facility to prevent reentrainment, and from buildings or work areas to prevent particulate from becoming airborne.
      e. Landscaping or planting of vegetation.
      f. Use of hoods, fans, filters, and similar equipment to contain, capture and/or vent particulate matter.

g. Confining abrasive blasting where possible.
h. Enclosure or covering of conveyor systems.

4. In determining what constitutes reasonable precautions for a particular facility, the Department shall consider the cost of the control technique or work practice, the environmental impacts of the technique or practice, and the degree of reduction of emissions expected from a particular technique or practice.

C. The facility shall be operated to control objectionable odors in accordance with **Rule 62-296.320(2), F.A.C.** If objectionable odors are detected off-site, the owner or operator shall comply with the requirements of **Rule 62-701.530(3)(b), F.A.C.**

1. **Objectionable Odor Prohibited.** No person shall cause, suffer, allow or permit the discharge of air pollutants which cause or contribute to an objectionable odor. **[Rule 62-296.320(2)]**
   a. An objectionable odor is any odor present in the outdoor atmosphere, which by itself or in combination with other odors, is or may be harmful or injurious to human health or welfare, which unreasonably interferes with the comfortable use and enjoyment of life or property, or which creates a nuisance. **[Rule 62-210.200(220), F.A.C.]**

2. **Odor Remediation Plan.** After being notified by the Department that objectionable odors have been confirmed beyond the landfill property boundary, the owner or operator shall:
   a. Immediately take steps to reduce the objectionable odors. Such steps may include applying or increasing initial cover, reducing the size of the working face, and ceasing operations in the areas where odors have been detected;
   b. Submit to the Department for approval an odor remediation plan for the gas releases. The plan shall describe the nature and extent of the problem and the proposed long-term remedy. The remedy shall be initiated within 30 days of approval; and
   c. Implement a routine odor monitoring program to determine the timing and extent of any off-site odors, and to evaluate the effectiveness of the odor remediation plan.

   [Rule 62-701.530(3) (b), F.A.C.]

3.6 Gas Management / Monitoring Program

A. The facility shall conduct a routine gas-monitoring program to monitor concentrations of combustible gases at ambient monitoring points and in soil monitoring probes.

1. Ambient monitoring points shall be located in on-site structures, excluding gas control or recovery components that can be impacted by combustible gases from the landfill as determined by the location of these structures and property boundaries of the facility.

2. Soil monitoring probes shall be installed along each property boundary segment of the facility, particularly those adjacent to off-site occupied structures within 100 feet of the property boundary or where distressed vegetation is present, and shall be spaced as needed to detect gas migration. Soil monitoring probes shall extend to the depth of the base of waste fill or at least three feet below ground surface, whichever is deeper. Sampling shall be conducted in the headspace of the monitoring probe without purging the gas before collecting the sample. Where sand, gravel, or more gas permeable soil strata may interconnect the waste deposit and the property boundary, multiple depth monitoring probes, or a single monitoring probe extending from the soil surface to the water table, are necessary to draw gas samples from the permeable layers.

3. All ambient monitoring points and soil monitoring probes shall be sampled quarterly for concentrations of combustible gases, and the results reported to the Department. Combustible gases shall be determined as a percent of the lower explosive limit and shall be calibrated to methane. The quarterly reports are to be submitted under separate cover on or before **January 1, April 1, July 1** and **October 1** of each year.

4. If the results of monitoring show that combustible gas concentrations exceed the lower explosive limits you shall:

   a. Immediately take all necessary steps to ensure protection of human health and notify the Department; and
   b. Within 7 days of detection, submit to the Department for approval a gas remediation plan for the gas releases. The plan shall describe the nature and extent of the problem and the proposed remedy. The remedy shall be completed within 60 days of detection unless otherwise approved by the Department.

   [Rules 62-701.530(2) & (3), F.A.C.]

3.7 <u>Water Quality Monitoring</u>

A. **Zone of discharge**. A facility's zone of discharge shall be determined pursuant to <u>Chapter 62-520, F.A.C.</u> The zone of discharge shall not exceed 100 feet from the edge of those solid waste disposal units permitted to be constructed, unless modified in accordance with **<u>Rule 62-520.470, F.A.C.</u> [Rule 62-701.320(18), F.A.C.]**

1. The allowable zone of discharge (ZOD) for this permit shall be as follows:

a. The horizontal ZOD shall not exceed 100 feet from the edge of the waste disposal units or property line; whichever is closer, as shown in **Attachment 2**.
b. The vertical ZOD shall extend from the land surface down to the top of the Jackson Bluff Formation, at approximately -30 to -40 feet North American Vertical Datum (NAVD).

B. Water Quality Standards and Criteria:

1. Compliance with ground water quality standards shall be met at and beyond the edges of the ZOD in accordance with **Rule 62-520.420, F.A.C.**, and as contained in **Rule 62-550.310, F.A.C.**, and **Rule 62-550.320, F.A.C.**
2. The minimum ground water criteria specified in **Rule 62-520.400, F.A.C.**, shall apply only outside the permitted zone of discharge, notwithstanding the provisions of **Rule 62-520.400 and Rule 62-520.420, F.A.C.** However, exceedances of ground water criteria within a permitted zone of discharge shall continue to require evaluation monitoring and prevention measures in accordance with **Rule 62-701.510(7), F.A.C. [Rule 62-701.320(17), F.A.C.]**
3. Comply with surface water quality criteria in accordance with **Rule 62-302.530, F.A.C.**
4. Compliance with minimum surface water criteria shall be in accordance with **Rule 62-302.500, F.A.C.**

C. New or replacement monitoring wells

1. Obtain well construction permits from the Northwest Florida Water Management District.
2. Construct in accordance with the guidelines provided on **Attachment 3**.
3. Submit sieve analyses for each well and use for proper well design.
4. Provide with appropriate diameter for reliable and representative water quality results.
5. Each well shall have appropriate screen length. **[Rule 62-701.510(3) (d) 4, F.A.C.]**
6. Properly develop new wells after installation and after settling
7. Submit lithologic logs, "as-installed" diagrams and descriptions of well development after installation of new wells.
8. Submit the latitude and longitude location of each well. **[Rule 62-701.510(3) (d) 1, F.A.C.]**
9. Constructed monitoring wells shall be lockable and shall be locked at all times. **[Rule 62-701.510(3) (d) 5, F.A.C.]**

D. The location of each water quality sampling locations, in degrees, minutes and seconds (to two decimal places) of latitude and longitude, and the elevation of the top of the well casing and surface water elevation to the nearest 0.01 foot, using a consistent, nationally recognized datum, shall be determined by a Florida Licensed Professional Surveyor and Mapper. **[Rule 62-701.510(3) (d) 1, F.A.C.]**

The location information shall include the method the data was collected using the following:

Field Name	Also Known As	Description
Object of Interest	Feature	The object the point represents.
Relationship of Point to Object of Interest	Proximity	Identifies how close the point is to the actual object of interest.
Collection Method	Method	The method used to collect the point.
Collection Date	Date	The date the point was collected.
Datum		The reference for measuring locations on the earth's surface.

[Rule 62-701.320(7) (f) 7, F.A.C.]

Upon completion of each well, **Form 62-701.900(30), Monitoring Well Completion Report**, **Attachment 7** shall be submitted to the Department to report details of the well construction and location. **[Rule 62-701.510(3) (d) 1, F.A.C. and Rule 62-701.510(4) (c), F.A.C.]**

E. Existing wells not used in the approved monitoring network for collection of samples or water elevation data shall be properly maintained and locked or shall be properly abandoned in accordance with **Rule 62-532.500(4), F.A.C.**

F. Any monitoring wells which are abandoned or which will be covered due to lateral expansions of a landfill or the construction of new solid waste disposal units shall be plugged as necessary so that they do not act as a conduit for any leachate release to the ground water. The Department shall be notified in writing before any monitoring wells are abandoned or plugged. Obtain appropriate well abandonment permits from the Northwest Florida Water Management District. **[Rule 62-701.510(3) (d) 6, F.A.C. and Rule 62-532.500(4), F.A.C.]**

G. The water-quality monitoring network shall consist of nine (9) upper surficial ground water monitoring wells (2-background, 1-detection, 6-compliance), seven (7) lower surficial ground water monitoring wells (1–background, 4–detection, 2–compliance), one (1) leachate collection location, and three (3) surface water monitoring locations. **Attachment 2** graphically represents the water quality network. Use the following designations for ground water, leachate, and surface water monitoring identification purposes in all future analysis reports:

Sample Location Name	Designation	Approximate Location	Test Site Number
		Upper Surficial	
MW-11	Background	In the southeast property corner	8541
MW-21R	Compliance	Approximately 900′ east of the northwest property corner and just south of the northern property line	23653
MW-22	Compliance	700′ north of the southwest property corner (the northwest corner of the Future Cell 6)	8692
MW-41[1]	Background	Approximately 100′ south of the northern property boundary and 75′ inside the western property boundary	23654
MW-42[1]	Compliance	Approximately 1,550′ from the northwest property corner just south of the northern property boundary	23655
MW-43[1]	Compliance	Approximately 2,500′ north of the southeast property boundary and 50′ inside the eastern property boundary	23656
MW-44[1]	Compliance	Approximately 1,500′ north of the southeast property corner, at the eastern property boundary	23657
MW-45[1]	Detection	Approximately 1,450′ west from the southeast property corner and 300′ north of the southern property line	23658
MW-46[1]	Compliance	Approximately 600′ west of the southwest property corner, on the property line	23659
		Lower Surficial	
MW-13	Compliance	Approximately 100′ northeast of the northeast corner of Cell 3	8714
MW-14	Detection	Approximately 900′ south of the northern property line and 150′ east of Cell A	8545
MW-15	Compliance	Approximately 100′ northeast of Cell A, on the ZOD	8546
MW-16	Detection	Approximately 350′ west of the eastern ZOD and 400′ south of the northern property line	8547
MW-20	Background	In the southeast property corner	8690

MW-25	Detection	Approximately 600' south of the northern property line, 400' west of the centerline of Otter Creek, 50' inside the ZOD	19763
MW-27	Detection	Approximately 100' east of the eastern boundary of Cell A and 300' north of the northern boundary of Cell 4	23406
		Surface Water and Leachate	
SW-1A	Background	At eastern property boundary in Otter Creek where it enters Steelfield property, outside landfill boundary	23587
SW-2	Compliance	At northern property boundary in Otter Creek where it leaves the property.	8552
SW-3	Compliance	Approximately 150' east of MW-15 in Otter Creek	23660
L-1	Leachate	Leachate holding tank	20529

1 Proposed monitoring wells to be installed. Install proposed monitoring wells within 60 days of issuance of permit modification and submit new monitoring well information in accordance with **Specific Condition 3.7.C.** Submit proposed new monitoring well coordinates in accordance with **Specific Condition 3.7.D.**

[**Rule 62-522, F.A.C.**, and permit application received **December 31, 2007**, subsequent incompleteness information, and the permit modification application received **January 25, 2010**]

H. Sample all groundwater-monitoring wells semiannually for parameters listed below:

Field Parameters	Laboratory Parameters
pH	Boron
Turbidity	Chlorides
Temperature	Nitrate
Specific Conductivity	Total Dissolved Solids
Dissolved Oxygen	Iron
Static water level in wells before purging	Aluminum
Colors and Sheens (by observation)	Sodium
	Mercury
	Total Ammonia – N
	Strontium
	Those parameters listed in **40 CFR Part 258 Appendix I**

I. Ground Water Sampling

1. Measure water levels in each monitoring well in a single day.
2. Measure water levels on the sample day and recorded prior to evacuating the wells or collecting samples.
3. At each well site, record water level, top of well casing and land surface elevations at a precision of plus or minus 0.01 feet NAVD for each analysis report
4. Prior to sampling, stabilize the field parameters for each well.
5. Use sampling and purging methods in the Standard Operating Procedures, as allowed in **Chapter 62-160, F.A.C.**

J. Sample all **surface** water test sites semiannually for the parameters listed below.

Field Parameters	Laboratory Parameters
pH	Aluminum
Turbidity	Boron
Temperature	Biochemical oxygen demand (BOD_5)
Specific Conductivity	Chlorophyll A
Dissolved Oxygen	Chemical Oxygen Demand (COD)
Colors and Sheens (by observation)	Copper
	Fecal Coliform
	Iron
	Mercury
	Strontium
	Nitrate
	Total Dissolved Solids (TDS)
	Total Hardness (as mg/L $CaCO_3$)
	Total Nitrogen
	Total Organic Compound (TOC)
	Total Phosphorus (as mg/L P)
	Total Suspended Solids (TSS)
	Unionized ammonia
	Zinc
	Those parameters listed in **40 CFR Part 258 Appendix I**

K. Sample leachate annually for the parameters listed below.

Field parameters	Laboratory parameters
Specific conductivity	Bicarbonate
pH	Boron
Dissolved oxygen	Biochemical oxygen demand (BOD_5)
Colors, sheens (by observation)	Chemical Oxygen Demand (COD)

Field parameters	Laboratory parameters
	Chlorides
	Iron
	Mercury
	Nitrate
	Sodium
	Strontium
	Total Alkalinity (as mg/L $CaCO_3$)
	Total ammonia - N
	Total dissolved solids (TDS)
	Those parameters listed in **40 CFR Part 258, Appendix II**

1. In addition to the annual leachate sampling required in **Specific Condition 3.7.K.**, the owner or operator shall sample and analyze the leachate every three (3) months for priority pollutant metals in accordance with **Rule 62-702.570(3), F.A.C.** Submit the results with the semiannual water quality monitoring reports due **April 1** and **October 1** of each year. The priority pollutant metals are listed below:

Laboratory parameters
Antimony
Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium

L. Water Sample Analysis

1. Conduct analyses of all samples using approved State and Federal analytical methods with detection limits at or below the maximum allowable concentrations for all parameters, whenever possible.
2. Background water quality shall be sampled and analyzed in accordance with the provisions of **Rule 62-701.510(6) (b), F.A.C.**
3. Sample and analyze all background and detection wells at least once prior to permit renewal for those parameters listed in **Rule 62-701.510(8) (a), F.A.C.**

M. The owner or operator of a solid waste disposal unit may request a permit modification from the appropriate District Office of the Department to delete specific monitoring parameters or field parameters from routine analyses of detection or compliance wells and surface water. The Department will grant such modification upon a demonstration that these parameters are not reasonably expected to be in or derived from the waste contained in the unit, or are not reasonably expected to be detected in the ground water as a result of the operations of the facility. **[Rule 62-701.510(6), F.A.C.]**

N. Measure rainfall at the site on a **daily** basis and the results submitted with the semiannual reports.

O. Water Quality Reporting

1. Report all representative water quality monitoring results to the Department within 60 days from completion of laboratory analyses. This report shall also include any leachate monitoring results obtained in accordance with **Specific Condition 3.7.K**. In accordance with **Rule 62-160.240(3), F.A.C. and Rule 62-160.340(4), F.A.C.**, water quality data contained in the report shall be provided to the Department in an electronic format consistent with requirements for importing into Department databases [See **Specific Condition 3.7.P**]. The owner or operator shall include **DEP Form 62-701.900(31), Water Quality Monitoring Certification** provided as **Attachment 4.** The operator of the landfill shall notify the Department at least 14 days before the sampling is scheduled to occur so that the Department may collect split samples. **[Rule 62-701.510(9) (a), F.A.C.]**

   The results of each set of semiannual water quality analyses shall be submitted separately, no later than **April 1** and **October 1** each year, commencing with the **October 1, 2009**, report. The report shall include but not be limited to the following:

   a. The facility name and identification number, sample collection dates, and analysis dates;
   b. All analytical results, including all peaks even if below maximum contaminant levels;
   c. Identification number and designation of all surface water and ground water monitoring points;
   d. Applicable water quality standards;
   e. Quality assurance, quality control notations;
   f. Method detection limits;
   g. Water levels recorded prior to evaluating wells or sample collection. Elevation reference shall include the top of the well casing and land surface at each well site at a precision of plus or minus 0.01 foot (using a consistent, nationally recognized datum);

h. An updated ground water table contour map signed and sealed by a professional geologist or professional engineer with experience in hydrogeologic investigations, with contours at no greater than one-foot intervals unless site-specific conditions dictate otherwise, which indicates ground water elevations and flow direction; and
i. A summary of any water quality standards or criteria that are exceeded.

2. Submit the Latitude and Longitude location for each monitoring well with the semiannual water quality analysis results. **[Rule 62-701.510(3) (d) 1, F.A.C.]**

3. Provide one complete bound copy and one unlocked electronic copy. The electronic copy should be one electronic file in Adobe Acrobat format.

4. Submit annual leachate analyses results separately, no later than April 1 each year.

P. Electronic Submission of Water Quality Analyses

1. Submit the results of each set of water quality analyses electronically on compact disc media readable by a Microsoft Windows computer.

Send all submittals in response to this specific condition to:

Florida Department of Environmental Protection
Northwest District Office
Solid Waste Section
160 Governmental Center, Suite 308
Pensacola, Florida 32502

And to:

Florida Department of Environmental Protection
Bob Martinez Center
Solid Waste Section, MS 4565
2600 Blair Stone Road
Tallahassee, Florida, 32399-2400

The data shall be evaluated using ADaPT to conduct data quality review and compliance checking. The owner or operator shall include **DEP Form 62-701.900(31), Water Quality Monitoring Certification** provided as Attachment 4 with each report certifying that the laboratory results have been reviewed and approved by the owner or operator. To download the appropriate version of the ADaPT software for data entry and submittals, go to the following ftp site:

ftp://ftp.dep.state.fl.us/pub/WACS-ADaPT.

The website with general information explaining ADaPT can be viewed using the following internet link:

http://www.dep.state.fl.us/labs/dqa/adaptedms.htm.

The ADaPT water quality analyses shall be submitted electronically on compact disc media readable by a Microsoft Windows computer. Electronic laboratory data must be submitted in a specific format called an Electronic Data Deliverable (EDD). The submittal shall also include Chain of Custody sheets, field data sheets (Form FD 9000-24 provided as Attachment 5), groundwater contour maps, water elevation table, summary of exceedences, recommendations, and the Groundwater Monitoring Report Certification. The Department will use ADaPT to conduct data quality review and compliance checking. For laboratories, the ftp site with information on the EDD and ADaPT can be accessed at:

ftp://ftp.dep.state.fl.us/pub/WACS-ADaPT.

[Rule 62-160.240(3), F.A.C. and Rule 62-160.340(4), F.A.C.]

2. The following data fields must be present in the data:

Analytical Method	Analytical Result
Analytical Result Units	Appropriate Data Qualifiers (as listed in Chapter 62-160, F.A.C.)
Date of Analysis	Date of Preparation (if applicable)
Date of Sampling	Detection Limit of the Analysis
DOH Certification Number of the Laboratory	Facility Identification Number
Matrix (Aqueous, Drinking Water, Saline/Estuarine, or Solids)	Parameter Name (Name of the Compound Analyzed for/Test Performed)
	Test site ID

3. If documents require a professional certification, submit original signed and sealed paper documents unless a specific law or rule allows an electronic signature.

[Rule 62-701.510(6), F.A.C. and Rules 62-701.510(8) (a), (b) and (d), F.A.C.]

Q. If at any time it is determined that any well in the routine monitoring system is not functioning properly and is not providing representative water quality samples, the owner or operator shall have the wells evaluated, redeveloped, or replaced such that representative samples will be obtained during the next required routine sampling event.

Any well requiring redevelopment should be surged with formation water or a surge block, only. Consider replacing wells, which still produce sediment and high turbidity. Evaluate wells with high turbidity using the procedures called for in **Rule 62-520.300(9), F.A.C.**

Design, install and complete any well requiring replacement in accordance with the suggested practices of document **ASTM D5092.**
[**Rule 62-701.510, F.A.C.** and **Rule 62-522, F.A.C.**]

R. Evaluation monitoring, prevention measures and corrective action

1. **Evaluation Monitoring.** If monitoring parameters are detected in detection wells in concentrations that are significantly above background water quality, or that are at levels above the Department's water quality standards or criteria specified in **Chapter 62-520, F.A.C.**, the owner or operator may resample the wells within 30 days after the sampling data is received, to confirm the data. Should the owner or operator choose not to resample, the Department will consider the water quality analysis as representative of current ground water conditions at the facility. If the data is confirmed, or if the owner or operator chooses not to resample, the owner or operator shall notify the Department in writing within 14 days of this finding. Upon notification by the Department, the owner or operator shall initiate evaluation monitoring in accordance with **Rule 62-701.510(7) (a), F.A.C.**

2. If the parameters detected in the detection wells identified in **Rule 62-701.510(7) (a), F.A.C.**, consist only of iron, aluminum, manganese, sulfates, or total dissolved solids (TDS), either individually or in any combination, then only the detected parameters are required to be monitored in the representative background wells, affected detection wells and downgradient compliance wells required in this section rather than the parameters listed in **Rule 62-701.510(8) (a), F.A.C.**, and **Rule 62-701.510(8) (d), F.A.C.** However, if the facility is unlined, the parameters specified in **Rule 62-701.510(8) (a), F.A.C.**, shall also be analyzed for in the initial sampling event for the affected detection wells and downgradient compliance wells.

3. **Corrective actions**. If any contaminants are detected and confirmed in compliance wells in concentrations that exceed both background levels and Department water quality standards or criteria, the owner or operator shall notify the Department within 14 days of this finding and shall initiate corrective actions. Evaluation

monitoring shall continue according to the requirements of **Rule 62-701.510(7) (a), F.A.C.**

The owner or operator shall initiate and complete corrective actions in accordance with Chapter 62-780, F.A.C., within the manner and timeframes specified therein and provide a site assessment report (SAR) in accordance with **Rule 62-780.600, F.A.C.**, that meets the objectives of said Rule within the manner and timeframes specified therein.

S. All water quality monitoring required by this permit shall be in accordance with **Rules 62-520.300, F.A.C.**, and **Rule 62-4.246, F.A.C.**, and shall be carried out under the requirements of **DEP-SOP-001/01 FS 2000** or applicable Standard Operating Procedures (SOPs) in accordance with **Chapter 62-160, F.A.C.**

T. A technical report, signed and sealed by a professional geologist or professional engineer with experience in hydrogeologic investigations, shall be submitted to the Department every two and one-half years during the active life of the facility, and every five years during the long-term care period. The report shall summarize and interpret the water quality and leachate monitoring results and water level measurements collected during the past two and one-half years. The report shall contain, at a minimum, the following:
   1. Tabular displays of any data which shows that a monitoring parameter has been detected, and graphical displays of any leachate key indicator parameters detected (such as pH, specific conductance, TDS, TOC, sulfate, chloride, sodium and iron), including hydrographs for all monitor wells;
   2. Trend analyses of any monitoring parameters consistently detected;
   3. Comparisons among shallow, middle, and deep zone wells;
   4. Comparisons between background water quality and the water quality in detection and compliance wells;
   5. Correlations between related parameters such as total dissolved solids and specific conductance;
   6. Discussion of erratic and/or poorly correlated data;
   7. An interpretation of the ground water contour maps, including an evaluation of ground water flow rates; and
   8. An evaluation of the adequacy of the water quality monitoring frequency and sampling locations based upon site conditions.

   Submit the technical report separately, no later than January 1, commencing with the January 1, 2011, report. Provide one complete bound copy and one unlocked electronic copy. The electronic copy should be one electronic file in Adobe Acrobat format.

   [Rule 62-701.510(9) (b), F.A.C.]

U. All field and laboratory records specified in <u>**Rule 62-160.600, F.A.C. and Rule 62-160.630, F.A.C.**</u>, shall be made available to the Department and be retained for the design period of the landfill. **[Rule 62-701.510(9) (c), F.A.C.]**

V. Ash residue shall be analyzed every three (3) months for priority pollutants metals. Representative composite samples shall be prepared for analysis by total digestion, using EPA Method 3050: Acid Digestion of Sediments, Sludges, and Soils, "Test Methods for Evaluation Solid Waste Physical/Chemical Methods," EPA Publication SW-846 (3rd Edition, as amended by Update I, December 1987). Collect and analyze samples for the priority pollutant metals listed in **Specific Condition 3.7.K.1.** The results shall be submitted with the semiannual water quality monitoring reports due **April 1** and **October 1** of each year.

4.0 Closure and Long-term Care

4.1 <u>Closure</u>

A. The owner or operator shall submit an application to the Department for final closure of the landfill at least 90 days before the date when wastes will no longer be accepted. The application shall be on **Form 62-701.900(1)**. If the landfill is operating under a Department permit, the owner or operator shall request a modification of the permit in lieu of submitting a closure permit application. The application or request for modification shall include a closure plan, which is made up of the following:
   1. A closure design plan. **[Rule 62-701.600(3), F.A.C.]**
   2. A closure operation plan. **[Rule 62-701.600(4), F.A.C.]**
   3. A plan for long-term care. **[Rule 62-701.620, F.A.C.]**
   4. A demonstration that proof of financial responsibility for long-term care will be provided. **[Rule 62-701.630, F.A.C.]**

B. After closure construction has been completed, the engineer of record shall certify to the Department on **DEP Form 62-701.900(2)** that the closure is complete and that it was done in accordance with the plans submitted to the Department except where minor deviation was necessary. All deviations shall be described in detail and the reasons therefore enumerated. If the certification is for the final closure of a landfill, it shall include a certification that one of the following has been done:

   1. For landfills with a final elevation of less than 20 feet above the natural land surface, concrete monuments shall be installed to mark the boundaries of the landfill property and other permanent markers shall be installed to outline the general waste filled areas. These markers shall be tied to one or more of the boundary markers by a survey performed by an engineer or a Florida Licensed Professional Surveyor and Mapper. The location and elevation of all markers shall be shown on a site plan filed with the "Declaration to the Public" described in **Rule 62-701.600(7), F.A.C.**, and **Specific Condition 4.1.C.**

2. For landfills with a final elevation of 20 feet or higher above the natural land surface, a final survey shall be performed after closure is complete by an engine[er] or a Florida Licensed Professional Surveyor and Mapper to verify that final contours and elevations of the facility are in accordance with the plans as approved in the permit. Aerial mapping techniques which provide equivalent survey accuracy may be substituted for the survey. Contours shall be shown at no greater than five-foot intervals. A copy of the survey shall be included with the certification of closure construction completion.

C. **Declaration to the public**. Once closure construction has been completed, the landfill owner or operator shall file a declaration to the public in the deed records in the office of the county clerk of the county in which the landfill is located. The declaration shall include a legal description of the property on which the landfill is located and a site plan specifying the area actually filled with solid waste. The declaration shall also include a notice that any future owner or user of the site should consult with the Department prior to planning or initiating any activity involving the disturbance of the landfill cover, monitoring system or other control structures. A certified copy of the declaration shall be filed with the Department. **[Rule 62-701.600(7), F.A.C.]**

[Rule 62-701.600, F.A.C.]

4.2 Long Term Care

A. The owner or operator of any landfill shall continue to monitor and maintain the integrity and effectiveness of the final cover as well as other appurtenances of the facility, control erosion, fill subsidences, comply with the ground water monitoring plan, and maintain the stormwater system, in accordance with an approved closure plan for 30 years from the date of closing.

B. Before the expiration of the long-term care monitoring and maintenance period, the Department may extend the time period if the closure design or closure operation plan is found to be ineffective or if the permittee has not performed all required monitoring and maintenance which includes, but is not be limited to the following:
1. The ground water monitoring system indicates that the landfill continues to impact ground water at concentrations that may be expected to result in violations of Department water quality standards or criteria;
2. The gas monitoring system indicates that the landfill continues to produce gas in amounts that may be expected to exceed the concentrations of combustible gases allowed in **Rule 62-701.530(1)(a), F.A.C.**;
3. Significant subsidence of waste has not ceased; or
4. The final cover does not have well established vegetation or is showing signs of continuing significant erosion problems.

[Rule 62-701.620, F.A.C.]

5.0 Financial Assurance

5.1 The owner or operator shall maintain, in good standing, the financial assurance mechanisms established to demonstrate proof of financial assurance. Support documentation and evidence of inflation adjustment increases shall be submitted within the time frames specified in **Rule 62-701.630, F.A.C.** Send all submittals in response to this specific condition to:

Florida Department of Environmental Protection
Bob Martinez Center
Solid Waste Section
Financial Coordinator
2600 Blair Stone Road
MS 4565
Tallahassee, Florida 32399-2400

5.2 **Closure and Long Term Care Cost Estimate Adjustments**

A. The owner or operator shall annually adjust the closure and long-term care cost estimate for inflation using **DEP Form 62-701.900(28) Closure Cost Estimating Form** (Attachment 6). Make adjustments in accordance with **Rule 62-701.630(4), F.A.C.**, and **40 CFR Part 264.142(a)** and **40 CFR Part 264.144(a)**. An owner or operator using a surety bonds, certificates of deposit, securities, letters of credit, trust fund agreements, closure insurance (excluding independent procurement), or financial tests and corporate guarantees shall submit the adjusted cost estimate between **January 1** and **March 1**. An owner or operator using an escrow account shall submit the adjusted estimate between **July 1** and **September 1**.

B. At the time of permit renewal, or every fifth year when a permit is issued with duration greater than 5 years, the owner or operator shall revise the cost estimate. Revisions shall be made by recalculating the total cost of closure or long-term care, in current dollars, as specified in **Rule 62-701.630(3), F.A.C.**

C. The owner or operator shall revise the closure cost estimate by recalculating the total cost of closure or long-term care, in current dollars, as specified in **Rule 62-701.630(3), F.A.C.**, in the following situations:
1. Prior to any changes to the closing or long-term care plan;
2. Within 30 days of discovery that any of the anticipated costs that formed the basis of the current approved closure cost estimate have changed significantly; or
3. Within 30 days of issuance of an order pursuant to **Rule 62-701.730(18), F.A.C.**, finding that the facility has exceeded any of its permitted dimensions.

D. If the value of the alternative funding mechanism is less than the total amount of the current closure cost estimate, the owner or operator shall revise the funding mechanisms to reflect the new estimate within the time frames outlined in **40 CFR Part 264, Subpart H**.

E. Send all submittals in response to **Specific Condition 5.2** to:

Florida Department of Environmental Protection
Northwest District
Solid Waste Section
160 Governmental Center, Suite 308
Pensacola, Florida 32502

With a copy to:

Florida Department of Environmental Protection
Bob Martinez Center
Solid Waste Section, MS 4565
Financial Coordinator
2600 Blair Stone Road
Tallahassee, Florida, 32399-2400.

5.3 Closure cost estimates and annual updates thereof shall comply with the provisions of **Rule 62-701.630(3), F.A.C.**, and **Rule 62-701.630(4) (a)** through **(d), F.A.C.**

5.4 If the owner or operator is required to undertake a corrective action program in accordance with **Rule 62-701.510(7), F.A.C.**, the owner or operator shall submit proof of financial assurance to the Department no later than 120 days after the corrective action remedy has been selected. **[Rule 62-701.630(2) (d), F.A.C.]**

A. Cost estimates for corrective action. An owner or operator of a landfill required to establish financial assurance for a corrective action program pursuant to **Rule 62-701.630(2) (d), F.A.C.**, and **Specific Condition 5.4** shall have a detailed written estimate in current dollars, estimated and certified by a professional engineer, of the cost of hiring a third party to perform the corrective action in accordance with **Rule 62-701.510(7), F.A.C.** The corrective action cost estimate must account for the total cost of corrective action activities as described in the corrective action plan for the entire corrective action period. The owner or operator shall submit the estimate, together with all necessary justification, to the Department for approval along with proof of financial assurance.

5.5 If long-term care is extended because the permittee has failed to perform all required monitoring and maintenance, financial assurance shall continue to be required during the extended long-term care. If the long-term care is extended for any other reason, financial assurance is not required during the extended long-term care period, except as may be required in **Rule 62-701.630 (7), F.A.C.** through **Rule 62-701.630 (9), F.A.C. [Rule 62-701.630(10), F.A.C.]**

6.0 Administrative

6.1 For uninterrupted operation, a permit renewal application must be submitted 60 days prior to the expiration of this permit. Provide four complete bound copies and one unlocked electronic copy. The electronic copy should be one electronic file in Adobe Acrobat format. **[Rule 62-4.050(2), F.A.C.]**

6.2 A copy of the Department approved engineering drawings, plans, reports, operational plan, and supporting information shall be kept on site at all times and be available for Department inspection. **[Rule 62-4.070(1), F.A.C.]**

6.3 Cite the Facility Identification Number and DEP File Number on all reports and correspondence concerning this facility. **[Rule 62-4.070(1), F.A.C.]**

6.4 The Department telephone number for reporting emergencies involving a significant threat to human health or the environment is (850) 413-9911, day or night.

6.5 This and other documents for this facility can be viewed at the following internet link:

http://appprod.dep.state.fl.us/WWW_WACS/REPORTS/SW_Facility_Docs.asp?wacsid=16

Issued this 15th day of March, 2010.

Expiration date: September 17, 2014

STATE OF FLORIDA DEPARTMENT
OF ENVIRONMENTAL PROTECTION

Michael S. Kennedy, P.G.
Waste Program Administrator

Northwest District
160 Governmental Center, Suite 308
Pensacola, Florida 32502-5794
(850) 595-8360

General Conditions

1. The terms, conditions, requirements, limitations and restrictions set forth in this permit, are "permit conditions" and are binding and enforceable pursuant to Sections 403.141, 403.727, or 403.859 through 403.861, F.S. The permittee is placed on notice that the Department will review this permit periodically and may initiate enforcement action for any violation of these conditions.

2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action by the Department.

3. As provided in subsections 403.987(6) and 403.722(5), F.S., the issuance of this permit does not convey any vested rights or any exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of personal rights, nor any infringement of federal, state, or local laws or regulations. This permit is not a waiver of or approval of any other department permit that may be required for other aspects of the total project which are not addressed in this permit.

4. This permit conveys no title to land or water, does not constitute State recognition or acknowledgment of title, and not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title.

5. This permit does not relieve the permittee from liability for harm or injury to human health or welfare, animal, or plant life, or property caused by the construction or operation of this permitted source, or from penalties therefore; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department.

6. The permittee shall properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed and used by the permittee to achieve compliance with the conditions of this permit, as required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules.

7. The permittee, by accepting this permit, specifically agrees to allow authorized Department personnel, upon presentation of credentials or other documents as may be required by law and at reasonable times, access to the premises where the permitted activity is located or conducted to:

a. Have access to and copy any records that must be kept under conditions of the permit;

b. Inspect the facility, equipment, practices, or operations regulated or required under this permit; and

c. Sample or monitor any substances or parameters at any location reasonably necessary to assure compliance with this permit or Department rules. Reasonable time may depend on the nature of the concern being investigated.

8. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately provide the Department with the following information:

a. A description of and cause of noncompliance; and

b. The period of noncompliance, including dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance. The permittee shall be responsible for any and all damages, which may result and may be subject to enforcement action by the Department for penalties or for revocation of this permit.

9. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source which are submitted to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except where such use is prescribed by Sections 403.111 and 403.73, F.S. Such evidence shall only be used to the extent it is consistent with the Florida Rules of Civil Procedure and appropriate evidentiary rules.

10. The permittee agrees to comply with changes in Department rules and Florida Statutes after a reasonable time for compliance; provided, however, the permittee does not waive any other rights granted by Florida Statutes or Department rules. A reasonable time for compliance with a new or amended surface water quality standard, other than those standards addressed in Rule 62-302.500, F.A.C., shall include a reasonable time to obtain or be denied a mixing zone for the new or amended standard.

11. This perrnit is transferable only upon Department approval in accordance with Rules 62-4.120 and 62-730.300, F.A.C., as applicable. The permittee shall be liable for any non-compliance of the permitted activity until the Department approves the transfer.

12. This permit or a copy thereof shall be kept at the work site of the permitted activity.

13. This permit also constitutes:

    a. Determination of Best Available Control Technology (BACT)

    b. Determination of Prevention of Significant Deterioration (PSD)

    c. Certification of compliance with State Water Quality Standards (Section 401, PL 92-500)

    d. Compliance with New Source Performance Standards

14. The permittee shall comply with the following:

    a. Upon request, the permittee shall furnish all records and plans required under Department rules. During enforcement actions, the retention period for all records will be extended automatically unless otherwise stipulated by the Department.

    b. The permittee shall hold at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation) required by the permit, copies of all reports required by this permit, and records of all data used to complete the application for this permit. These materials shall be retained at least three years from the date of the sample, measurement, report, or application unless otherwise specified by Department rule.

    c. Records of monitoring information shall include:

       (1) The date, exact place, and time of sampling or measurements;
       (2) The person responsible for performing the sampling or measurements;
       (3) The dates analyses were performed;
       (4) The person responsible for performing the analyses;
       (5) The analytical techniques or methods used;
       (6) The results of such analyses.

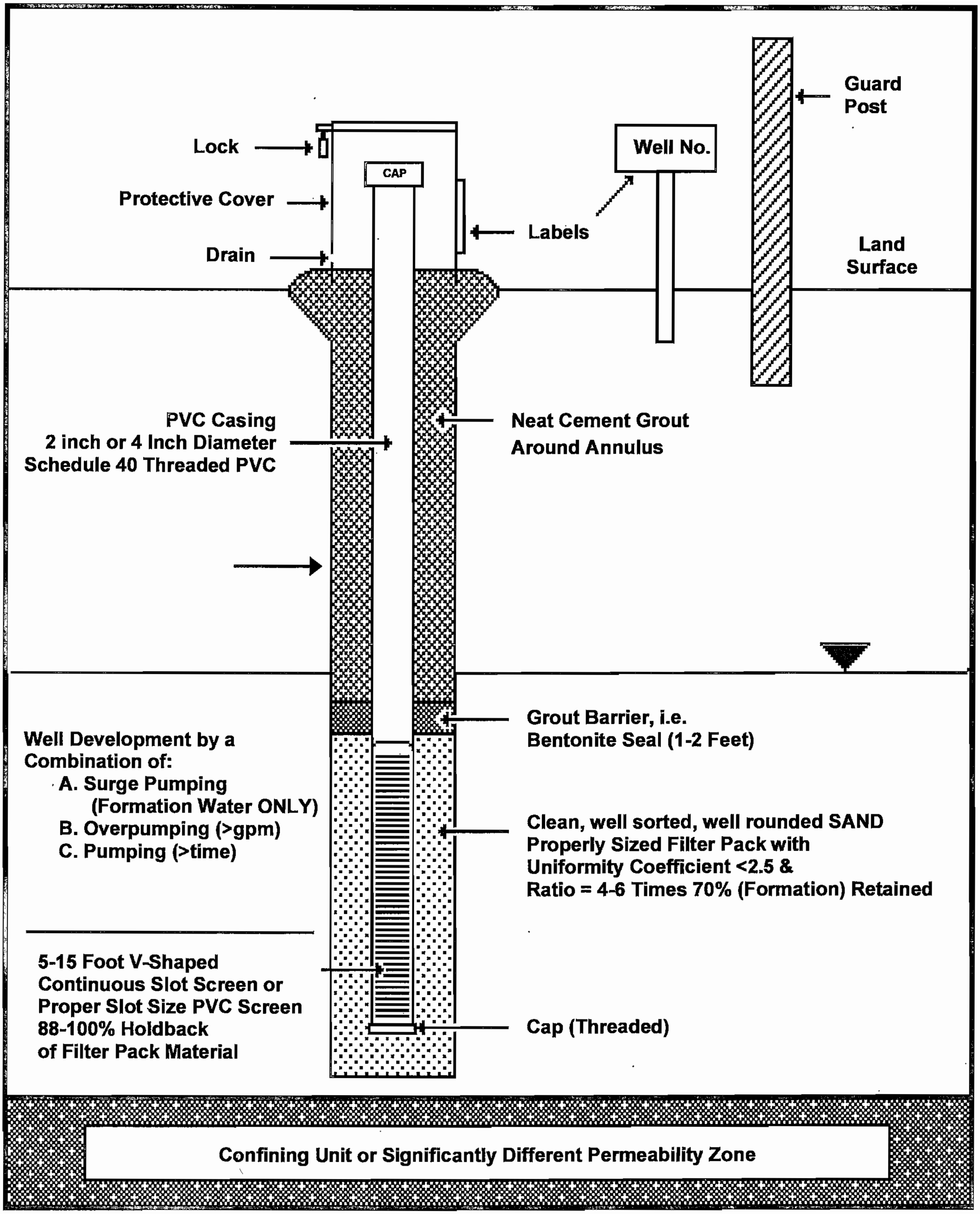
15. When requested by the Department, the permittee shall within a reasonable time furnish any information required by law, which is needed to determine compliance with the permit. If the permittee becomes aware the relevant facts were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be corrected promptly.

MATCH LINE (SEE DRAWING NO. 2b)

LEGEND

MATCH LINE (SEE DRAWING NO. 2a)

LEGEND



Basic Monitor Well Design
in a Water Table Aquifer

Florida Department of
Environmental Protection
Northwest District Office

Department of Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

DEP Form #: 62-701.900(31)
Form Title: Water Quality Monitoring Certification
Effective Date: January 6, 2010
Incorporated in Rule 62-701.510(9)

WATER QUALITY MONITORING CERTIFICATION

PART I GENERAL INFORMATION

(1) Facility Name ______________________________

Address ______________________________

City ______________________ Zip ____________ County ____________

Telephone Number (____) ______________________________

(2) WACS Facility ID ______________________________

(3) DEP Permit Number ______________________________

(4) Authorized Representative's Name ______________________ Title ____________

Address ______________________________

City ______________________ Zip ____________ County ____________

Telephone Number (____) ______________________________

Email address (if available) ______________________________

CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submission of false information including the possibility of fine and imprisonment.

______________ (Date) ______________________________ (Owner or Authorized Representative's Signature)

PART II QUALITY ASSURANCE REQUIREMENTS

Sampling Organization ______________________________

Analytical Lab NELAC / HRS Certification # ______________________________

Lab Name ______________________________

Address ______________________________

Phone Number (____) ______________________________

Email address (if available) ______________________________

Form FD 9000-24

GROUNDWATER SAMPLING LOG

SITE NAME:		SITE LOCATION:
WELL NO:	SAMPLE ID:	DATE:

PURGING DATA

WELL DIAMETER (inches):	TUBING DIAMETER (inches):	WELL SCREEN INTERVAL DEPTH: feet to feet	STATIC DEPTH TO WATER (feet):	PURGE PUMP TYPE OR BAILER:

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY
only fill out if applicable)
= (feet – feet) X gallons/foot = gallons

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME
(only fill out if applicable)
= gallons + (gallons/foot X feet) + gallons = gallons

INITIAL PUMP OR TUBING DEPTH IN WELL (feet):	FINAL PUMP OR TUBING DEPTH IN WELL (feet):	PURGING INITIATED AT:	PURGING ENDED AT:	TOTAL VOLUME PURGED (gallons):

TIME	VOLUME PURGED (gallons)	CUMUL. VOLUME PURGED (gallons)	PURGE RATE (gpm)	DEPTH TO WATER (feet)	pH (standard units)	TEMP. (^{o}C)	COND. (µmhos/cm or µS/cm)	DISSOLVED OXYGEN (circle mg/L or % saturation)	TURBIDITY (NTUs)	COLOR (describe)	ODOR (describe)

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLING DATA

SAMPLED BY (PRINT) / AFFILIATION:	SAMPLER(S) SIGNATURES:	SAMPLING INITIATED AT:	SAMPLING ENDED AT:
PUMP OR TUBING DEPTH IN WELL (feet):	SAMPLE PUMP FLOW RATE (mL per minute):	TUBING MATERIAL CODE:	
FIELD DECONTAMINATION: Y N	FIELD-FILTERED: Y N FILTER SIZE: ____ µm Filtration Equipment Type: ____	DUPLICATE: Y N	

SAMPLE CONTAINER SPECIFICATION				SAMPLE PRESERVATION			INTENDED ANALYSIS AND/OR METHOD	SAMPLING EQUIPMENT CODE
SAMPLE ID CODE	# CONTAINERS	MATERIAL CODE	VOLUME	PRESERVATIVE USED	TOTAL VOL ADDED IN FIELD (mL)	FINAL pH		

REMARKS:

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

NOTES:1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)
pH: ± 0.2 units **Temperature:** ± 0.2 °C **Specific Conductance:** ± 5% **Dissolved Oxygen:** all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater) **Turbidity:** all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Department of
Environmental Protection
Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

DEP Form # 62-701.900(28)
Form Title: Closure Cost Estimating Form For Solid Waste Facilities
Effective Date: January 6, 2010
Incorporated in Rule 62-701.630(3), F.A.C.

CLOSURE COST ESTIMATING FORM FOR SOLID WASTE FACILITIES

Date of DEP Approval: ____________

I. GENERAL INFORMATION:

Facility Name: ________________________ WACS ID: __________
Permit Application or Consent Order No.: ____________ Expiration Date: __________
Facility Address: ________________________
Permittee or Owner/Operator: ________________________
Mailing Address: ________________________

Latitude: ____________ Longitude: ____________
Coordinate Method: ____________ Datum: ____________
Collected by: ____________ Company/Affiliation: ____________

Solid Waste Disposal Units Included in Estimate:

Phase / Cell	Acres	Date Unit Began Accepting Waste	Active Life of Unit From Date of Initial Receipt of Waste	If active: Remaining life of unit	If closed: Date last waste received	If closed: Official date of closing

Total disposal unit acreage included in this estimate: Closure: ______ Long-Term Care: ______

Facility type: _____Class I _____Class III _____C&D Debris Disposal
(Check all that apply) _____Other: ________________________

II. TYPE OF FINANCIAL ASSURANCE DOCUMENT (Check type)

_____Letter of Credit* _____Insurance Certificate _____Escrow Account
_____Performance Bond* _____Financial Test _____Form 29 (FA Deferral)
_____Guarantee Bond* _____Trust Fund Agreement

* - Indicates mechanisms that require the use of a Standby Trust Fund Agreement

III. ESTIMATE ADJUSTMENT

40 CFR Part 264 Subpart H as adopted by reference in Rule 62-701.630, Florida Administrative Code, (F.A.C.) sets forth the method of annual cost estimate adjustment. Cost estimates may be adjusted by using an inflation factor or by recalculating the maximum costs of closure in current dollars. Select one of the methods of cost estimate ajustment below.

☐ **(a) Inflation Factor Adjustment**

Inflation adjustment using an inflation factor may only be made when a Department approved closure cost estimate exists and no changes have occurred in the facility operation which would necessitate modification to the closure plan. The inflation factor is derived from the most recent Implicit Price Deflator for Gross National Product published by the U.S. Department of Commerce in its survey of Current Business. The inflation factor is the result of dividing the latest published annual Deflatory by the Deflator for the previous year. The inflation factor may also be obtained from the Solid Waste website www.dep.state.fl.us/waste/categories/swfr or call the Financial Coordinator at (850) 245-8706.

This adjustment is based on the Department approved closing cost estimate dated: ____________

Latest Department Approved Closing Cost Estimate:		Current Year Inflation Factor		Inflation Adjusted Closing Cost Estimate:
____________	X	____________	=	____________

This adjustment is based on the Department approved long-term care cost estimate dated: ____________

Annual Long-Term Care Cost Estimate:		Current Year Inflation Factor		Inflation Adjusted Annual Long-Term Care Cost Estimate:
____________	X	____________	=	____________

Number of Years of Long Term Care Remaining: X ____________

Inflation Adjusted Long-Term Care Cost Estimate: = ____________

Signature by: ☐ **Owner/Operator** ☐ **Engineer** (check what applies)

____________ Signature	____________ Address
____________ Name & Title	____________ City, State, Zip Code
____________ Date	____________ E-Mail Address (if available)
____________ Telephone Number	

☐ **(b) Recalculated or New Cost Estimates** (see Section IV)

IV. ESTIMATED CLOSING COST (check what applies)

☐ **Recalculated Cost Estimate** ☐ **New Facility Cost Estimate**

**** For the time period in the landfill operation when the extent and manner of its operation makes closing most expensive.**

**** Cost estimate must be certified by a professional engineer (see Section VI).**

**** Costs must be for a third party providing all material, equipment and labor which is at least at fair market value.**

**** In some cases, a price quote in support of individual item estimates may be required.**

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
1. Proposed Monitoring Wells		(Do not include wells already in existence.)		
	EA	_______	_______	_______
			Subtotal Monitoring Wells:	_______
2. Slope and Fill (bedding layer between waste and barrier layer):				
Excavation	CY	_______	_______	_______
Placement and Spreading	CY	_______	_______	_______
Compaction	CY	_______	_______	_______
Off-Site Material	CY	_______	_______	_______
Delivery	CY	_______	_______	_______
			Subtotal Slope and Fill :	_______
3. Cover Material (Barrier Layer):				
Off-Site Clay	CY	_______	_______	_______
Synthetics - 40 mil	SY	_______	_______	_______
Synthetics - GCL	SY	_______	_______	_______
Synthetics - Geonet	SY	_______	_______	_______
Synthetics - Other (describe)	_______	_______	_______	_______
			Subtotal Barrier Layer Cover:	_______
4. Top Soil Cover:				
Off-Site Material	CY	_______	_______	_______
Delivery	CY	_______	_______	_______
Spread	CY	_______	_______	_______
			Subtotal Top Soil Cover:	_______
5. Vegetative Layer				
Sodding	SY	_______	_______	_______
Hydroseeding	AC	_______	_______	_______
Fertilizer	AC	_______	_______	_______
Mulch	AC	_______	_______	_______
Other (describe)	_______	_______	_______	_______
			Subtotal Vegetative Layer:	_______
6. Stormwater Control System:				
Earthwork	CY	_______	_______	_______
Grading	SY	_______	_______	_______
Piping	LF	_______	_______	_______
Ditches	LF	_______	_______	_______
Berms	LF	_______	_______	_______
Control Structures	EA	_______	_______	_______
Other (describe)	_______	_______	_______	_______
			Subtotal Stormwater Control:	_______

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
7. Gas Control: Passive				
Wells	EA	______	______	______
Pipe and Fittings	LF	______	______	______
Monitoring Probes	EA	______	______	______
NSPS/Title V requirements	LS	______	______	______
			Subtotal Passive Gas Control:	______
8. Gas Control: Active Extraction				
Traps	EA	______	______	______
Sumps	EA	______	______	______
Flare Assembly	EA	______	______	______
Flame Arrestor	EA	______	______	______
Mist Eliminator	EA	______	______	______
Flow Meter	EA	______	______	______
Blowers	EA	______	______	______
Collection System	LF	______	______	______
Other (describe)	______	______	______	______
			Subtotal Active Gas Extraction:	______
9. Security System:				
Fencing	LF	______	______	______
Gate(s)	EA	______	______	______
Sign(s)	EA	______	______	______
			Subtotal Security System:	______
10. Engineering:				
Closure Plan report	LS	______	______	______
Certified Engineering Drawings	LS	______	______	______
NSPS/Title V Air Permit	LS	______	______	______
Final Survey	LS	______	______	______
Certification of Closure	LS	______	______	______
Other (describe)	______	______	______	______
			Subtotal Engineering:	______

DESCRIPTION	HOURS	LS	HOURS	LS	TOTAL
11. Professional Services					
	Contract Management		Quality Assurance		
P.E. Supervisor					
On-Site Engineer					
Office Engineer					
On-Site Technician					
Other (explain)					

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
Quality Assurance Testing	LS			
		Subtotal Professional Services:		

Subtotal of 1-11 Above: ____________

12. Contingency ________ % of Total ____________

Closing Cost Subtotal: ____________

13. Site Specific Costs (explain)
    - Mobilization ____________
    - Waste Tire Facility ____________
    - Materials Recovery Facility ____________
    - Special Wastes ____________
    - Leachate Management System Modification ____________
    - Other ____________

Subtotal Site Specific Costs: ____________

TOTAL CLOSING COSTS: ____________

V. ANNUAL COST FOR LONG-TERM CARE

(Check Term Length)

__________ 5 Years __________ 20 Years __________ 30 Years

__________ Other __________ Years

See 62-701.600(1)a.1., 62-701.620(1), 62-701.630(3)a. and 62-701.730(11)b. F.A.C. for required term length. For landfills certified closed and Department accepted, enter the remaining long-term care length as "Other" and provide years remaining.

****Cost estimates must be certified by a professional engineer (see Section VI).**

**** Costs must be for a third party providing all material, equipment and labor which is at least at fair market value.**

**** In some cases, a price quote in support of individual item estimates may be required.**

All items must be addressed. Attach a detailed explanation for all items marked not applicable (N/A)

DESCRIPTION	SAMPLING FREQUENCY (EVENT/YEAR)	NUMBER OF WELLS	$ / WELL / EVENT	$ / YEAR
1. Groundwater Monitoring [62-701.510(6), and (8)(a)]				
Monthly	12			
Quarterly	4			
Semi-Annually	2			
Annually	1			
			Subtotal Groundwater Monitoring:	
2. Surface Water Monitoring [62-701.510(4), and (8)(b)]				
Monthly	12			
Quarterly	4			
Semi-Annually	2			
Annually	1			
			Subtotal Surface Water Monitoring:	
3. Gas Monitoring [62-701.400(10)]				
Monthly	12			
Quarterly	4			
Semi-Annually	2			
Annually	1			
			Subtotal Gas Monitoring:	
4. Leachate Monitoring [62-701.510(5), (6)(b) and 62-701.510(8)c]				
Monthly	12			
Quarterly	4			
Semi-Annually	2			
Annually	1			
Other (describe)				
			Subtotal Leachate Monitoring:	

DESCRIPTION	UNIT	QUANTITY	UNIT COST	ANNUAL COST
5. Leachate Collection/Treatment Systems Maintenance				
Maintenance				
Collection Pipes	LF			
Sumps, Traps	EA			
Lift Stations	EA			
Cleaning	LS			
Tanks	EA			
Impoundments				
Liner Repair	SY			
Sludge Removal	CY			
Aeration Systems				
Floating Aerators	EA			
Spray Aerators	EA			
Disposal				
Off-site	1000 gallon			
(Include Transportation and Disposal)		Subtotal LCS/Treatment System Maintenance:		

DESCRIPTION	UNIT	HOURS	$/HOUR	TOTAL
6. Leachate Collection/Treatment Systems Operation				
Operation				
P.E. Supervisor	HR			
On-Site Engineer	HR			
Office Engineer	HR			
OnSite Technician	HR			
Materials	LS			
		Subtotal LCS/Treatment System Operation:		
7. Maintenance of Groundwater Monitoring Wells				
Monitoring Wells	LF			
Replacement	EA			
Abandonment	EA			
		Subtotal Groundwater Monitoring Well Maintenance:		

DESCRIPTION	UNIT	QUANTITY	UNIT COST	ANNUAL COST
8. Gas System Maintenance				
Piping, Vents	LF			
Blowers	EA			
Flaring Units	EA			
Meters, Valves	EA			
Compressors	EA			
Flame Arrestors	EA			
Operation	LS			
			Subtotal Gas System:	

DESCRIPTION	UNIT	QUANTITY	UNIT COST	ANNUAL COST
9. Landscape Maintenance				
Mowing	AC			
Fertilizer	AC			
			Subtotal Landscape Maintenance:	
10. Erosion Control & Cover Maintenance				
Sodding	SY			
Regrading	AC			
Liner Repair	SY			
Clay	CY			
			Subtotal Erosion Control and Cover Maintenance:	
11. Storm Water Management System Maintenance				
Conveyance Maintenance	LS			
			Subtotal Storm Water System Maintenance:	
12. Security System Maintenance				
Fences	LF			
Gate(s)	EA			
Sign(s)	EA			
			Subtotal Security System:	
13. Utilities	LS		Utilities Subtotal:	

DESCRIPTION	UNIT	HOURS	$/HOUR	TOTAL
14. Administrative				
P.E. Supervisor	HR			
On-Site Engineer	HR			
Office Engineer	HR			
OnSite Technician	HR			
Other (explain)				
			Subtotal Administrative:	

15. Contingency ________ % of Total

Subtotal Contingency: ________

DESCRIPTION	UNIT	QUANTITY	UNIT COST	TOTAL
16. Site Specific Costs (explain)				

ANNUAL LONG-TERM CARE COST ($/Year): ________

NUMBER OF YEARS OF LONG-TERM CARE ________

TOTAL LONG-TERM CARE COST ($) ________

VI. CERTIFICATION BY ENGINEER

This is to certify that the Cost Estimates pertaining to the engineering features of this solid waste management facility, known as ______________________________, have been examined by me and found to conform to

Facility Name

engineering principles applicable to such facilities. In my professional judgment, the Cost Estimates are a true, correct and complete representation of the financial liabilities for closing and long-term care of the facility and comply with the requirements of Florida Administrative Code (F.A.C.), Rule 62-701.630 and all other Department of Environmental Protection rules, and statutes of the State of Florida. It is understood that the Cost Estimates shall be submitted to the Department annually, revised or adjusted as required by Rule 62-701.630(4), F.A.C.

Signature	Mailing Address
Name and Title (please type)	City, State, Zip Code
Date	E-Mail address (if available)
Florida Registration Number (please affix seal)	( ) Telephone Number

VII. SIGNATURE BY OWNER/OPERATOR

Signature of Applicant	Mailing Address
Name and Title (please type)	City, State, Zip Code
E-Mail address (if available)	( ) Telephone Number

Department of
Environmental Protection
Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

DEP Form # 62-701.900(30)
Form Title: Monitoring Well Completion Report
Effective Date: January 6, 2010
Incorporated in Rule 62-701.510(3)

MONITORING WELL COMPLETION REPORT

DATE: ______________________

FACILITY NAME: ______________________

DEP PERMIT NO.: ______________ WACS_FACILITY: ______________

WACS MONITORING SITE_NUM.: ______________ WACS_WELL: ______________

WELL_TYPE: BACKGROUND ________ DETECTION ________ COMPLIANCE ________

LATITUDE AND LONGITUDE (see back for requirements): ______________

Coordinate Accuracy ________ Datum ________ Elevation Datum ________

Collection Method ______________ Collection Date ______________

Collector Name ______________ Collector Affiliation ______________

AQUIFER MONITORED: ______________________

DRILLING METHOD: ______________ DATE INSTALLED: ______________

INSTALLED BY: ______________________

BORE HOLE DIAMETER: ________ TOTAL DEPTH: ______________ (BLS)

CASING TYPE: ________ CASING DIAMETER: ________ CASING LENGTH: ________

SCREEN TYPE: ________ SCREEN SLOT SIZE: ________ SCREEN LENGTH: ________

SCREEN DIAMETER: ________ SCREEN INTERVAL: ________ TO ________
(BLS)

FILTER PACK TYPE: ______________ FILTER PACK GRAIN SIZE: ______________

INTERVAL COVERED: ________ TO ________ (BLS)

SEALANT TYPE: ________ SEALANT INTERVAL: ________ TO________ (BLS)

GROUT TYPE:________ GROUT INTERVAL: ________ TO ________ (BLS)

TOP OF CASING ELEVATION (NGVD): ________ GROUND SURFACE ELEVATION (NGVD): ________

DESCRIBE WELL DEVELOPMENT: ______________________

POST DEVELOPMENT WATER LEVEL ELEVATION (NGVD): ______________

DATE AND TIME MEASURED: ______________________

REMARKS: ______________________

____

NAME OF PERSON PREPARING REPORT: ______________________

____

(Name, Organization, Phone No., E-mail)

NOTE: ATTACH AS-BUILT MW CONSTRUCTION DIAGRAM AND LITHOLOGIC LOG.(NGVD) NATIONAL GEODETIC VERTICAL DATUM OF 1988 (BLS) = BELOW LAND SURFACE

Latitude must be measured in degrees, minutes and seconds, to at least two (2) decimal places.

Longitude must be measured in degrees, minutes and seconds, to at least two (2) decimal places.

Eastings and northings (State Plane Coordinates) **must** be converted to latitude and longitude.

Coordinate Accuracy: the measured, estimated degree of correctness of the measurement. An accuracy of 15 feet or 5 meters is preferred.

Datum: the horizontal reference for measuring locations on the Earth's surface. NAD83- North American Datum of 1983 is preferred.

Elevation Datum: the reference datum from which elevation measurements are made. NGVD88 (National Geodetic Vertical Datum of 1988) is preferred.

Collection Method: the method or mechanism used to derive the measurements, e.g. GPS, map, aerial photo, etc.

Collection Date: the date and time on which the measurements were taken.

Collector Name: the name of the person taking the measurement.

Collector Affiliation: the agency or company for whom the collector works.

Department of Environmental Protection

Bob Martinez Center
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

DEP Form #: 62-701.900(7)
Form Title: Annual Report for a Construction and Demolition Debris Facility
Effective Date: January 6, 2010
Incorporated in Rule: 62-701.710(9), F.A.C.

ANNUAL REPORT FOR A CONSTRUCTION AND DEMOLITION DEBRIS FACILITY

1. **Company Name:** ______________________ **Reporting Year**________
2. **Name of Facility:** ______________________ ☐ **Landfill** ☐**MRF** ☐**TS**
3. **Physical Address:** ______________________
4. **Mailing Address:** ______________________
5. **County Location:** ______________________
6. **Debris County of Origin:** ______________________
7. **Company Contact:** ______________________
   (the individual responsible for this information)
8. **Phone Number:** ____________ **Fax Number** ____________ **E-Mail:** ____________

MATERIAL TYPES	MATERIALS RECOVERED	TOTAL TONS RECYCLED (SHIPPED)
ASPHALT	Used for________________	________
CONCRETE	**Source: Roads, Bridges, Sidewalks, Curbs** **Source: Building Construction/Demolition:** Used for fill (lake or land) Used for Road base Other Use________________	________ ________ ________ ________ Subtotal Concrete ________
FINES/RECOVERED SCREEN MATERIALS	Used for________________	________
WOOD	Daily/Intermediate Cover Waste-to-Energy fuel (see pg.2 for facility list) Other processed fuel Mulch, compost Final cover Other Use________________	________ ________ ________ ________ ________ ________ Subtotal Wood ________
LAND CLEARING DEBRIS	Daily/Intermediate Cover Waste-to-Energy fuel (see pg.2 for facility list) Other processed fuel Mulch, compost Final cover Other Use________________	________ ________ ________ ________ ________ ________ Subtotal Wood ________
DRYWALL	All	________
SHINGLES/ROOFING	How used?________________	________
Subtotal Page 1 Subtotal Page 2		________ ________

9. **TOTAL TONS OF C&D DEBRIS RECYCLED** *(add subtotals page 1 & 2 above):* ____________
10. **TOTAL TONS OF C&D DEBRIS DISPOSED** *(all debris landfilled):* ☐ **on-site** ☐ **off-site** ____________

Signature (authorized Representative) ____________ Title ____________ Date ____________

Print Name ____________

NOTE: Use one of these forms for each county from which the facility received materials

Attachment 8

MATERIAL TYPES	MATERIALS RECOVERED	TOTAL TONS RECYCLED
PAPER	Old Corrugated Containers (OCC) Other Paper	_______ _______ Subtotal Paper _______
PLASTIC	Plastic containers/buckets All other plastic	_______ _______ Subtotal Plastic _______
METALS	Aluminum Other Non-Ferrous (brass, copper, etc.) Steel Other Ferrous	_______ _______ _______ _______ Subtotal Metals _______
TEXTILES	Miscellaneous/carpet	_______
Subtotal Page 2		_______

Waste to Energy Facilities

- **Bay County Resource Recovery**
- **Broward County N. Resource Recovery**
- **Broward County S. Resource Recovery**
- **Dade County Resource Recovery**
- **Hillsborough County SWE Recovery**
- **Lake County Resource Recovery**
- **Lee County SW Resource Recovery**
- **McKay Bay Refuse to Energy Project**
- **Southernmost WTE Facility**
- **North County Regional Resource Recovery**
- **Pasco County SW Resource Recovery**
- **Pinellas County Resource Recovery**

Processed wood/land clearing debris that goes to any facility for fuel other than above is considered "Other Processed Fuel".

ATTACHMENT R.1
CLOSURE AND LONG TERM CARE COSTS APPROVAL CORRESPONDENCE

Florida Department of Environmental Protection

Southwest District Office
13051 North Telecom Parkway
Temple Terrace, FL 33637-0926

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

March 22, 2010

Transmitted electronically only:
lerose@scgov.net

Ms. Lois E. Rose, Manager
Sarasota County Solid Waste Operations
4000 Knights Trail Road
Sarasota, Fl. 34275

RE: Sarasota Central County Solid Waste Disposal Complex
Financial Assurance Cost Estimates
Permit No.: 130542-007-SO, Class I
WACS No. SWD/58/51614

Dear Ms. Rose:

This letter is to acknowledge receipt of inflation-adjusted cost estimates dated January 25, 2010 (received January 27, 2010), prepared by HDR, for closure and long-term care of the Sarasota Central County Solid Waste Disposal Complex. The cost estimates received January 27, 2010 (total for closing $32,298,822.74 and long term-care $1,017,734.52/year X 30 years = $30,532,035.56) are **APPROVED for 2010.** The next annual update (either revised or inflation-adjusted) shall be due no later than March 1, 2011.

A copy of these estimates will be forwarded to Mr. Fred Wick, Solid Waste Section, FDEP, 2600 Blair Stone Road, Tallahassee, Florida 32399-2407. Please work with him directly to assess the facility's compliance with the funding mechanism requirements of Rule 62-701.630, F.A.C. If you have any questions, you may contact me at (813) 632-7600 ext. 374.

Sincerely,

Melissa Madden
Solid Waste Section
Southwest District

mam
cc: Thomas M. Yanoschak, P.E., DEE, HDR Engineering, Inc, Thomas.Yanoschak@hdrinc.com
Fred Wick/Frank Hornbrook, FDEP, Tallahassee, w/attachment
Susan Pelz, P.E., FDEP Tampa (via email)

SARASOTA COUNTY
"Dedicated to Quality Service"

Dept Of Environmental Protection
JAN 27 2010
Southwest District

January 25, 2010

Susan J. Pelz, P.E.
Solid Waste Section
Department of Environmental Protection
13051 North Telecom Parkway
Temple Terrace, FL 33637-0926

Re: Central County Solid Waste Disposal Complex (CCSWDC)
Permit Number 130542-007-SO/01
Financial Assurance Cost Estimate

Dear Ms. Pelz:

Enclosed is the annual Financial Assurance Cost Estimate for the CCSWC submitted in accordance with 62-701.630(4)(a) and Part D.4.a of the above operating permit. An inflation adjustment was used to calculate the adjusted closure cost estimate.

Please contact me if you have any questions at (941) 861-1589 or lerose@scgov.net.

Sincerely,

Lois E Rose

Lois E. Rose
Manager, Solid Waste

Enc

cc: Financial Coordinator, Solid Waste Section, Tallahassee
Kelly Betz, Clerk of the Court, Finance Section

DEP Form # 62-701.900(28)
Form Title Financial Assurance Cost Estimate Form
Effective Date 05-27-01
DEP Application No. ________ (Filled by DEP)

Florida Department of Environmental Protection
Twin Towers Office Bldg. • 2600 Blair Stone Road • Tallahassee, FL 32399-2400

FINANCIAL ASSURANCE COST ESTIMATE FORM

Date: January 25, 2010   Date of DEP Approval: ____________

I. GENERAL INFORMATION:

Facility Name: Central County Solid Waste Disposal Complex WACS or GMSID #: SWD/58/51614

Permit / Application No.: 130542-007-SO/01   Expiration Date: 11/18/2013

Facility Address: 4000 Knights Trail Road, Nokomis, FL 34275

Permittee: Sarasota County Solid Waste Operations

Mailing Address: 4000 Knights Trail Road, Nokomis, FL 34275

Latitude: 27° 12' 10.7"   Longitude: 82° 23' 16.39"   or   UTM: ____________

Solid Waste Disposal Units Included in Estimate:

Phase / Cell	Acres	Date Unit Began Accepting Waste	Design Life of Unit From Date of Initial Receipt of Waste
Phase I	55	6/15/1998	12
Phase II	54	Late 2010	10

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
JAN 27 2010
SOUTHWEST DISTRICT
TAMPA

Total Landfill Acreage included in this estimate. 109 Closure 109 Long-Term Care

Type of landfill: ✓ Class I ____ Class III ____ C&D Debris

II. TYPE OF FINANCIAL ASSURANCE DOCUMENT (Check Type)

____ Letter of Credit*
____ Insurance Certificate
____ Surety Bond*
____ Escrow Account
____ Trust Fund Agreement
✓ Financial Test

*Indicates mechanisms that require use of a Standby Trust Fund Agreement

III. ESTIMATE ADJUSTMENT

40 CFR Part 264 Subpart H as adopted by reference in Rule 62-701.630, Florida Administrative Code sets forth the method of annual cost estimate adjustment. Cost estimates may be adjusted by using an inflation factor or by recalculating the maximum costs of closure in current dollars. Select one of the methods of cost estimate adjustment below.

☑ **(a) Inflation Factor Adjustment**

Inflation adjustment using an inflation factor may only be made when a Department approved closure cost estimate exists and no changes have occurred in the facility operation which would necessitate modification to the closure plan. The inflation factor is derived from the most recent Implicit Price Deflator for Gross National Product published by the U.S. Department of Commerce in its survey of Current Business. The inflation factor is the result of dividing the latest published annual Deflator by the Deflator for the previous year. The inflation factor may also be obtained from the Solid Waste Financial Coordinator at (850)-245-8732.

This adjustment is based on the Department approved closure cost estimate dated: 10/29/09

Latest Department Approved Closure Cost Estimate:		Current Year Inflation Factor		Inflation Adjusted Closure Cost Estimate:
$31,665,512.49	x	1.020	=	$32,298,822.74

This adjustment is based on the Department approved long-term care cost estimate dated: 10/29/09

Latest Department Approved Annual Long-Term Care Cost Estimate:		Current Year Inflation Factor		Inflation Adjusted Annual Long-Term Care Cost Estimate:
$997,778.94	x	1.020	=	$1,017,734.52

Number of Years of Long Term Care Remaining: x 30

Inflation Adjusted Long-Term Care Cost Estimate: = $ 30,532,035.56

☐ **(b) Recalculate Estimates** (see section V)

IV. CERTIFICATION BY ENGINEER

This is to certify that the Financial Assurance Cost Estimates pertaining to the engineering features of the this solid waste management facility have been examined by me and found to conform to engineering principals applicable to such facilities. In my professional judgement, the Cost Estimates are a true, correct and complete representation of the financial liabilities for closing and long-term care of the facility and comply with the requirements of Florida Administrative Code (F.A.C.), Rule 62-701.630 and all other Department of Environmental Protection rules, and statutes of the State of Florida. It is understood that the Financial Assurance Cost Estimates shall be submitted to the Department annually, revised or adjusted as required by Rule 62-701.630(4), F.A.C.

Thomas M. Yanoschak
Signature of Engineer

Thomas M. Yanoschak, PE, Project Mgr
Name & Title (please type)

P.E. Number 44200
Florida Registration Number (affix seal) &Date

3233 National Drive Suite 207
Raleigh, NC 27612-4845
Mailing Address

(919) 232-6618
Telephone Number

Lois Rose
Signature of Owner/Operator

Lois E. Rose, Solid Waste Manager
Name & Title (please type)

(941) 861-1589
Telephone Number

lerose@scgov.net
Owner/Operator E-mail address

Thomas.yanoschak@hdrinc.com
Engineer E-mail address

THOMAS M. YANOSCHAK
LICENSE
No. 44200
STATE OF FLORIDA
PROFESSIONAL ENGINEER

Page 2 of 11

1/25/10

Madden, Melissa

From: Pelz, Susan
Sent: Monday, February 01, 2010 12:12 PM
To: 'Lois E. Rose'
Cc: Lora M. Ross; Gary Bennett; Morgan, Steve; Madden, Melissa
Subject: RE: FACE - Permit No. 134912-004-SO/31
Attachments: image001.jpg

Lois,

This email is to confirm that the Department anticipates that the County will continue to include the MRF cost estimates as part of the Central County landfill cost estimate submittal.

If you have any questions, please call or email (email is better).

Susan J. Pelz, P.E.
Solid Waste Program Manager
Southwest District

13051 N. Telecom Parkway
Temple Terrace, Fl. 33637
813-632-7600 x 386
susan.pelz@dep.state.fl.us

From: Lois E. Rose [mailto:lerose@scgov.net]
Sent: Thursday, January 28, 2010 11:04 AM
To: Pelz, Susan
Cc: Lora M. Ross; Gary Bennett
Subject: FACE - Permit No. 134912-004-SO/31

Susan -

I wanted to clarify and have you confirm that the county does not have to submit separate financial assurance documents for the above Materials Recovery Facility (MRF) permit as the financial information for this site is included in the financial assurance documents for the Central County Solid Waste Disposal Complex - Permit No. 130542-007-SO/01.

When we received the new MRF permit dated November 18, 2009, the Financial Assurance section changed and omitted language that was in the prior permit that stated, The permittee shall provide financial assurance for the facility in accordance with Rule 62-701.710(7), F.A.C., either separately or as part of the financial assurance for the adjacent landfill as required by the current landfill operations permit.

Thanks -

Lois Rose
Manager, Solid Waste
Sarasota County Government

(941) 861-1589 Work
(941) 650-0722

4000 Knights Trail Road
Nokomis, FL 34275
lerose@scgov.net

ATTACHMENT R.1
CLOSURE AND LONG TERM CARE COSTS APPROVAL CORRESPONDENCE

Florida Department of Environmental Protection

Southwest District Office
13051 North Telecom Parkway
Temple Terrace, FL 33637-0926

March 22, 2010

Transmitted electronically only:
lerose@scgov.net

Ms. Lois E. Rose, Manager
Sarasota County Solid Waste Operations
4000 Knights Trail Road
Sarasota, Fl. 34275

RE: Sarasota Central County Solid Waste Disposal Complex
Financial Assurance Cost Estimates
Permit No.: 130542-007-SO, Class I
WACS No. SWD/58/51614

Dear Ms. Rose:

This letter is to acknowledge receipt of inflation-adjusted cost estimates dated January 25, 2010 (received January 27, 2010), prepared by HDR, for closure and long-term care of the Sarasota Central County Solid Waste Disposal Complex. The cost estimates received January 27, 2010 (total for closing $32,298,822.74 and long term-care $1,017,734.52/year X 30 years = $30,532,035.56) are APPROVED for 2010. The next annual update (either revised or inflation-adjusted) shall be due no later than March 1, 2011.

A copy of these estimates will be forwarded to Mr. Fred Wick, Solid Waste Section, FDEP, 2600 Blair Stone Road, Tallahassee, Florida 32399-2407. Please work with him directly to assess the facility's compliance with the funding mechanism requirements of Rule 62-701.630, F.A.C. If you have any questions, you may contact me at (813) 632-7600 ext. 374.

Sincerely,

Melissa Madden
Solid Waste Section
Southwest District

mam

cc: Thomas M. Yanoschak, P.E., DEE, HDR Engineering, Inc, Thomas.Yanoschak@hdrinc.com
Fred Wick/Frank Hornbrook, FDEP, Tallahassee, w/attachment
Susan Pelz, P.E., FDEP Tampa (via email)

SARASOTA COUNTY
"Dedicated to Quality Service"

Dept. Of Environmental Protection
JAN 27 2010
Southwest District

January 25, 2010

Susan J. Pelz, P.E.
Solid Waste Section
Department of Environmental Protection
13051 North Telecom Parkway
Temple Terrace, FL 33637-0926

Re: Central County Solid Waste Disposal Complex (CCSWDC)
Permit Number 130542-007-SO/01
Financial Assurance Cost Estimate

Dear Ms. Pelz:

Enclosed is the annual Financial Assurance Cost Estimate for the CCSWC submitted in accordance with 62-701.630(4)(a) and Part D.4.a of the above operating permit. An inflation adjustment was used to calculate the adjusted closure cost estimate.

Please contact me if you have any questions at (941) 861-1589 or lerose@scgov.net.

Sincerely,

Lois E. Rose

Lois E. Rose
Manager, Solid Waste

Enc

cc: Financial Coordinator, Solid Waste Section, Tallahassee
Kelly Betz, Clerk of the Court, Finance Section

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FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
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Thomas M. Yanoschak
Signature of Engineer

Thomas M. Yanoschak, PE, Project Mgr
Name & Title (please type)

P.E. Number 44200
Florida Registration Number (affix seal) &Date

3233 National Drive Suite 207
Raleigh, NC 27612-4845
Mailing Address

(919) 232-6618
Telephone Number

Lois Rose
Signature of Owner/Operator

Lois E. Rose, Solid Waste Manager
Name & Title (please type)

(941) 861-1589
Telephone Number

lerose@scgov.net
Owner/Operator E-mail address

Thomas.yanoschak@hdrinc.com
Engineer E-mail address

THOMAS M. YANOSCHAK LICENSE No. 44200 STATE OF FLORIDA PROFESSIONAL ENGINEER

1/25/10

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Sent: Monday, February 01, 2010 12:12 PM
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Subject: RE: FACE - Permit No. 134912-004-SO/31
Attachments: image001.jpg

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Southwest District

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Lois Rose
Manager, Solid Waste
Sarasota County Government

(941) 861-1589 Work
(941) 650-0722

4000 Knights Trail Road
Nokomis, FL 34275
lerose@scgov.net

ATTACHMENT R.2
FINANCIAL ASSURANCE MECHANISM APPROVAL

Florida Department of Environmental Protection

Bob Martinez Center
2600 Blair Stone Road MS 4565
Tallahassee, Florida 32399-2400

Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

March 30, 2010

Mr. Peter Ramsden
Director of Finance
Sarasota County
Post Office Box 3079
Sarasota, Florida 34230-3079

Re: WACS 51614 – Sarasota Central County Solid Waste Disposal Complex
WACS 51611 – Bee Ridge Landfill

Dear Mr. Ramsden:

I reviewed the documentation submitted to demonstrate financial assurance for the above referenced facilities and find it is in order. The fiscal year end 2009 financial test demonstrates adequate financial assurance covering the Department approved closing and long-term care cost estimates of $32,298,822.74 and $30,532,035.56 for the Sarasota Central County Solid Waste Complex and $57,222.00 for the closing of the Bee Ridge gas to energy system and $9,115,632.42 for long-term care of the Bee Ridge Landfill. Therefore, these facilities are in compliance with the financial assurance requirements of Rule 62-701.630, Florida Administrative Code, at this time.

If you have any questions, please contact me at (850) 245-8745.

Sincerely,

Frank Hornbrook
Environmental Specialist
Solid Waste Section

cc: Fred Wick, DEP/TLH
Susan Pelz, DEP/TPA

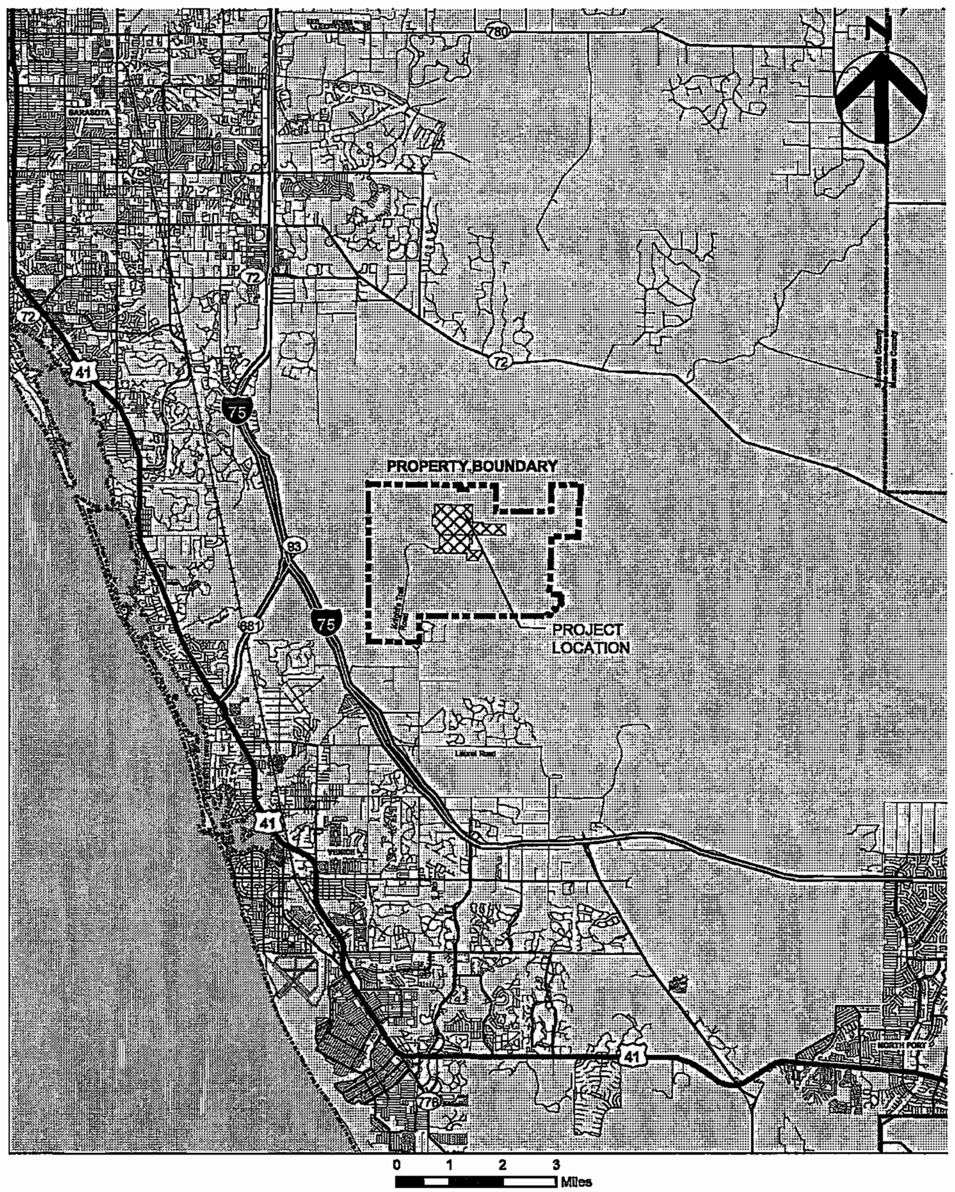
APPENDIX A
CONSTRUCTION DESIGN DRAWINGS
(FULL SIZE SIGNED AND SEALED DRAWINGS BOUND SEPARATELY)

C:\pwworking\tpa\d0201056\00G-01.dwg, Plot, 4/29/2010 1:36:48 PM, irivera

HDR

HDR Engineering, Inc.
2621 Cattlemen Road, Suite 106
Sarasota, FL 34232-62121
(941) 342-2700
CA00004213

Sarasota County



Permit Drawings For

Phase I Class I Landfill Closure

Central County Solid Waste Disposal Complex

Project No. 096-125174-002

Sarasota County, Florida
CIP No. 95206

Issued for Approval

APRIL 2010

INDEX OF DRAWINGS

THOMAS M. YANOSCHAK, P.E.
CERTIFICATE NO. 44200

SHEET
00G-01

ENGINEERING SYMBOLOGY

- EMBANKMENT SLOPE
- VEGETATION (SIZE)
- CO — CLEANOUT
- MH — MANHOLE
- MW — GROUNDWATER MONITORING WELL
- P — PIEZOMETER
- WATER SUPPLY WELL
- C-1/P2-1 — LEACHATE MONITORING POINT
- STW — STORMWATER MONITORING STATION
- GP — GAS PROBE
- UV — UTILITY VAULT
- PP — POWER POLE
- TP — TELEPHONE POLE
- FH — FIRE HYDRANT
- YH-X — YARD HYDRANT
- × 75.5 — EXISTING SPOT ELEVATION
- 75.8 — FINISHED SPOT ELEVATION
- HORIZONTAL CONTROL POINT OR BENCHMARK
- DOWNGUY
- SWAMP OR WETLANDS
- B4-R — SURFACE WATER MONITORING STATION

NOTES:

1. UTILITIES THAT ARE SUSPENDED ABOVE GRADE ARE DESIGNATED BY THE PREFIX "OH" (OVERHEAD).

- ———T——— TELEPHONE LINE
- ———E——— ELECTRIC LINE
- ———F——— FIBER OPTIC
- ———C——— COMMUNICATION
- PIPELINE
- LARGE PIPELINE
- RAILROAD
- DRAINAGE FLOW
- NATURAL WATERWAY
- ——X——X—— CHAIN LINK FENCE
- ——X——X—— FIELD FENCE
- PROPERTY BOUNDARY
- CENTERLINE
- ———RB——— ROCK BERM
- SILT FENCE
- LIMITS OF CONSTRUCTION
- WATERWAY
- LIMITS OF EASEMENT
- EASEMENT CENTERLINE
- CONSTRUCTION TRAFFIC ROUTE (SEE NOTE 5)
- EXISTING ROADWAY
- PHASE LIMITS
- ROW

- EXISTING ELEVATION CONTOUR
- PROPOSED ELEVATION CONTOUR
- LIMITS OF PROPOSED LINER
- APPROXIMATE LIMITS OF EXISTING LINER
- ASPHALT (PLAN OR SMALL-SCALE SECTION)
- ASPHALT (LARGE-SCALE SECTION)
- PROTECTIVE COVER SOIL
- INITIAL COVER
- INTERMEDIATE COVER
- CHECKERED PLATE (PLAN)
- CONCRETE (PLAN AND/OR SECTION)
- CONCRETE MASONRY (PLAN AND/OR SECTION)
- SOLID WASTE (SECTION)
- FABRIC-FORMED CONCRETE (PLAN)
- FABRIC-FORMED CONCRETE (SECTION)
- FINISHED WOOD (SECTION)
- GRANULAR FILL (SECTION)
- GRATING (PLAN)
- GROUT (SECTION)
- PRECAST CONCRETE (PLAN AND/OR SECTION)
- RIPRAP OR RUBBLE (PLAN AND/OR SECTION)
- DRAINAGE STONE (SECTION)
- SAND (SECTION)
- TOPSOIL (SECTION)
- SOD OR GRASS (SECTION)
- WOOD – CONTINUOUS (SECTION)
- WOOD BLOCKING (SECTION)
- GEOSYNTHETIC DRAINAGE LAYER (SECTION)
- GEOMEMBRANE (SECTION)
- GEOTEXTILE (SECTION)
- 20 MIL POLYETHYLENE RAIN COVER
- 40 MIL GEOMEMBRANE (LLDPE TEXTURED/SMOOTH)
- 60 MIL GEOMEMBRANE (HDPE TEXTURED)
- LEACHATE FORCEMAIN TO OFFSITE WWTP (SEE NOTE 4)

GENERAL SYMBOLOGY

ARROW INDICATES DIRECTION OF PLAN NORTH — N

PLAN
1/4" = 1'-0"
PLAN TITLE

SECTION LETTER
FLAG INDICATES DIRECTION OF SECTION CUT
X / XXX
SHEET WHERE SECTION IS LOCATED *
SECTION CUT MARKER

SECTION
3/8" = 1'-0"
SECTION LETTER
SHEET WHERE SECTION VIEW IS FIRST CUT *
X / XXX
SECTION TITLE

DETAIL NUMBER
/ XXX
SHEET WHERE DETAIL IS LOCATED *
DETAIL MARKER
FOR REFERENCING DETAILS INCLUDED IN DRAWING SET.

XXXXXXXX
DETAIL MARKER
FOR REFERENCING DETAILS BOUND IN SPECIFICATIONS OR SEPARATE VOLUME.

DETAIL
3" = 1'-0"
DETAIL NUMBER
SHEET WHERE DETAIL WAS CALLED OUT
/ XXX
DETAIL TITLE

* FOR COMMON DETAILS AND SECTIONS OR DETAILS THAT ARE CUT OR CALLED OUT ON MULTIPLE SHEETS, THE SHEET NUMBER IS REPLACED BY A DASH (–).

ELEVATION NUMBER
ARROW INDICATES POINT OF VIEW
SHEET WHERE ELEVATION IS LOCATED *
X / XXX
SINGLE ELEVATION OR PHOTO MARKER

A B C D
ELEVATION NUMBER
ARROW INDICATES POINT OF VIEW ELEVATION
INDICATES SHEET WHERE ELEVATION IS LOCATED
X / XXX
MULTIPLE ELEVATION OR PHOTO MARKER

ELEVATION
3" = 1'-0"
ELEVATION IDENTIFICATION NUMBER
SHEET WHERE POINT OF VIEW MARKER CAN BE FOUND *
X / XXX
ELEVATION TITLE

ABBREVIATIONS

APPROX – APPROXIMATE, APPROXIMATELY
BLDG – BUILDING
BTM – BOTTOM
CB – CATCH BASIN
CM – CONCRETE MONUMENT
CONC – CONCRETE
CONT – CONTINUOUS
CORR – CORRUGATED
DET – DETAIL
DIA – DIAMETER
DIM – DIMENSION
DWG – DRAWING
EA – EACH
EOL – EDGE OF LINER
ETC – ET CETERA
ENCL – ENCLOSE, ENCLOSURE
EL – ELEVATION
EQUIP – EQUIPMENT
EXIST – EXISTING
FDEP – FLORIOA DEPARTMENT OF ENVIRONMENTAL PROTECTION
FDOT – FLORIDA DEPARTMENT OF TRANSPORTATION
FES – FLARED END SECTION
FIN – FINISHED
FM – FORCE MAIN
GALV – GALVANIZED
GCL – GEOSYNTHETIC CLAY LINER
GFFR – GROUT FILLED FIBER REVETMENT
GR – GRADE
GDL – GEOSYNTHETIC DRAINAGE LINER
GM – GAS MONITORING LOCATION
GP – GAS PROBE
HDPE – HIGH OENSITY POLYETHYLENE
HP – HIGH POINT
ID – INSIDE OIAMETER
IE – INVERT ELEVATION
LF – LINEAL FEET
LFG – LANDFILL GAS
LLDPE – LINEAR LOW DENSITY POLYETHYLENE
LP – LOW POINT
MAX – MAXIMUM
MFR – MANUFACTURER
MH – MANHOLE
MIN – MINIMUM
MISC – MISCELLANEOUS
MSL – (ABOVE) MEAN SEAL LEVEL
MT – MOUNT
MW – GROUNOWATER MONITORING WELL
N/A – NOT APPLICABLE
N/AVAIL – NOT AVAILABLE
NGVD – NATIONAL GEODETIC VERTICAL DATUM
NIC – NDT IN CONTRACT
No – NUMBER
NP – NONPERFORATEDP – PIEZOMETER
NTS – NOT TO SCALE
OC – ON CENTER
OD – OUTSIDE OIAMETER
OSHA – OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION
P – PIEZOMETER
PLS – PROFESSIONAL LAND SURVEYOR
PS – PUMP STATION
R – RADIUS
RCP – REINFORCED CONCRETE PIPE
REF – REFERENCE
REQD – REQUIRED
SL–SLDPE
SCH – SCHEDULE
SDR – STANDARD DIMENSION RATIO
SHT – SHEET
SIM – SIMILAR
SS – STAINLESS STEEL
STD – STANDARD
STL – STEEL
STW – STORMWATER MONITORING STATION
TRM – TURF REINFORCEMENT MATTING
TYP – TYPICAL
USC&GS – UNITED STATES COASTAL AND GEODETIC SURVEY
USGS – UNITED STATES GEOLOGICAL SURVEY
WGT – WEIGHT
W.E. – WATER ELEVATION
WWTP – WASTE WATER TREATMENT PLANT

GENERAL NOTES

1. THIS IS A STANDARD SHEET SHOWING COMMON SYMBOLOGY. ALL SYMBOLS ARE NOT NECESSARILY USED ON THIS PROJECT.
2. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE-EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FDR USAGE.
3. EXISTING TOPOGRAPHY WITHIN PHASES I THROUGH IV AREAS COMPILED BY KUCERA INTERNATIONAL INC. OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
4. EXISTING TOPOGRAPHY WITHIN THE FUTURE USE AREAS COMPILED FROM THE CDM CONSTRUCTION PLANS DATED APRIL 1998 AND BY PBS&J LEACHATE FORCEMAIN AND PUMP STATION DRAWING SET DATED JULY 2005.
5. LOCATIONS OF EXISTING PIEZOMETERS, MONITORING WELLS AND STAFF GAUGES OBTAINED FROM SPECIFIC PURPOSE SURVEY BY SARASOTA CDUNTY, MARCH 2008. VERIFY LOCATIONS IN FIELD.
6. EXISTING UNOERGROUND FACILITIES, STRUCTURES, AND UTILITIES HAVE BEEN LOCATED FROM THE BEST AVAILABLE SURVEY DATA ANO RECORDS AND THEIR LOCATIONS MUST ONLY BE CONSIDERED AS APPROXIMATE. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO VERIFY THE EXACT LOCATION OF ALL EXISTING UTILITIES SHOWN ON THE PLANS AND ANY OTHER UTILITIES WHICH MAY NOT BE SHOWN ON THE PLANS. THE CONTRACTOR SHALL NOTIFY ALL UTILITY COMPANIES IN THE AREA AT LEAST 72 HOURS PRIOR TO BEGINNING CONSTRUCTION. CALL FLORIDA SUNSHINE STATE ONE CALL CENTER AT 811. ALL COORDINATION AND REQUIRED UTILITY COMPANY TEMPORARY PROTECTION SHALL BE AT THE CONTRACTOR'S EXPENSE. IT IS THE CONTRACTOR'S RESPONSIBILITY TO ENSURE UNINTERUPTION OF SERVICE AND REPLACEMENT OF DAMAGED UTILITES.
7. THE CONTRACTOR SHALL RESTORE TO THE OWNER'S SATISFACTION ALL AREAS DISTURBED BY CONSTRUCTION; INCLUDING PERIMETER ROADWAY SURFACES, ROADWAY SHOULDERS AND DITCHES, DRAINAGE STRUCTURES AND OTHER EXISTING FEATURES.
8. HORIZONTAL DATUM IS BASED ON THE FLORIDA STATE PLANE COORDINATE SYSTEM–WEST ZONE (NAD 83). VERTICAL DATUM IS BASED ON THE NATIONAL GEODETIC VERTICAL DATUM (NGVD 88).
9. THE CONTRACTOR SHALL OBTAIN ALL PERMITS AND APPROVALS PRIOR TO COMMENCING WORK.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MEETING ALL CONDITIONS AND REQUIREMENTS OF ALL PERMITS AND ALL GOVERNING FEDERAL, STATE, AND LOCAL AGENCIES.
11. THESE PLANS ACCOMPANY AND ARE PART OF THE TECHNICAL SPECIFICATIONS. WHEN THESE DRAWINGS ANO/OR TECHNICAL SPECIFICATIONS LACK SPECIFICITY, CONSULT THE DESIGN ENGINEER (HDR ENGINEERING, INC.).
12. ANY CONFLICTS BETWEEN THESE PLANS AND THE PERMIT SHOULD BE BROUGHT TO THE ATTENTION OF THE DESIGN ENGINEER (HDR ENGINEERING, INC.).
13. THE CONTRACTOR IS RESPONSIBLE FOR DEWATERING (IF REQUIRED) ALL EXCAVATIONS, FILL AREAS, ETC. IN ORDER TO WORK IN DRY CONDITIONS. REFER TO THE SPECIFICATIONS FOR ADDITIONAL INFORMATION.
14. ATTENTION IS DIRECTED TO THE FACT THAT AN ACTIVE LANDFILL ANO OTHER FACILITIES WILL BE IN OPERATION DURING THE CONSTRUCTION PERIOD. WASTE HAULING TRUCKS WILL BE ACTIVE DURING NORMAL BUSINESS HOURS. THE CONTRACTOR SHALL NOT BLOCK WASTE HAULING OR OTHER LANDFILL ACTIVITIES WITHOUT PRIOR WRITTEN APPROVAL FROM THE OWNER. IF NECESSARY, CONTRACTOR SHALL PROVIDE TRAFFIC CONTROL TO MAINTAIN LANDFILL ACTIVITIES. THE CONTRACTOR IS ADVISED THAT SCALE RECORDS ARE AVAILABLE, UPON REQUEST FROM THE OWNER, WHICH INDICATE HISTORICAL DELIVERIES, BOTH DAILY AND HOURLY, OF WASTE TO THE LANDFILL.
15. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR SITE SAFETY ASSOCIATED WITH THE WORK UNDER THIS CONTRACT AND FOR COMPLIANCE WITH ALL FEDERAL, STATE AND LOCAL HEALTH AND SAFETY LAWS, CODES, REGULATIONS AND ORDINANCES INCLUDING BUT NOT LIMITED TO THOSE MANDATED BY OSHA AND THE FLORIDA TRENCH SAFETY ACT. CONTRACTOR SHALL ALSO COORDINATE A SITE SAFETY PLAN WITH COUNTY PERSONNEL. THE CONTRACTOR SHALL INCLUDE IN THE TOTAL BID PRICE ALL COSTS FOR COMPLIANCE WITH THESE REGULATIONS.
16. THE CONTRACTOR IS RESPONSIBLE FOR DEVELOPING AND MAINTAINING A SITE AND PERSONNEL SAFETY PROGRAM TO ADDRESS MONITORING DF THE WORK WITHIN AND ADJACENT TO THE EXISTING LANDFILL. REFER TO TECHNICAL SPECIFICATIONS FOR ENVIRONMENTAL CONTROL PROGRAM REQUIREMENTS FOR FURTHER INFORMATION.
17. THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING THE LOCATION AND ELEVATION OF ALL EXISTING BENCHMARKS. FURTHER, THE CONTRACTOR WILL NEED TO EMPLOY A LICENSED SURVEYOR FOR EXTENDING BOTH HORIZONTAL AND VERTICAL CONTROLS AS NECESSARY TO PERFORM THE WORK UNDER THIS CONTRACT.
18. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO EXISTING FACILITIES, STRUCTURES, OR UTILITIES ABOVE OR BELOW GROUND, CAUSED BY CONSTRUCTION OPERATIONS WHICH HAVE BEEN PREVIOUSLY LOCATED BY THEIR RESPECTIVE OWNERS.
19. THE CONTRACTOR'S WORK SHALL BE SCHEDUELD BETWEEN 7:00 AM AND 5:30 PM WITH A MAXIMUM OF 10 HOURS PER DAY AND 5 DAYS PER WEEK. SHOULD THE CONTRACTOR REQUIRE MORE WORK HOURS TO MAINTAIN THE CONTRACT SCHEDULE, A REQUEST SHALL BE SUBMITTED IN WRITING TO THE ENGINEER STATING THE REASONS WHY AND HOW MANY ADDITIONAL HOURS ARE NEEDED. ALSO, THE CONTRACTOR SHALL REQUEST IN WRITING TO THE ENGINEER WITH A MINIMUM OF SEVENTY–TWO (72) HOURS ADVANCE NOTICE, OF ANY PLANS FOR WORKING ON ANY WEEKEND DAYS OR OBSERVED NATIONAL HOLIDAYS. SHOULD THE ENGINEER APPROVE THE REQUEST FOR ADDITIONAL HOURS, THE CONTRACTOR SHALL REIMBURSE THE OWNER FOR ACTUAL COSTS FOR RESIDENT INSPECTION INCURRED DURING THE ADDITIONAL HOURS APPROVED. THE HOURLY RATE FOR THESE ADDITIONAL HOURS WILL BE $100.00 PER HOUR.
20. THE CONTRACTOR SHALL PROVIDE PROPER WARNING SIGNS, BARRICADES, TEMPORARY FENCING AND OTHER APPROPRIATE SAFETY DEVICES DURING THE EXECUTION OF THE WORK TO PROVIDE PUBLIC PROTECTION AND SAFETY.
21. THE CONTRACTOR SHALL PROVIDE ACCESS FOR TRAFFIC AT ALL TIMES DURING CONSTRUCTION.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

SHEET NAMING CONVENTION

G	GENERAL
V	SURVEYING/MAPPING
X	DEMOLITION
C	CIVIL
U	MULTI–DISCIPLINE
S	STRUCTURAL
A	ARCHITECTURAL
D	PROCESS
M	MECHANICAL (HVAC)
P	PLUMBING
E	ELECTRICAL
Y	INSTRUMENTATION
LFG	LANDFILL GAS

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ISSUE	DATE	DESCRIPTION
A	4/2010	ISSUED FOR APPROVAL

PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

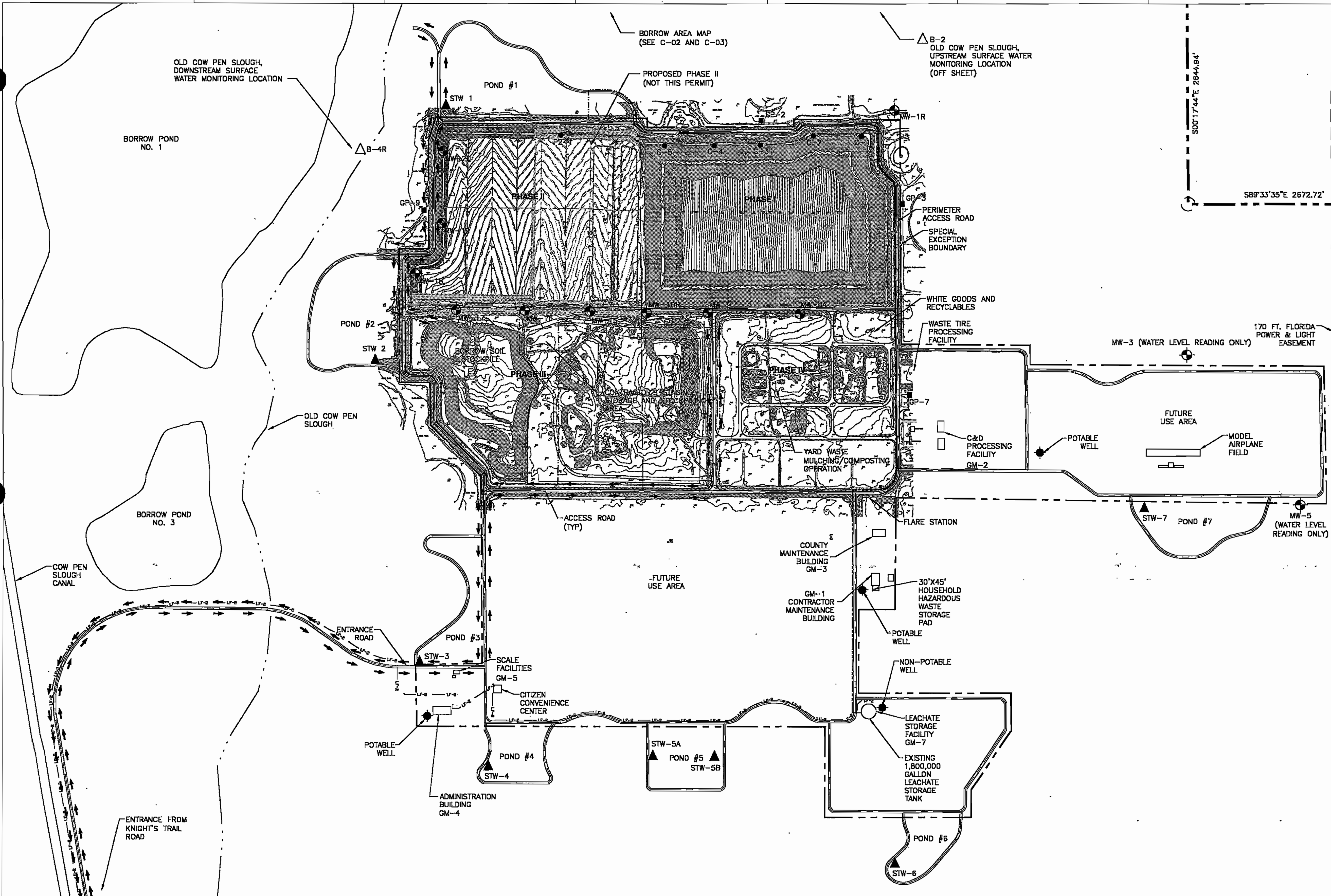
THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY — FLORIDA

GENERAL NOTES, LEGEND AND ABBREVIATIONS

FILENAME
SCALE: AS SHOWN
SHEET: 00G-02



NOTES:

1. TOPOGRAPHY WITHIN PHASES III AND IV AREAS COMPILED BY KUCERA INTERNATIONAL INC., OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
2. LOCATIONS OF MONITORING WELLS OBTAINED FROM SPECIFIC PURPOSE SURVEYS BY SARASOTA COUNTY. VERIFY LOCATIONS IN FIELD.
3. APPROXIMATE LOCATION OF PHASE I LEACHATE FORCEMAIN OBTAINED FROM RECORD DRAWINGS BY CAMP DRESSER & McKEE, INC. DATED APRIL 1998. VERIFY LOCATION IN FIELD.
4. APPROXIMATE LOCATION OF LEACHATE FORCEMAIN TO OFFSITE WWTP OBTAINED FROM CONFORMED DRAWINGS BY PBS&J DATED JULY 2005. VERIFY LOCATION IN FIELD.
5. CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ROADS USED BY CONTRACTOR AND SUBCONTRACTOR DURING PROJECT. CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING MUD AND TRASH, SUPRESSING DUST, AND REPAIRING ROADS AND OTHER FACILITIES DAMAGED BY HIS VEHICLES.
6. GRADES WITHIN PHASE II OBTAINED FROM PHASE II AS-BUILT DRAWINGS BY HYATT SURVEY SERVICES, INC. DATED MAY 2009.
7. PHASE I GRADES REPRESENT MAXIMUM PROPOSED GRADES AT TIME OF CLOSURE. ACTUAL GRADES AT TIME OF CLOSURE CONSTRUCTION MAY VARY FROM THOSE SHOWN BUT WILL NOT EXCEED THE ELEVATIONS SHOWN.

LEGEND

GP-1	GAS PROBE
MW-10R	GROUNDWATER MONITORING WELL
GM-1	GAS MONITORING LOCATION
	WATER SUPPLY WELL
C-1/P2-1	LEACHATE MONITORING POINT
STW-1	STORMWATER MONITORING STATION
B4-R	SURFACE WATER MONITORING STATION
	WATERWAY
	LIMITS OF EASEMENT
	EASEMENT CENTERLINE
	SPECIAL EXCEPTION BOUNDARY
	EXISTING ROADWAY
	PHASE LIMITS
	PROPERTY BOUNDARY
	EXISTING PHASE I LEACHATE FORCEMAIN (SEE NOTE 3)
LF-2	LEACHATE FORCEMAIN TO OFFSITE WWTP (SEE NOTE 4)
	LIMITS OF LINER
	CONSTRUCTION TRAFFIC ROUTE (SEE NOTE 5)
	LIMITS OF CONSTRUCTION
	OLD COW PEN SLOUGH

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ISSUE	DATE	DESCRIPTION
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PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE
PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

OVERALL SITE PLAN AND PHASING PLAN

FILENAME
SCALE 1"=400'
SHEET 00C-01

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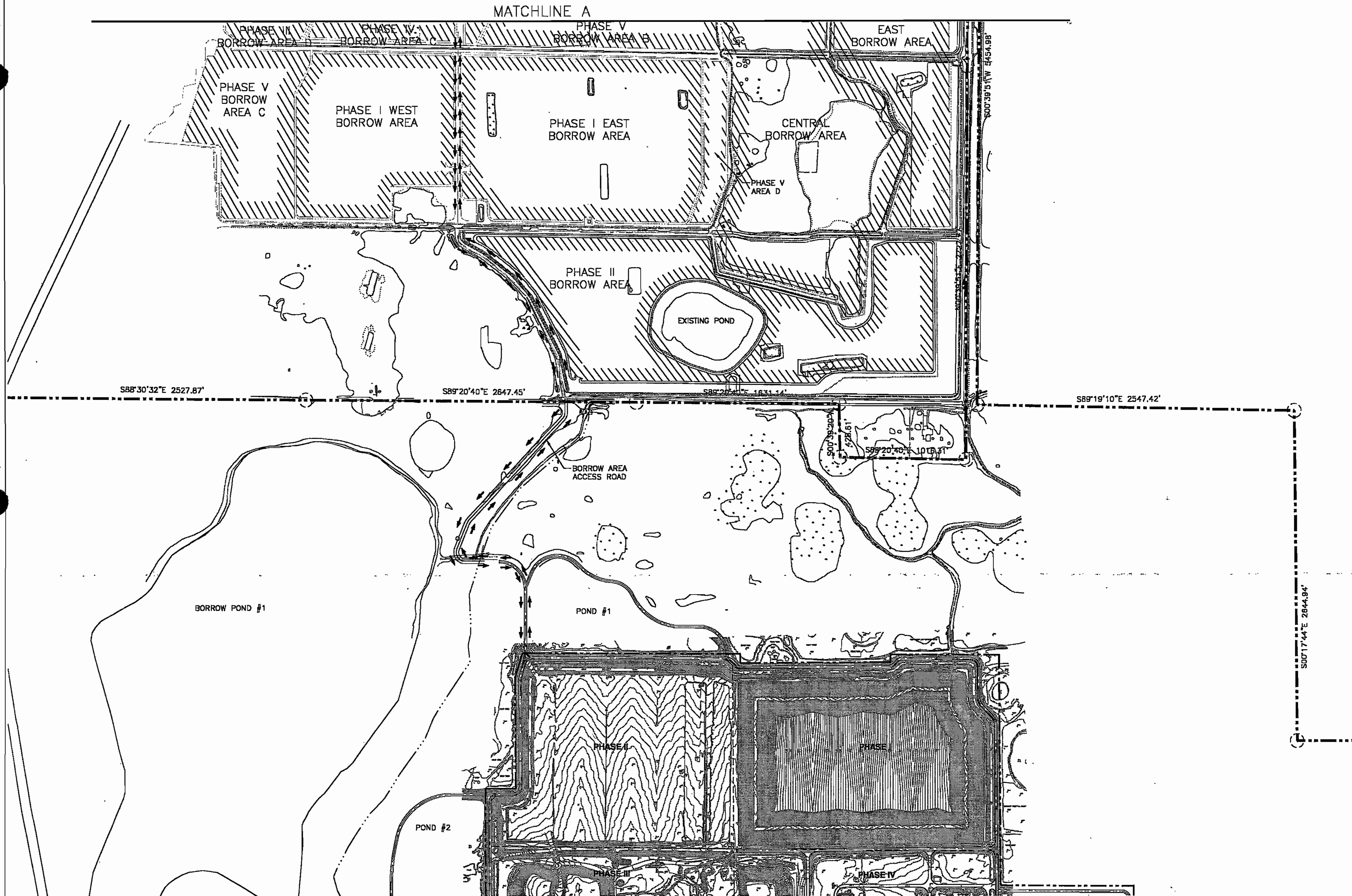

NOTES:

1. EXISTING TOPOGRAPHY WITHIN LANDFILL PHASES III AND IV AREAS COMPILED BY KUCERA INTERNATIONAL, INC. OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
2. PHASE I AND II BORROW AREA DESIGN AND TOPOGRAPHIC INFORMATION OBTAINED FROM "CONSTRUCTION PLANS FOR CENTRAL COUNTY SOLID WASTE DISPOSAL CENTER ALBRITION BORROW FACILITY, PHASE 2" BY PBS&J, JULY 2006.
3. CONTRACTOR SHALL MAINTAIN AND OPERATE BORROW AREA IN ACCORDANCE WITH ALL PERMIT CONDITIONS AND OWNER REQUIREMENTS.
4. CONTRACTOR SHALL ONLY OPERATE IN AREAS OF BORROW PIT DESIGNATED BY OWNER.
5. CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ROADS USED BY CONTRACTOR AND SUBCONTRACTORS DURING PROJECT. CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING MUD AND TRASH, SUPPRESSING DUST, AND REPAIRING ROADS AND OTHER FACILITIES DAMAGED BY HIS VEHICLES.
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7. PHASE I GRADES REPRESENT MAXIMUM PROPOSED GRADES AT TIME OF CLOSURE. ACTUAL GRADES AT TIME OF CLOSURE CONSTRUCTION MAY VARY FROM THOSE SHOWN BUT WILL NOT EXCEED THE ELEVATIONS SHOWN.

LEGEND

- PROPERTY BOUNDARY
- SPECIAL EXCEPTION BOUNDARY
- EXISTING ROADWAY
- PHASE LIMITS
- CONSTRUCTION TRAFFIC ROUTE (SEE NOTE 5)

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THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

SARASOTA COUNTY

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

BORROW AREA MAP (1 OF 2)

0 1" 2"

FILENAME	
SCALE	1"=400'

SHEET **00C-02**

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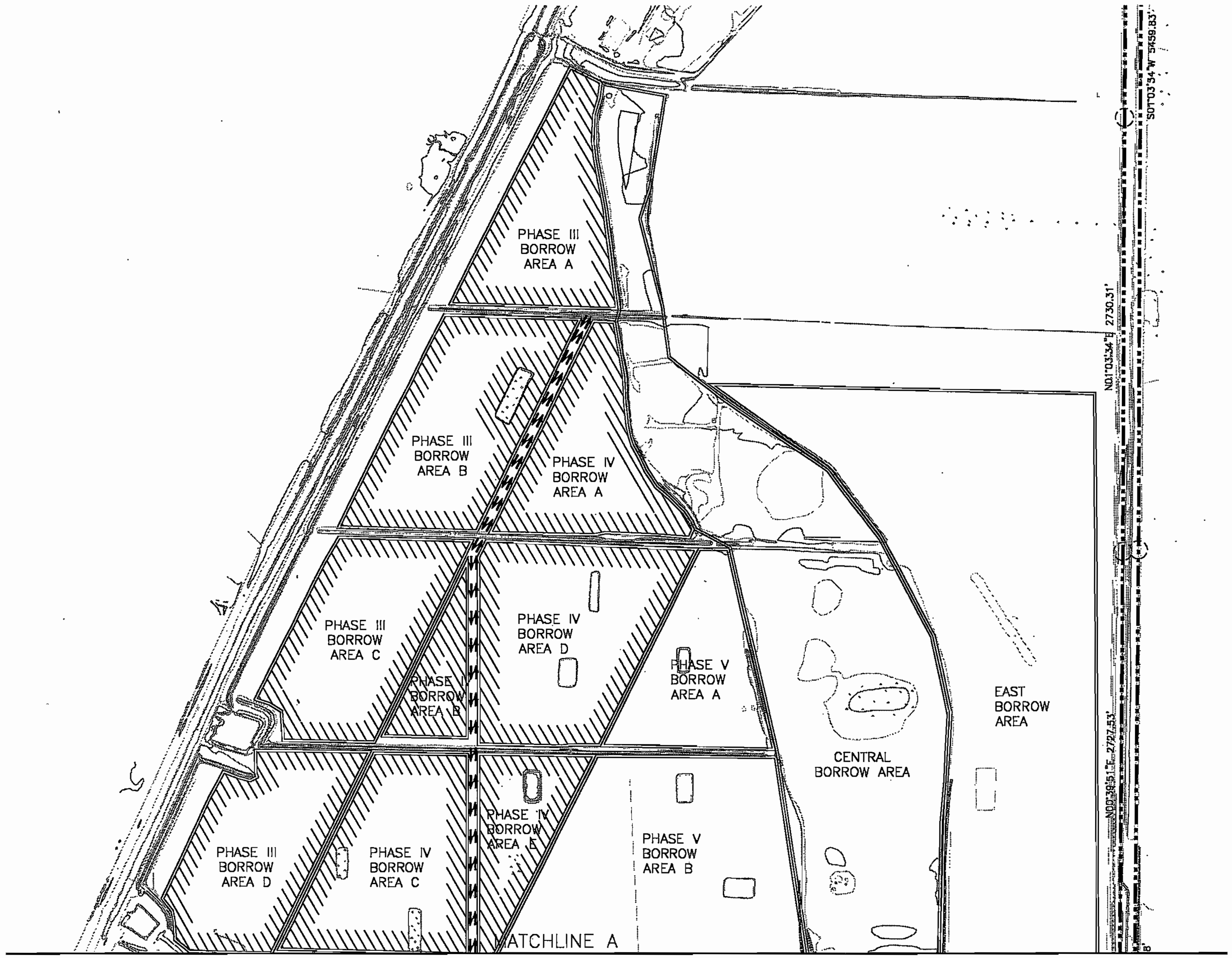
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA



NOTES:

1. EXISTING TOPOGRAPHY WITHIN LANDFILL PHASES III AND IV AREAS COMPILED BY KUCERA INTERNATIONAL, INC. OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
2. PHASE I AND II BORROW AREA DESIGN AND TOPOGRAPHIC INFORMATION OBTAINED FROM "CONSTRUCTION PLANS FOR CENTRAL COUNTY SOLID WASTE DISPOSAL CENTER ALBRITION BORROW FACILITY, PHASE 2" BY PBS&J, JULY 2006
3. PHASE III BORROW AREA DESIGN AND TOPOGRAPHIC INFORMATION OBTAINED FROM "CONSTRUCTION PLANS FOR CENTRAL COUNTY SOLID WASTE DISPOSAL COMPLEX BORROW FACILITY – PHASE III" BY PBS&J, OCTOBER 2007.
4. PHASE IV BORROW AREA DESIGN AND TOPOGRAPHIC INFORMATION OBTAINED FROM "CONSTRUCTION PLANS FOR CENTRAL COUNTY SOLID WASTE DISPOSAL COMPLEX BORROW FACILITY – PHASE IV" BY PBS&J, SEPTEMBER 2008.
5. CONTRACTOR SHALL MAINTAIN AND OPERATE BORROW AREA IN ACCORDANCE WITH ALL PERMIT CONDITIONS AND OWNER REQUIREMENTS.
6. CONTRACTOR SHALL ONLY OPERATE IN AREAS OF BORROW PIT DESIGNATED BY OWNER.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ROADS USED BY CONTRACTOR AND SUBCONTRACTORS DURING PROJECT. CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING MUD AND TRASH, SUPRESSING DUST, AND REPAIRING ROADS AND OTHER FACILITIES DAMAGED BY HIS VEHICLES.

LEGEND

PROPERTY BOUNDARY
SPECIAL EXCEPTION BOUNDARY
EXISTING ROADWAY
PHASE LIMITS
CONSTRUCTION TRAFFIC ROUTE (SEE NOTE 6)

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ISSUE	DATE	DESCRIPTION
A	4/2010	ISSUED FOR APPROVAL

PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

SARASOTA COUNTY

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

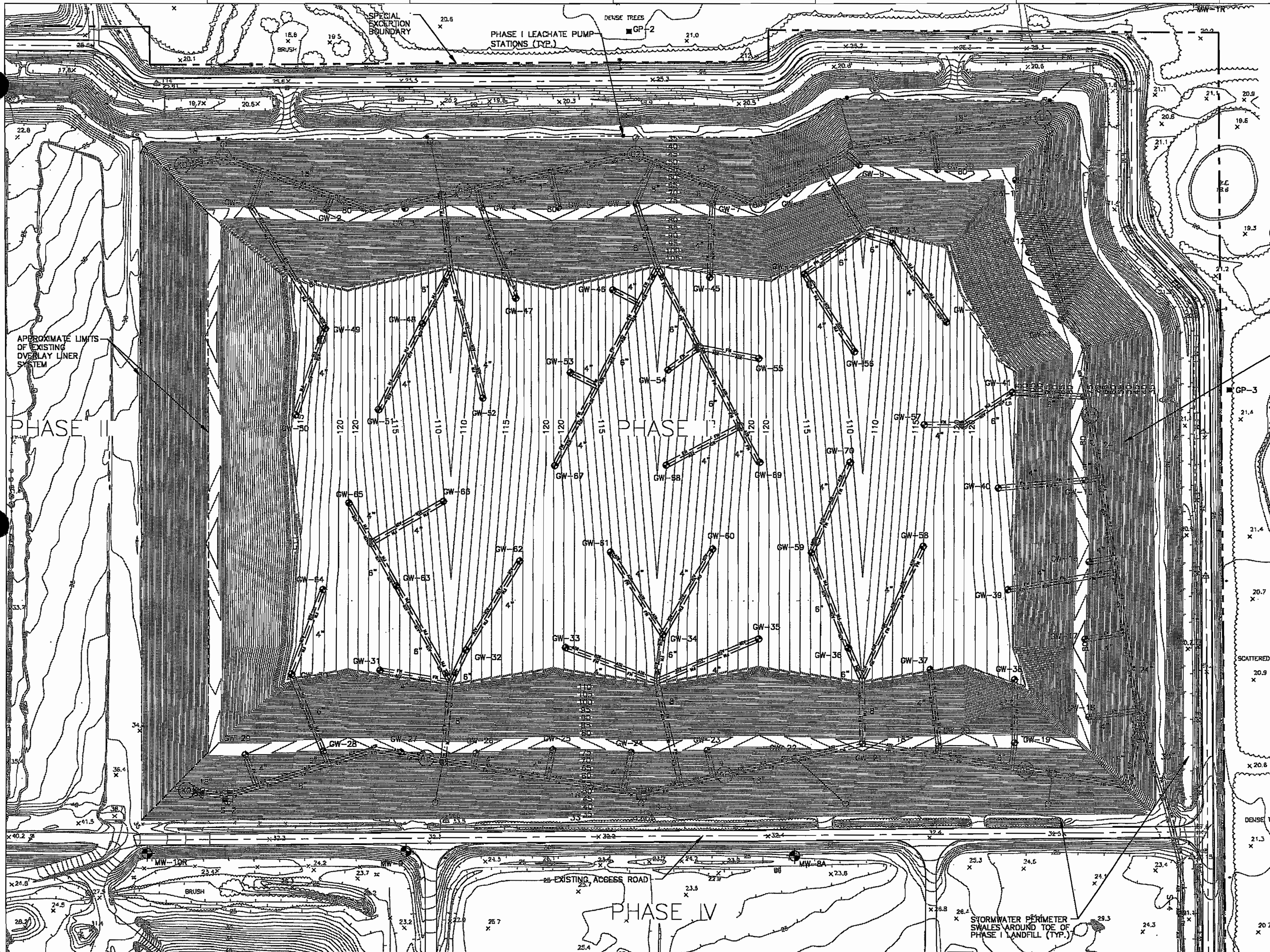
BORROW AREA MAP (2 OF 2)

0 1" 2"

FILENAME

SCALE 1"=400'

SHEET **00C-03**



N

NOTES:

1. TOPOGRAPHY WITHIN PHASES I, III, AND IV AREAS COMPILED BY KUCERA INTERNATIONAL INC., OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
2. LOCATIONS OF MONITORING WELLS OBTAINED FROM SPECIFIC PURPOSE SURVEYS BY SARASOTA COUNTY. VERIFY LOCATIONS IN THE FIELD.
3. APPROXIMATE LOCATION OF PHASE I LEACHATE FORCEMAIN OBTAINED FROM RECORD DRAWINGS BY CAMP DRESSER & McKEE, INC. DATED APRIL 1998. VERIFY LOCATION IN FIELD.

LEGEND

- GP-1 GAS PROBE
- MW-10R GROUNDWATER MONITORING WELL
- GM-1 GAS MONITORING LOCATION
- WATER SUPPLY WELL
- STW-1 STORMWATER MONITORING STATION
- B4-R SURFACE WATER MONITORING STATION
- LEACHATE PUMP STATION
- WATERWAY
- LIMITS OF EASEMENT
- EASEMENT CENTERLINE
- SPECIAL EXCEPTION BOUNDARY
- EXISTING ROADWAY
- PHASE BOUNDARY
- CHAIN LINK FENCE
- APPROX. LOCATION OF PHASE I LEACHATE FORCEMAIN (SEE NOTE 3)
- GW-60 PROPOSED LFG WELLS
- GW-60 EXISTING LFG WELLS
- PROPOSED LFG PIPE
- EXISTING LFG PIPE

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ISSUE	DATE	DESCRIPTION
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PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

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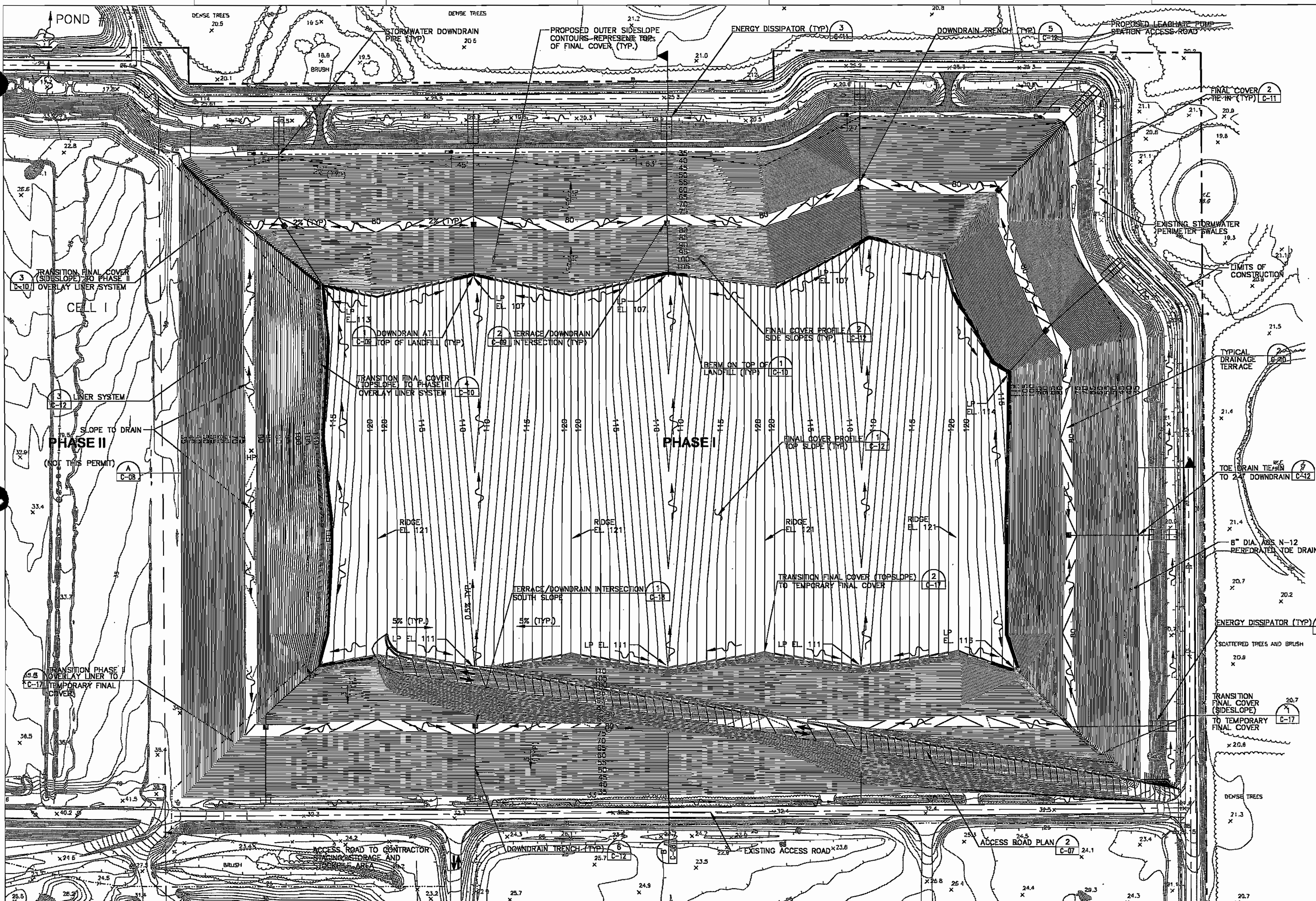
Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

FUTURE INTERMEDIATE COVER GRADES SITE CONDITIONS

0 1" 2"

FILENAME
SCALE 1"=100'
SHEET 00C-04



FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

NOTES:

1. TOPOGRAPHY WITHIN PHASES III AND IV AREAS COMPILED BY KUCERA INTERNATIONAL INC., OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
2. CONTOURS WITHIN PHASE I CLOSURE AREA REPRESENT PROPOSED TOP OF FINAL COVER.
3. OPERATIONAL AND FINAL GRADES SHALL NOT BE GREATER THAN 3:1.
4. APPROXIMATE LOCATION OF PHASE I LEACHATE FORCEMAIN OBTAINED FROM RECORD DRAWINGS BY CAMP DRESSER & McKEE, INC. DATED APRIL 1998. VERIFY LOCATION IN FIELD.
5. CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING ROADS USED BY CONTRACTOR AND SUBCONTRACTORS DURING PROJECT. CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING MUD AND TRASH, SUPPRESSING DUST, AND REPAIRING ROADS AND OTHER FACILITIES DAMAGED BY HIS VEHICLES.
6. LFG WELLS NOT SHOWN FOR CLARITY.

LEGEND

- EXISTING CONTOUR
- PROPOSED ELEVATION
- SPECIAL BOUNDARY
- EXISTING ROADWAY
- LIMITS OF CONSTRUCTION
- PHASE LIMITS
- APPROX. LOCATION OF PHASE I LEACHATE FORCEMAIN (SEE NOTE 4)
- TOP OF BERM
- LP LOW POINT
- HP HIGH POINT
- TERRACE/DOWNDRAIN INTERSECTION
- PHASE I LEACHATE PUMP STATIONS
- CONSTRUCTION TRAFFIC ROUTE (SEE NOTE 5)
- STORMWATER FLOW DIRECTION
- FABRIC-FORMED CONCRETE APRON
- TOE DRAIN
- VAULT BOX
- LEACHATE PUMP STATION STABILIZED ACCESS ROAD

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ISSUE	DATE	DESCRIPTION
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DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

Central County Solid Waste Disposal Complex

PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

PHASE I FINAL BUILD-OUT GRADING PLAN

0 1" 2"

FILENAME
SCALE 1"=100'

SHEET 00C-05

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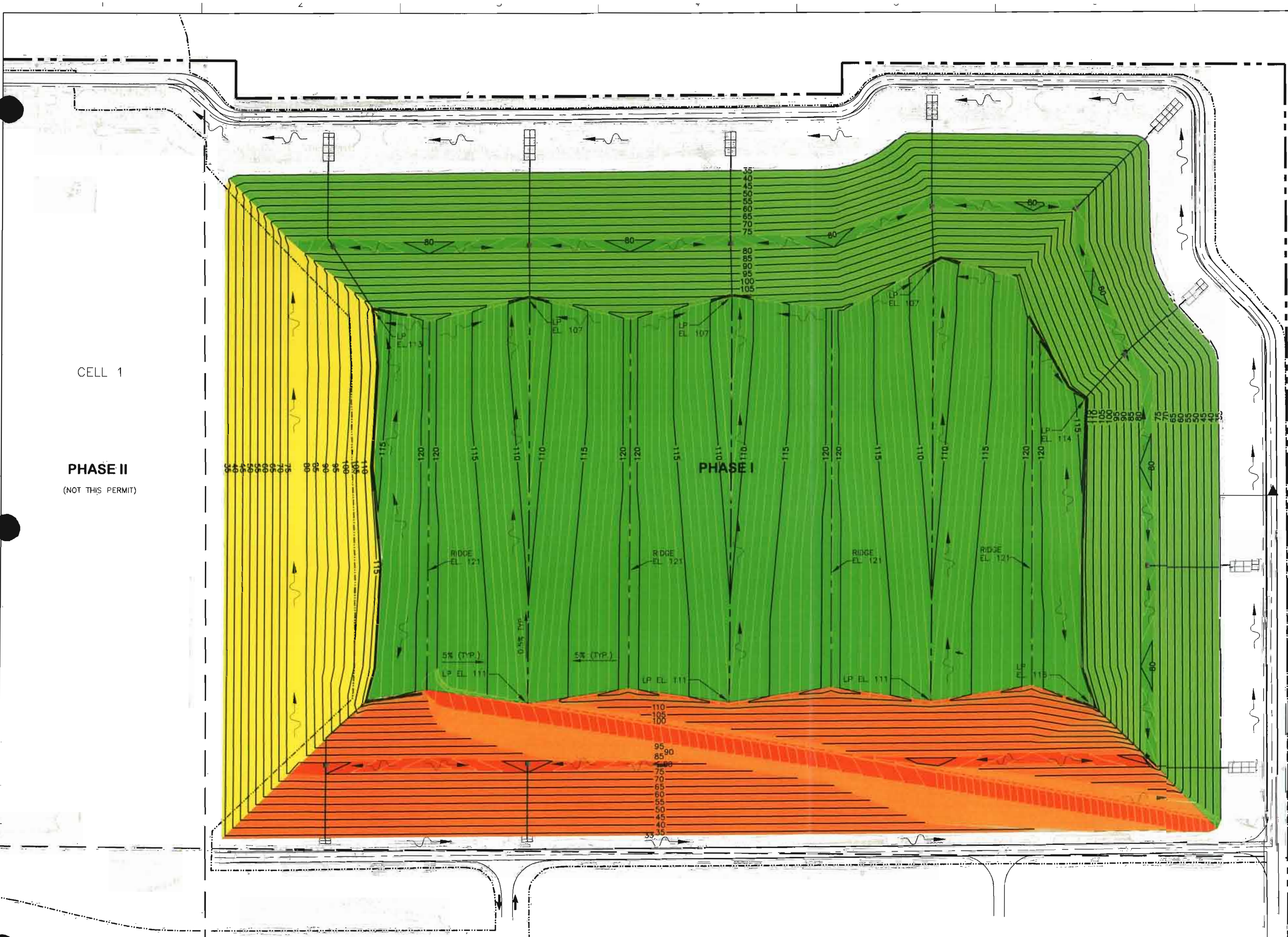

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

NOTES:

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2. CONTOURS WITHIN PHASE I CLOSURE AREA REPRESENT PROPOSED TOP OF FINAL COVER.
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LEGEND

- EXISTING CONTOUR
- PROPOSED ELEVATION
- SPECIAL EXCEPTION BOUNDARY
- APPROX. LIMITS OF EXISTING LINER
- STORMWATER FLOW DIRECTION
- FABRIC-FORMED CONCRETE APRON
- LIMITS OF CONSTRUCTION
- PHASE LIMITS
- LP LOW POINT
- TERRACE/DOWNDRAIN INTERSECTION
- CONSTRUCTION TRAFFIC ROUTE (SEE NOTE 4)
- TEMPORARY FINAL COVER
- PHASE I OVERLAY LINER
- FINAL CLOSURE COVER

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SARASOTA COUNTY

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

PHASE I CLOSURE COVER KEY SHEET

0 1" 2"

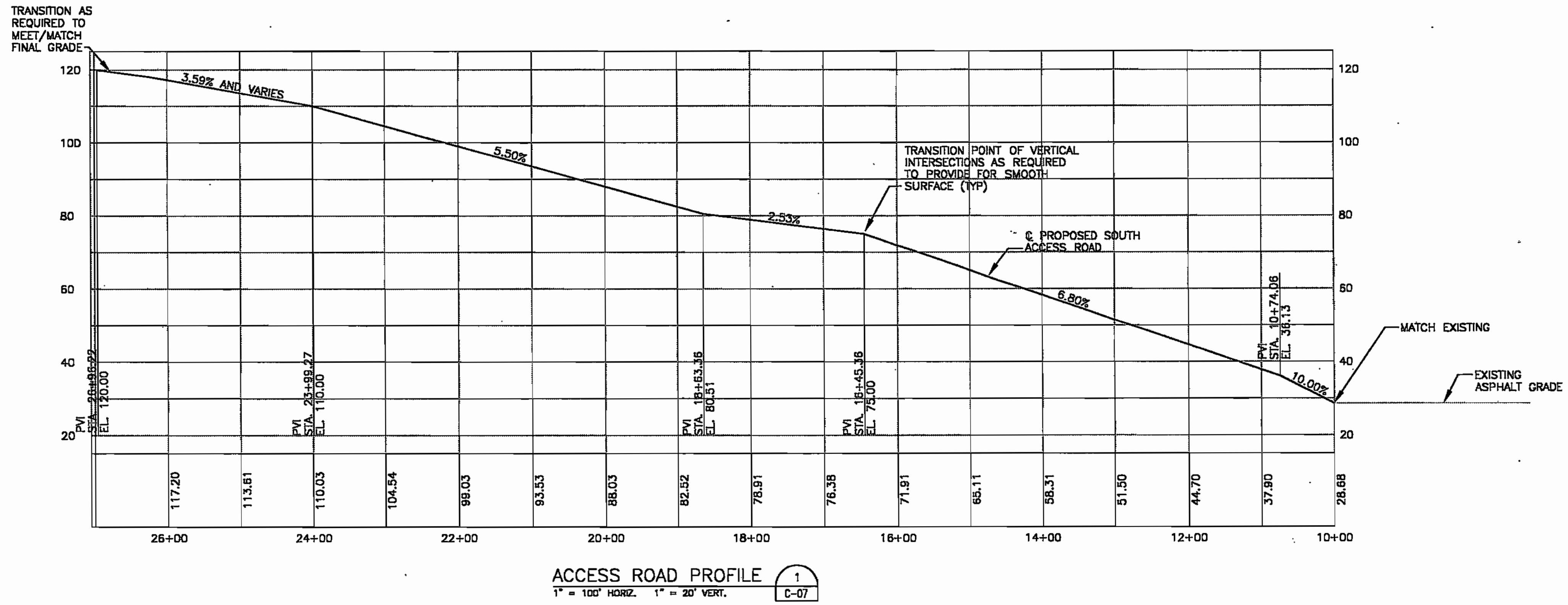
FILENAME
SCALE 1"=100'
SHEET 00C-06

c:\pwworking\tpa\d0201056\00C-07.dwg, SOUTH ROAD PLAN PROFILE, 4/29/2010 1:50:22 PM, irivera

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

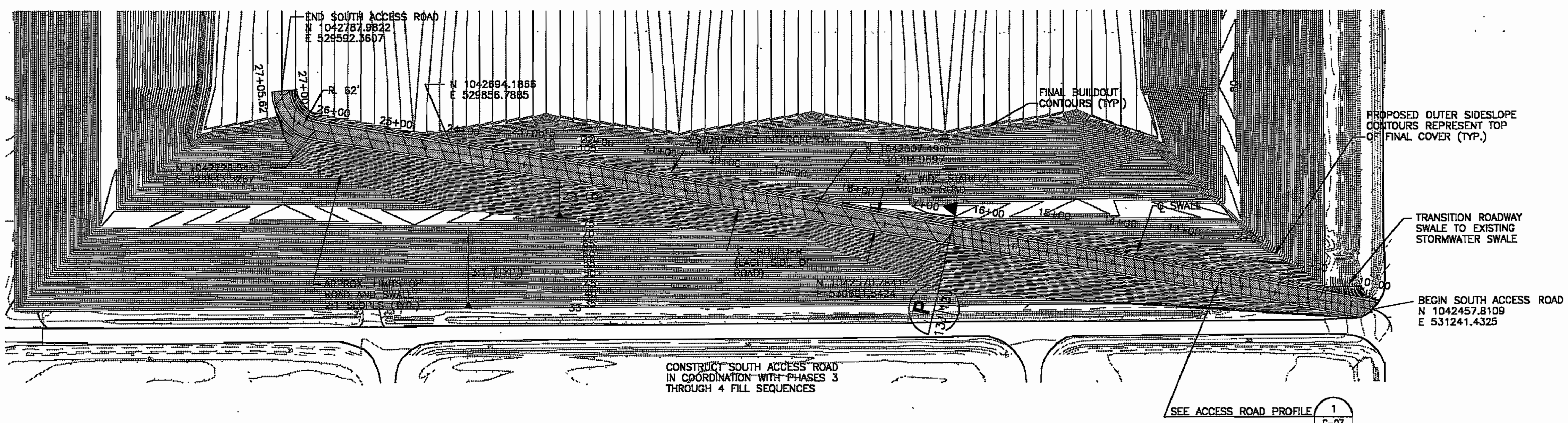
N

GRAPHIC SCALE
0 50 100 200
SCALE IN FEET
1" = 100'
AND AS SHOWN



ACCESS ROAD PROFILE (1 / C-07)

1" = 100' HORIZ. 1" = 20' VERT.



ACCESS ROAD PLAN (2 / C-05)

SCALE 1" = 100' HORIZ.

NOTES:

1. FILLING GRADES AND ELEVATIONS ARE APPROXIMATE, SEE PERMITTED FILLING PLAN PREPARED BY SCS ENGINEERS, DATED MARCH 2004, FOR GRADES AND ELEVATIONS.

2. OPERATIONAL AND FINAL GRADES SHALL NOT BE GREATER THAN 3:1.

3. MAINTAIN OPERATION BERMS AT ALL ACTIVE WORKING FACES TO CONTAIN ALL STORMWATER COMMINGLED WITH WASTE.

4. MAINTAIN POSITIVE DRAINAGE AT ALL TIMES.

5. CONSTRUCT SOUTH ACCESS ROAD IN COORDINATION WITH PHASE 3 THROUGH 4 FILL SEQUENCES.

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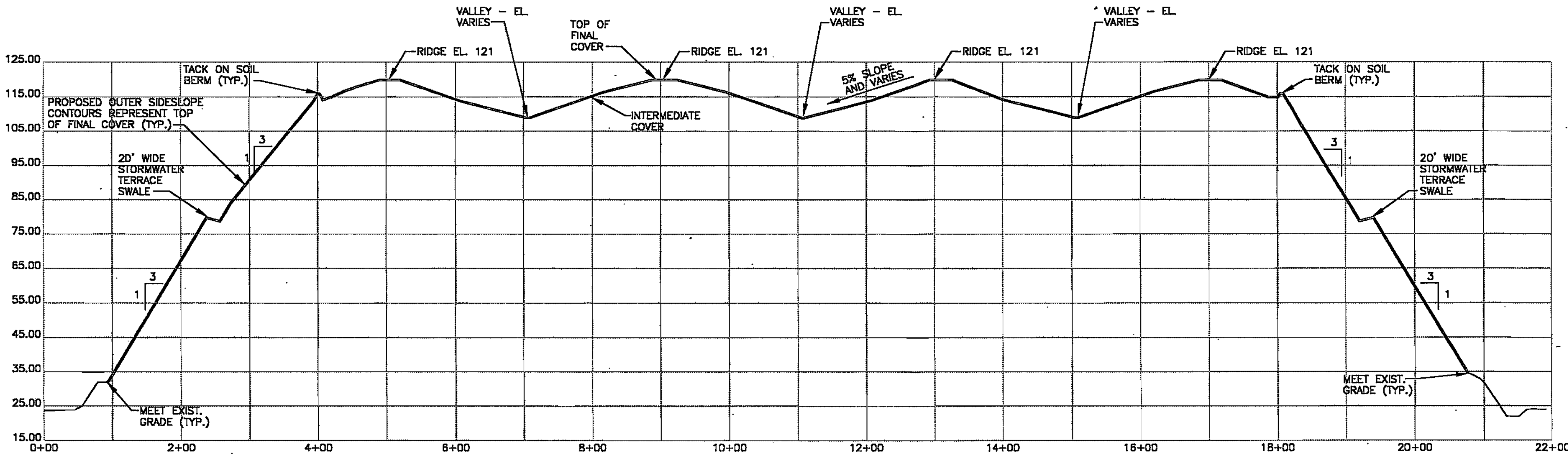
Central County Solid Waste Disposal Complex

PHASE I CLASS I LANDFILL CLOSURE
PERMIT DRAWINGS

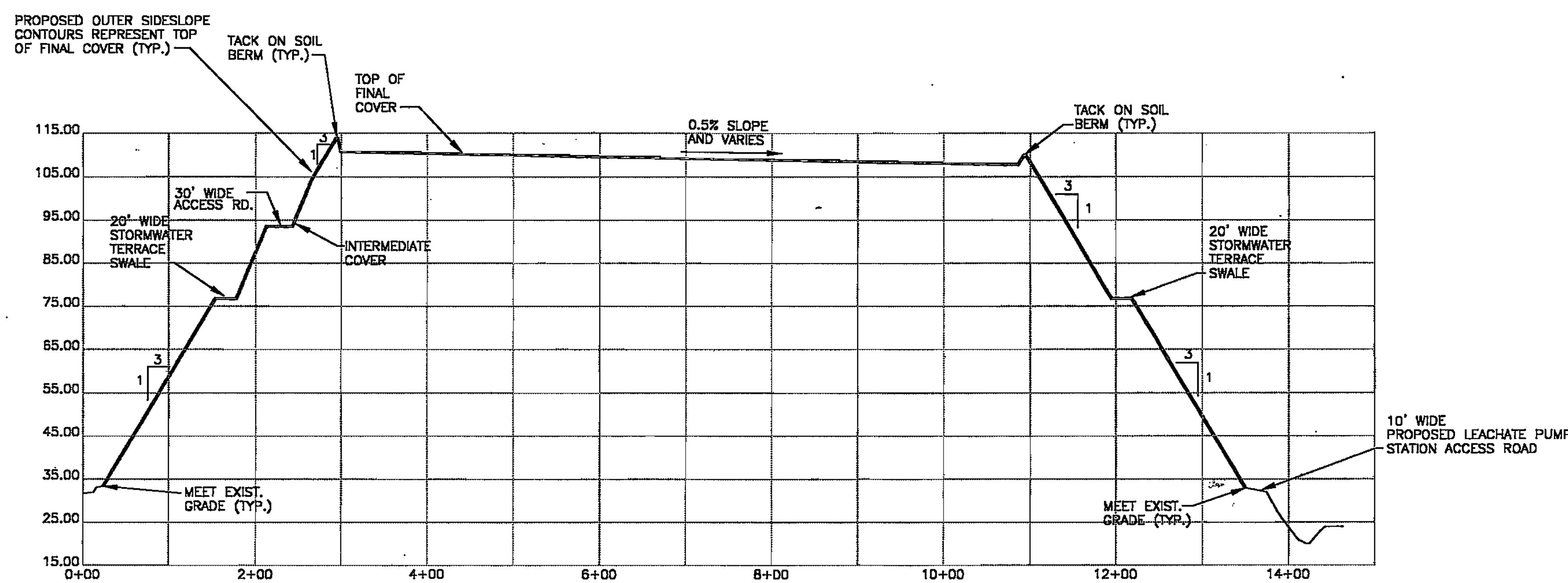
SARASOTA COUNTY FLORIDA

PLAN AND PROFILE PHASE I ACCESS ROAD

FILENAME
SCALE AS SHOWN
SHEET 00C-07



SECTION A (A / C-05)
1" = 100' HORIZ. 1" = 10' VERT.



SECTION B (B / C-05)
1" = 100' HORIZ. 1" = 10' VERT.

GRAPHIC SCALE
0 50 100 200
SCALE IN FEET
1" = 100'

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

NOTES:

1. TOPOGRAPHY WITHIN PHASES I THROUGH IV AREAS COMPILED BY KUCERA INTERNATIONL INC., OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.

2. FILLING GRADES AND ELEVATIONS ARE APPROXIMATE, SEE PERMITTED FILLING PLAN PREPARE BY SCS ENGINEERS, DATED MARCH 2004, FOR GRADES AND ELEVATIONS.

3. OPERATIONAL AND FINAL GRADES SHALL NOT BE GREATER THAN 3:1.

4. MAINTAIN OPERATION BERMS AT ALL ACTIVE WORKING FACES TO CONTAIN ALL STORMWATER COMMINGLED WITH WASTE.

5. MAINTAIN POSITIVE DRAINAGE AT ALL TIMES.

HDR
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2521 Cattleman Rd., Ste. 108
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ISSUE	DATE	DESCRIPTION
A	4/2010	ISSUED FOR APPROVAL

PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

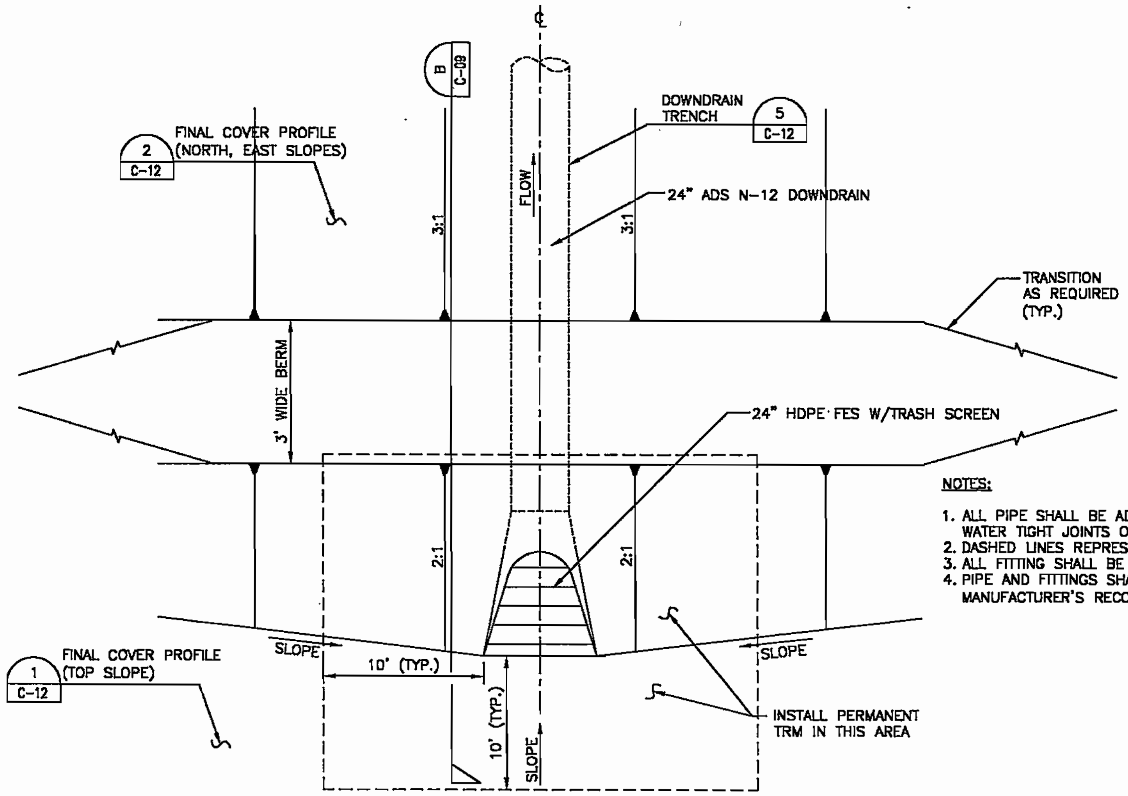
THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS
SARASOTA COUNTY FLORIDA

PHASE I CROSS SECTIONS

FILENAME
SCALE AS SHOWN
SHEET 00C-08

C:\pwworking\tpa\d0201056\00C-08.dwg, FULL BUILDOUT SECTIONS, 4/29/2010 1:50:47 PM, irivera



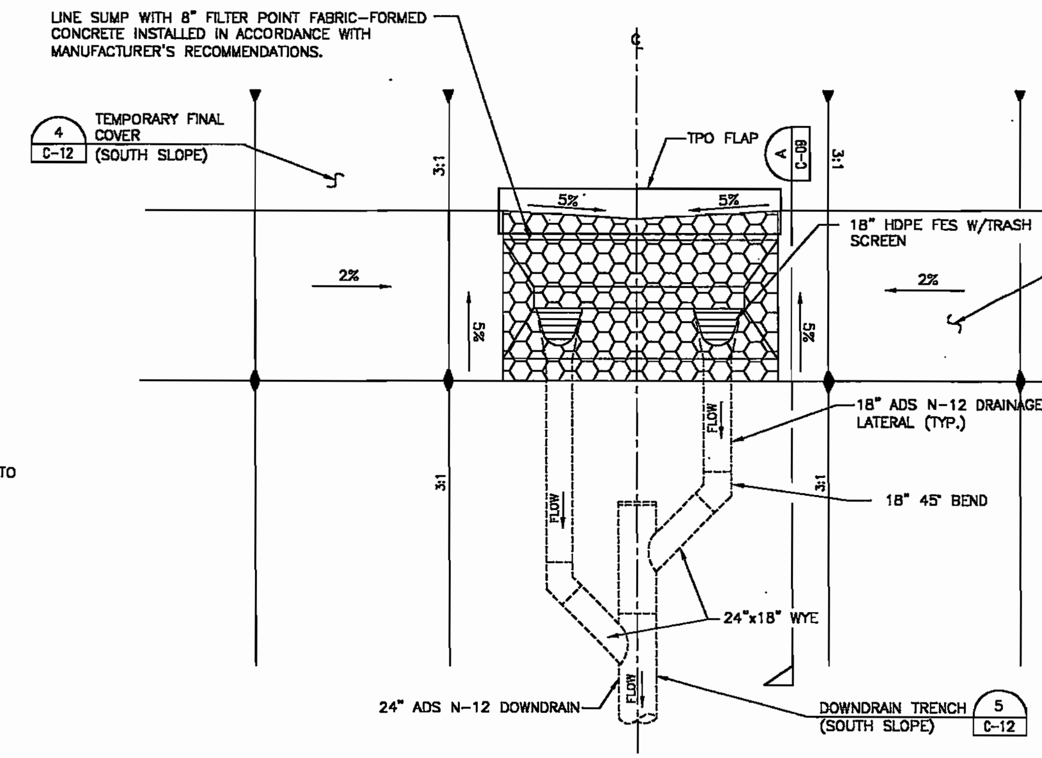
NOTES:

1. ALL PIPE SHALL BE ADS N-12 WITH WATER TIGHT JOINTS OR EQUAL.
2. DASHED LINES REPRESENT BURIED PIPE.
3. ALL FITTING SHALL BE PRE-FABRICATED.
4. PIPE AND FITTINGS SHALL BE INSTALLED TO MANUFACTURER'S RECOMMENDATIONS.

PLAN VIEW

DOWNDRAIN AT TOP OF LANDFILL (1 / C-05)

NOT TO SCALE



FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

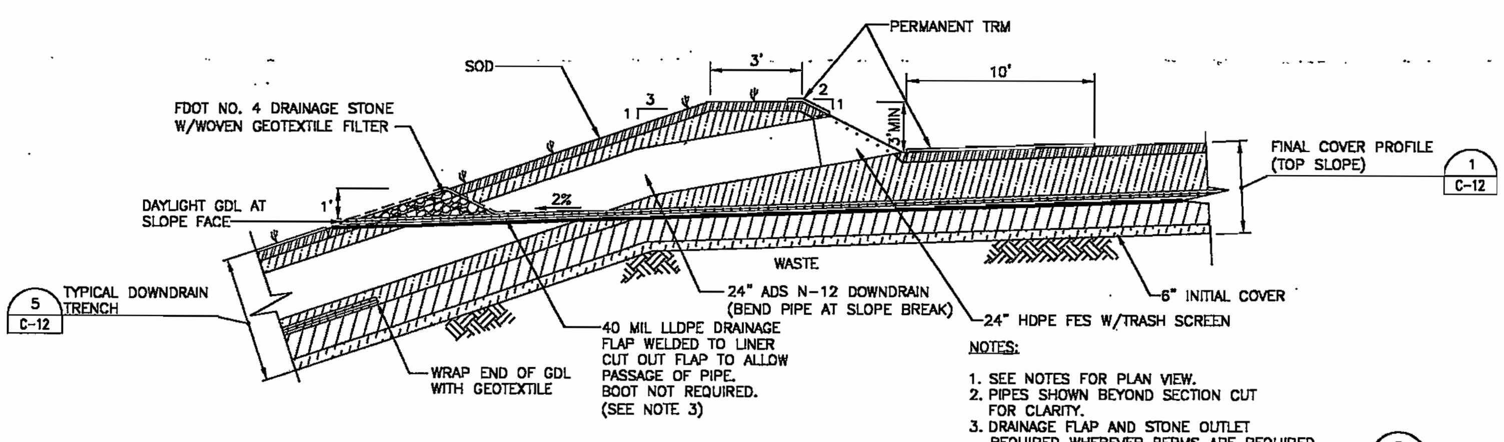
NOTES:

1. ALL PIPE SHALL BE ADS N-12 WITH WATER TIGHT JOINTS.
2. DASHED LINES REPRESENT BURIED PIPE.
3. ALL FITTINGS SHALL BE PRE-FABRICATED.
4. PIPE AND FITTINGS SHALL BE INSTALLED TO MANUFACTURER'S RECOMME
5. TPO SHALL BE CONNECTED TO CONCRETE PAD USING S.S. BATTEN AND PROVIDE A WATER TIGHT CONNECTION.
6. EXTEND 24" PIPE BEYOND SUMP WHERE REQUESTED ON PLANS SIMILAR 2, SHEET C-09.

PLAN VIEW

TERRACE / DOWNDRAIN INTERSECTION (SOUTH SLOPE) (1 / C-05, C-13)

NOT TO SCALE

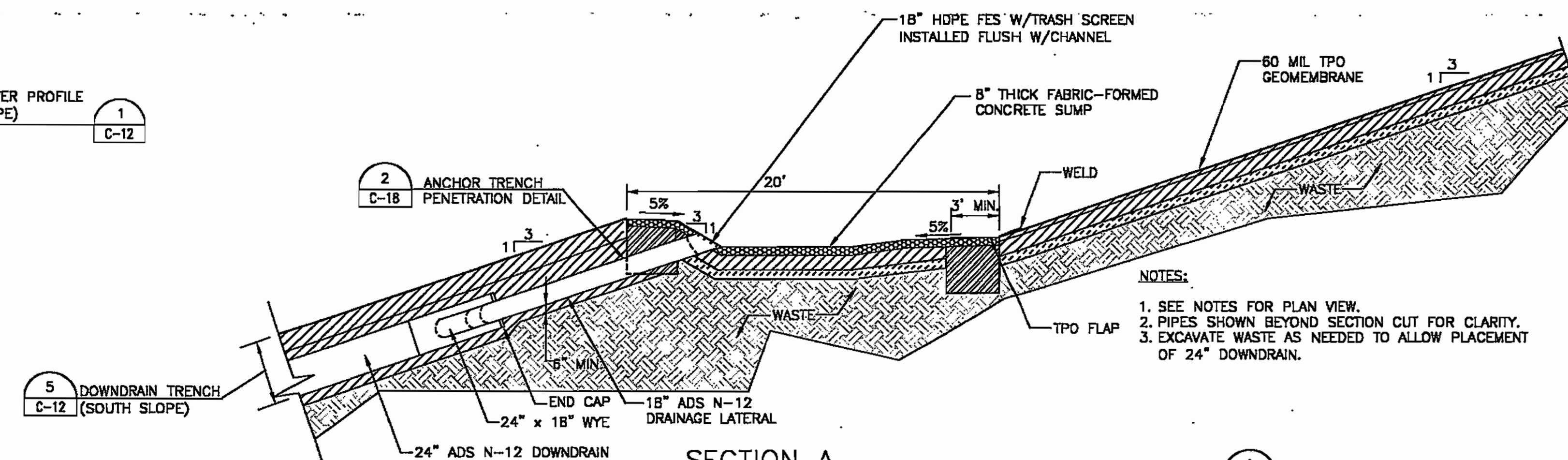


NOTES:

1. SEE NOTES FOR PLAN VIEW.
2. PIPES SHOWN BEYOND SECTION CUT FOR CLARITY.
3. DRAINAGE FLAP AND STONE OUTLET REQUIRED WHEREVER BERMS ARE REQUIRED AT THE TOP OF THE LANDFILL (SEE SHEET C-05)

SECTION B (B / C-09)

NOT TO SCALE



NOTES:

1. SEE NOTES FOR PLAN VIEW.
2. PIPES SHOWN BEYOND SECTION CUT FOR CLARITY.
3. EXCAVATE WASTE AS NEEDED TO ALLOW PLACEMENT OF 24" DOWNDRAIN.

SECTION A (A / C-09)

NOT TO SCALE

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PROJECT MANAGER	R. SIEMERING
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Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

PHASE I CLOSURE DETAILS

FILENAME

SCALE AS SHOWN

SHEET 00C-09

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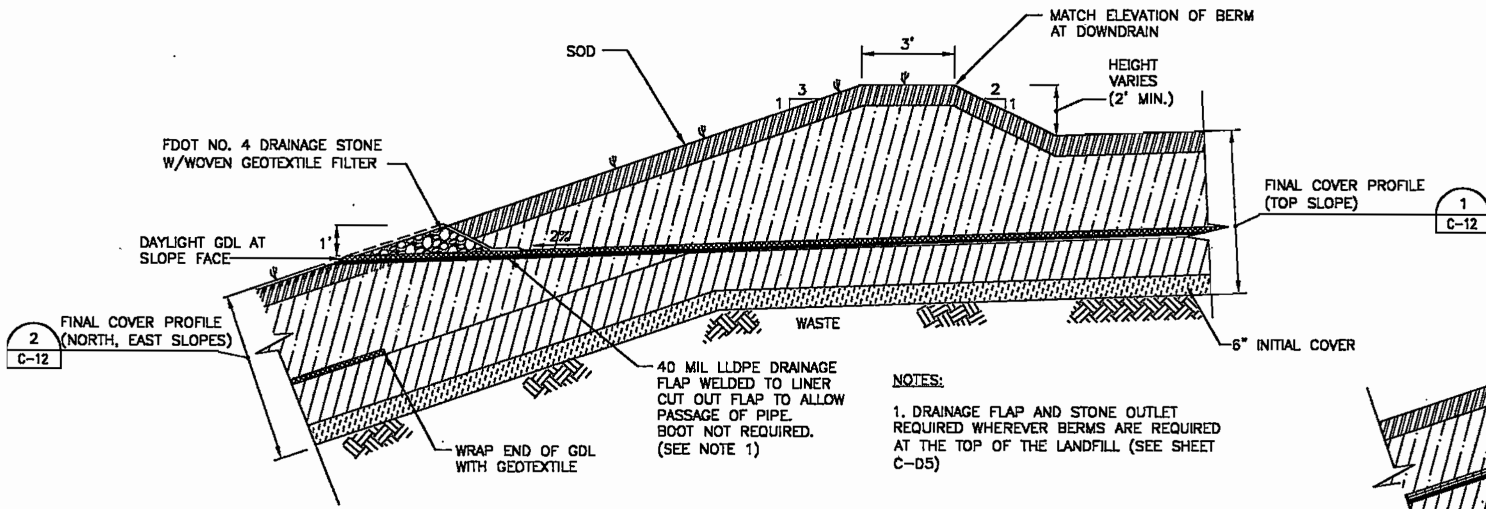
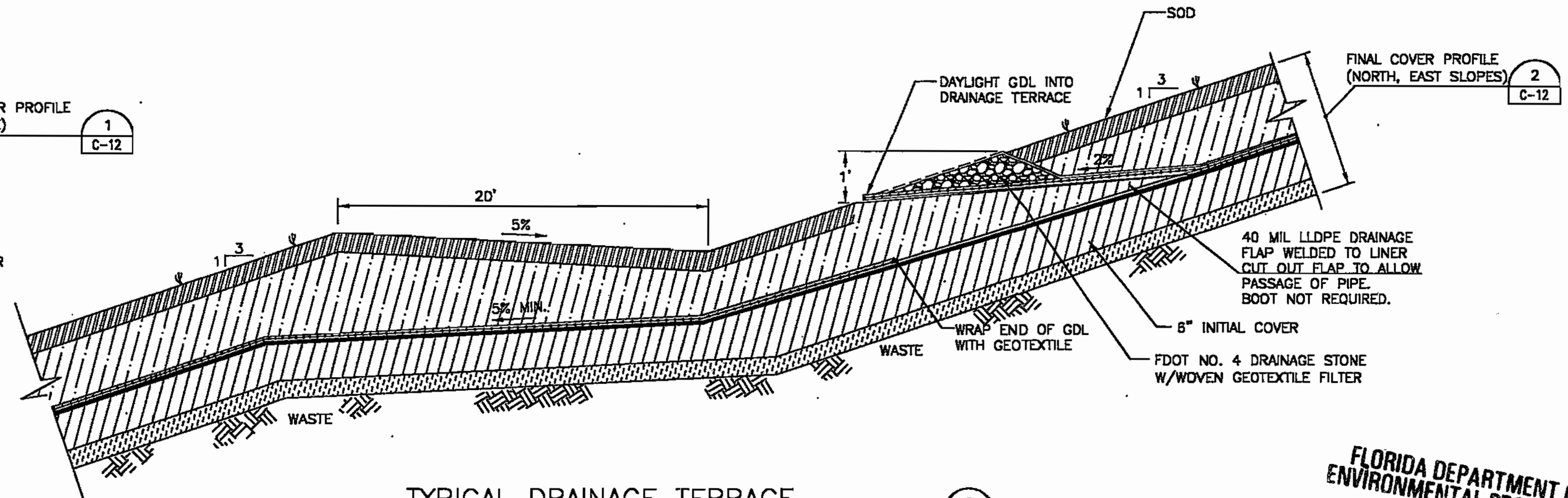
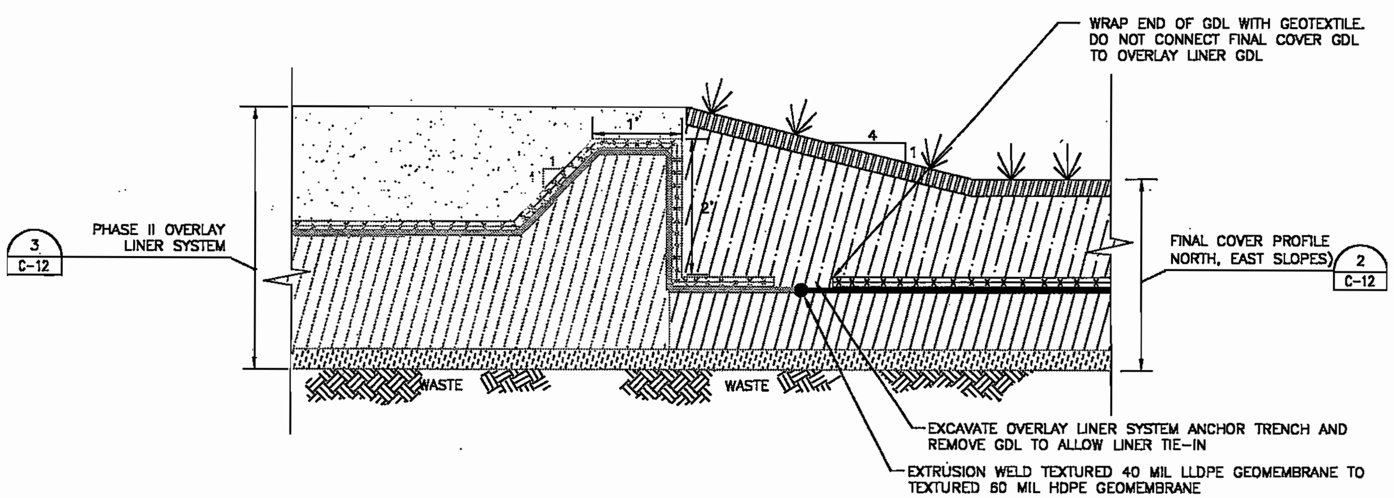


BERM ON TOP OF LANDFILL 1 C-05
NOT TO SCALE

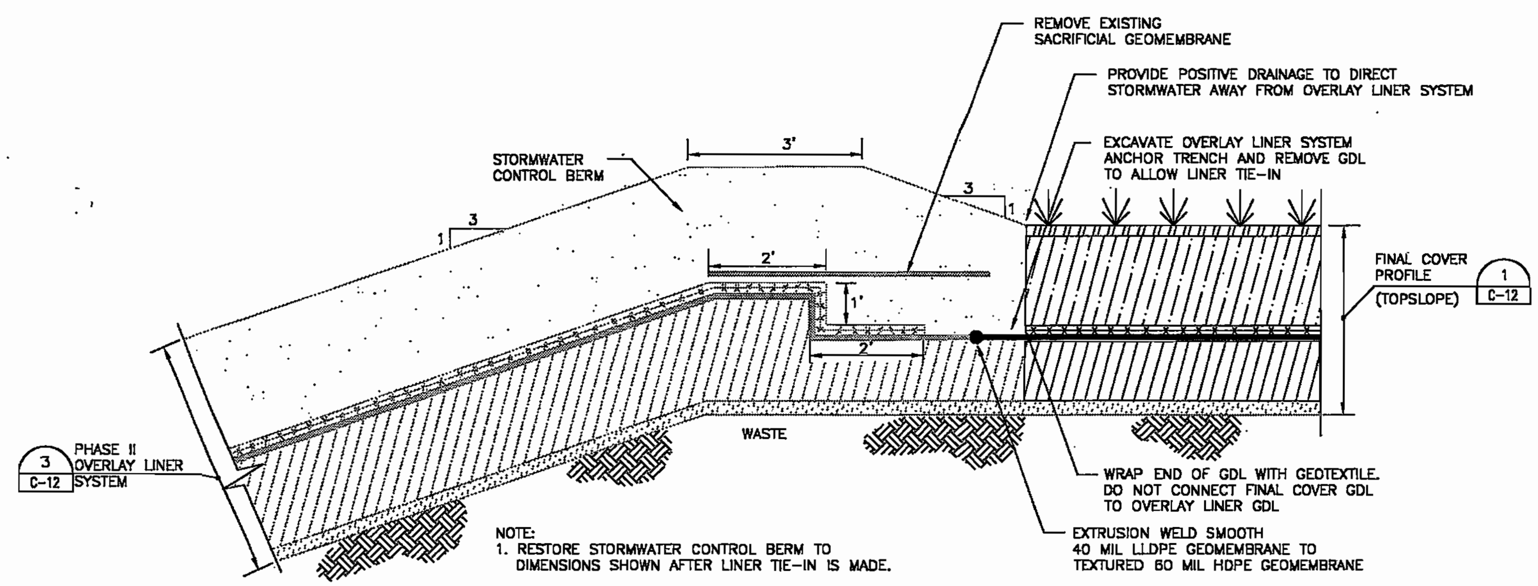


TYPICAL DRAINAGE TERRACE 2 C-05
NOT TO SCALE

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA



TRANSITION FINAL COVER (SIDE SLOPE) TO PHASE II OVERLAY LINER SYSTEM 3 C-05
NOT TO SCALE



TRANSITION FINAL COVER (TOP SLOPE) TO PHASE II OVERLAY LINER SYSTEM 4 C-05
NOT TO SCALE

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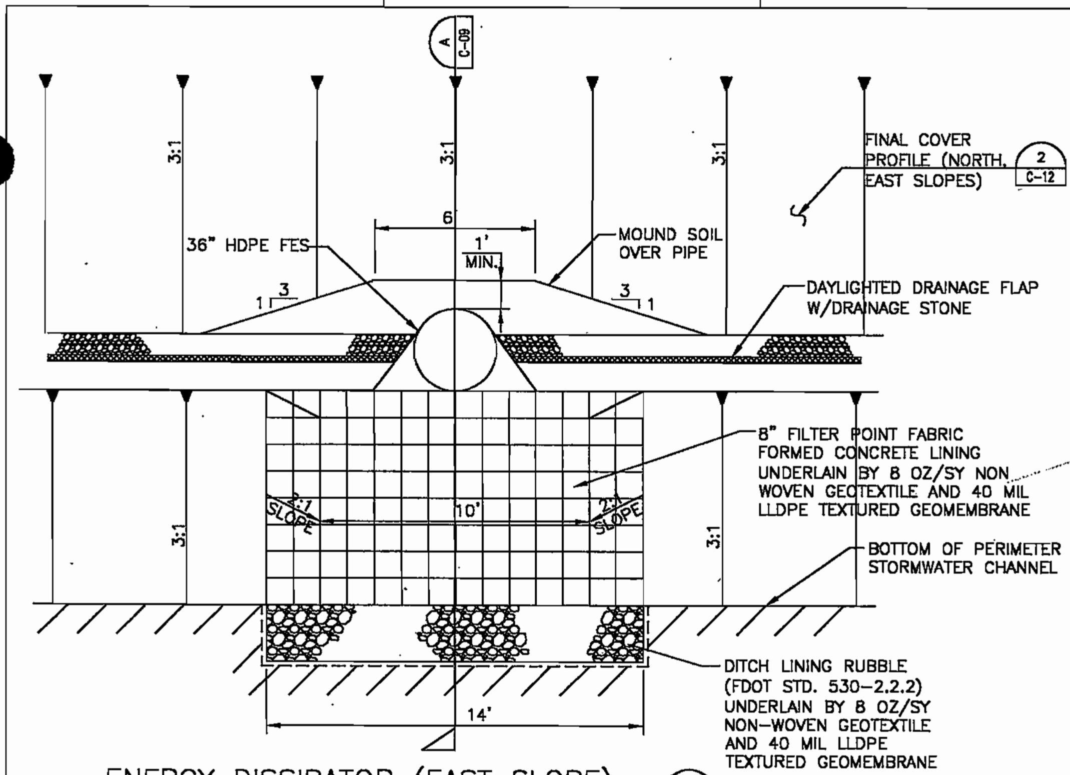
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

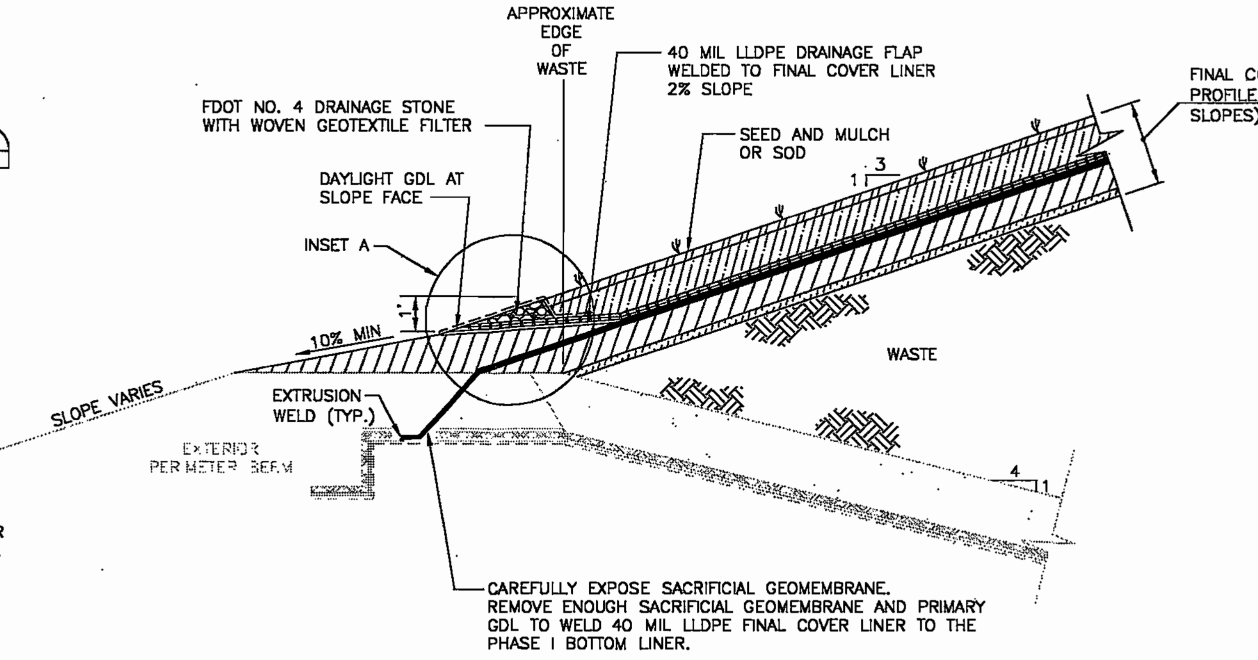
Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE
PERMIT DRAWINGS
SARASOTA COUNTY FLORIDA

PHASE I CLOSURE DETAILS

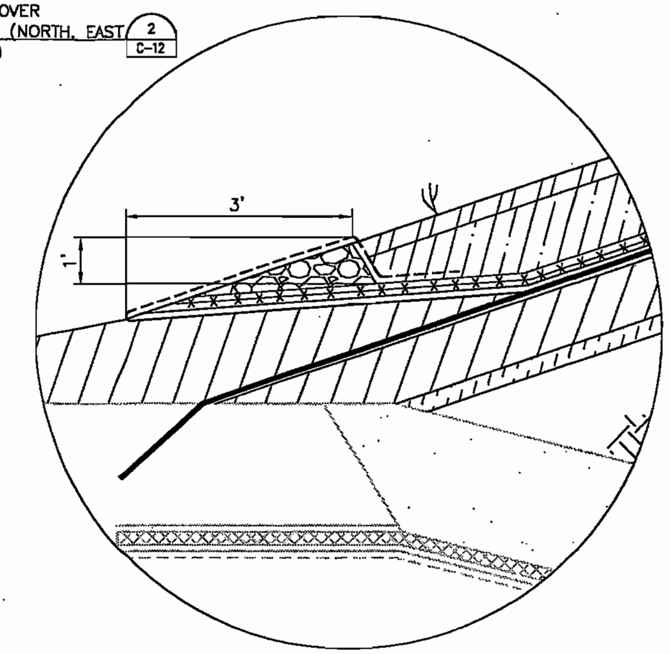
FILENAME
SCALE AS SHOWN
SHEET **00C-10**



ENERGY DISSIPATOR (EAST SLOPE) 1 C-05
NOT TO SCALE

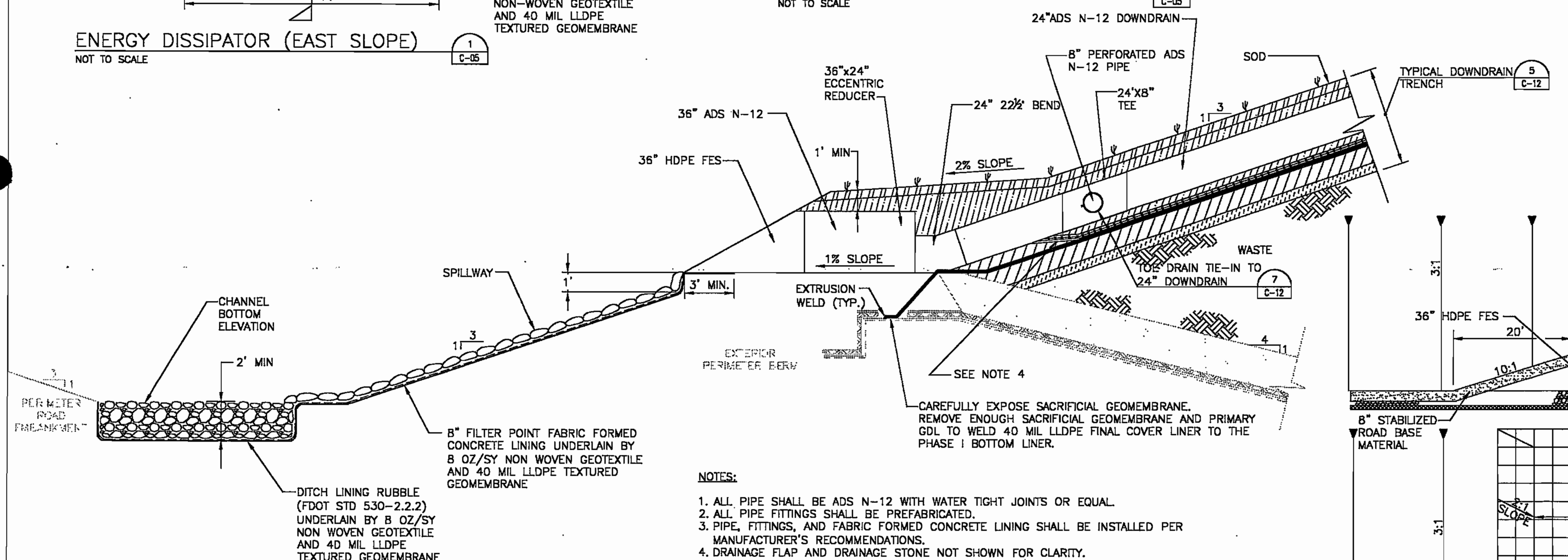


FINAL COVER TIE-IN 2 C-05
NOT TO SCALE



INSET A
SCALE: NOT TO SCALE

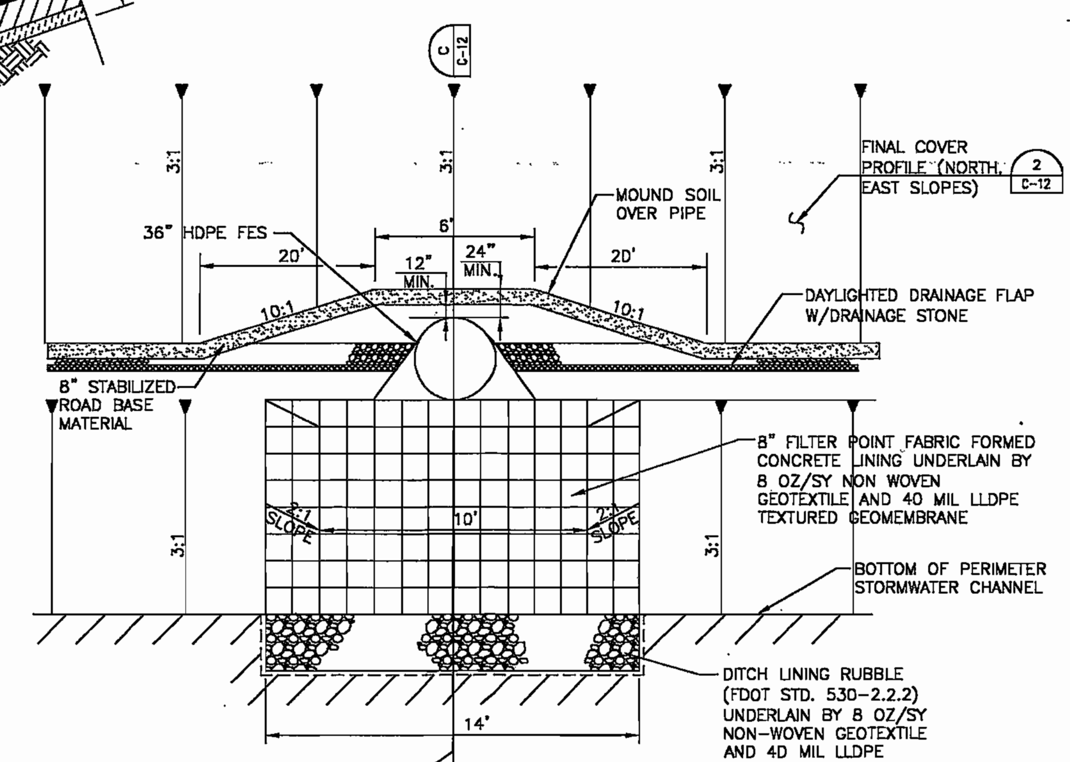
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA



NOTES:

1. ALL PIPE SHALL BE ADS N-12 WITH WATER TIGHT JOINTS OR EQUAL.
2. ALL PIPE FITTINGS SHALL BE PREFABRICATED.
3. PIPE, FITTINGS, AND FABRIC FORMED CONCRETE LINING SHALL BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS.
4. DRAINAGE FLAP AND DRAINAGE STONE NOT SHOWN FOR CLARITY. SEE DETAIL 2 THIS SHEET FOR TYPICAL FLAP CONSTRUCTION AT TOE OF SLOPE.

SECTION A A C-08
NOT TO SCALE



ENERGY DISSIPATOR (NORTH SLOPE) 3 C-05
NOT TO SCALE

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REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

SARASOTA COUNTY

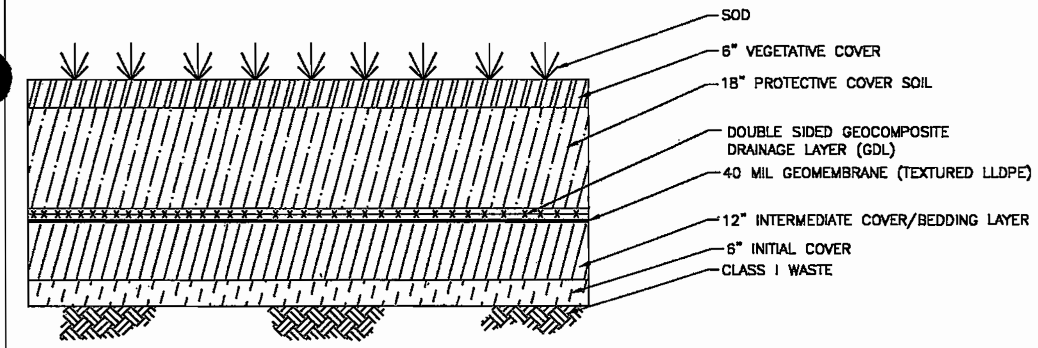
Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY — FLORIDA

PHASE I CLOSURE DETAILS

FILENAME
SCALE: AS SHOWN
SHEET 00C-11

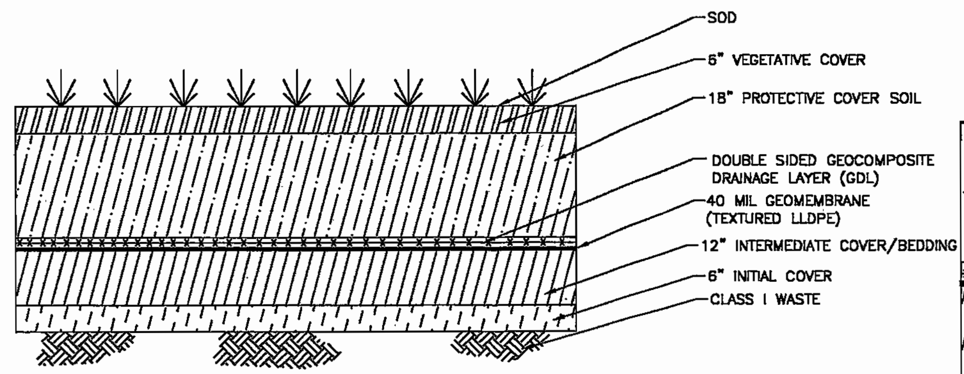
S:\pwworking\tpa\d0201056\00C-11.DWG, Plot, 4/29/2010 1:52:09 PM, irivera



FINAL COVER PROFILE (TOP SLOPE)

NOT TO SCALE

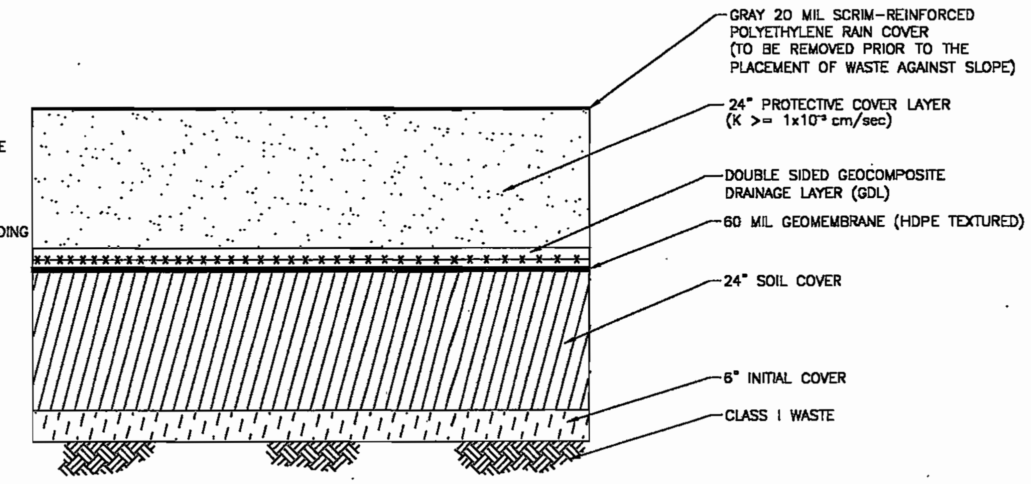
1 / C-05 / C-09 / C-10 / C-17



FINAL COVER PROFILE (NORTH, EAST SLOPES)

NOT TO SCALE

2 / C-05 / C-09 / C-10 / C-11 / C-17



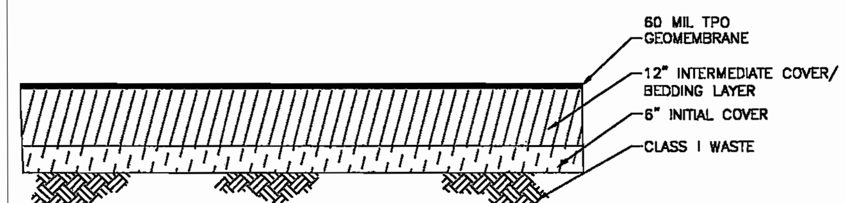
PHASE I/II OVERLAY LINER SYSTEM

NOT TO SCALE

3 / C-10 / C-17

NOTES:

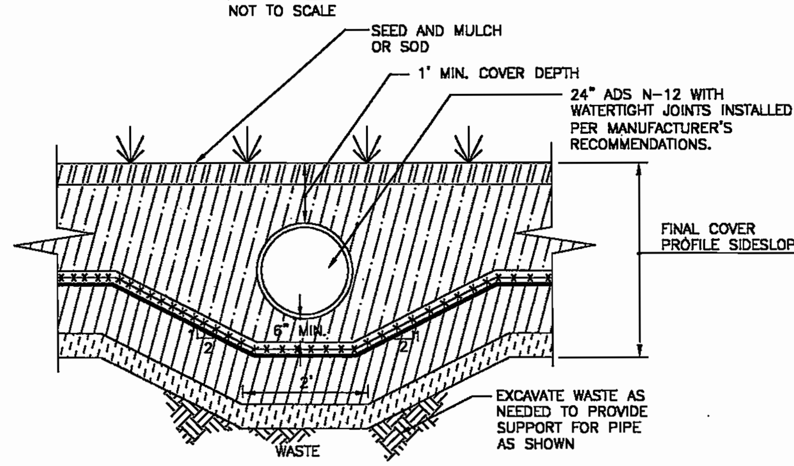
1. OVERLAY LINER SYSTEM WILL BE INSTALLED PRIOR TO FINAL COVER CONSTRUCTION AS PART OF PHASE II CONSTRUCTION.
2. OWNER MAY ELECT TO INSTALL PROTECTIVE COVER IN STAGES AS NEEDED FOR OPERATIONS.
3. RAIN COVER MAY NOT BE REQUIRED IF PROTECTIVE COVER IS INSTALLED IN STAGES.



TEMPORARY FINAL COVER (SOUTH SLOPE)

NOT TO SCALE

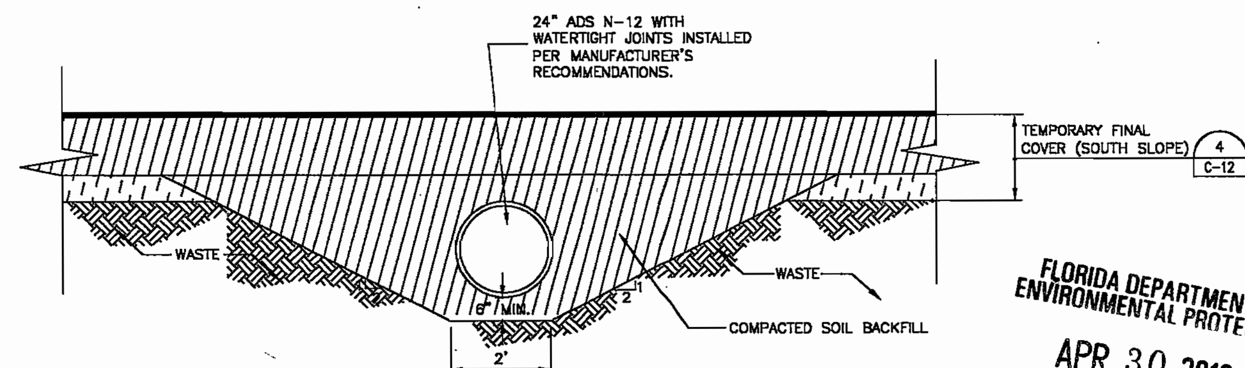
4 / C-14 / C-17 / C-18



DOWN DRAIN TRENCH (NORTH, EAST SLOPES)

NOT TO SCALE

5 / C-05 / C-09 / C-11 / C-18 / C-19



DOWNDRAIN TRENCH (SOUTH SLOPE)

NOT TO SCALE

6 / C-05 / C-19

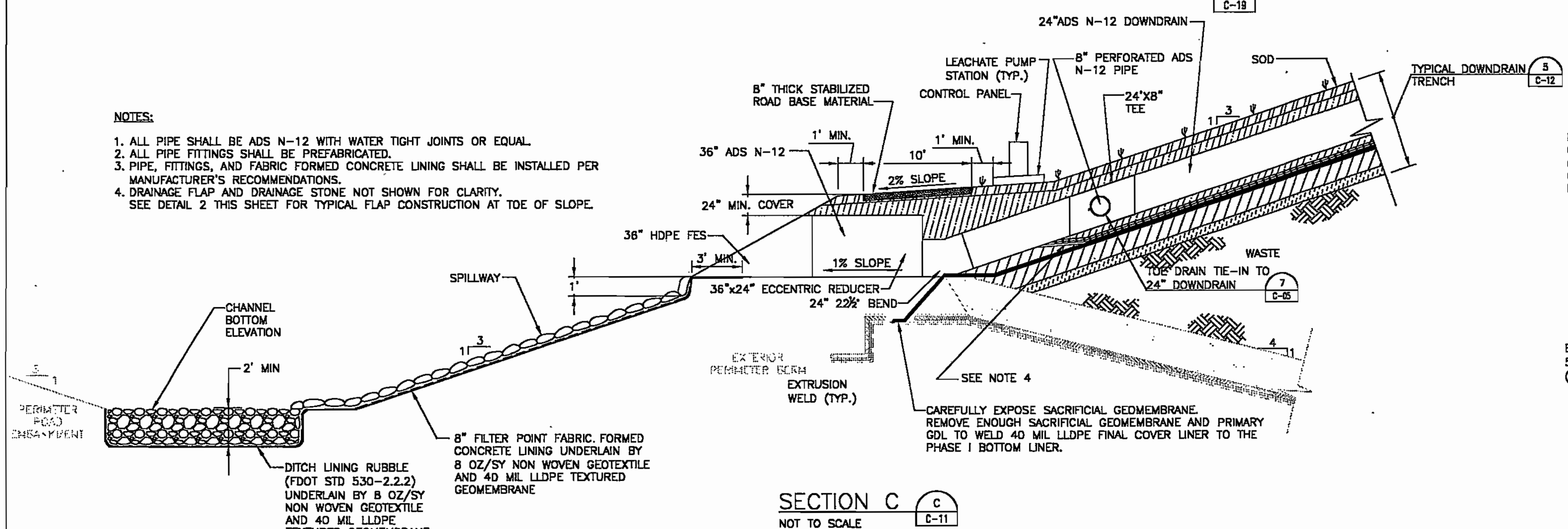
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

APR 30 2010

SOUTHWEST DISTRICT TAMPA

NOTES:

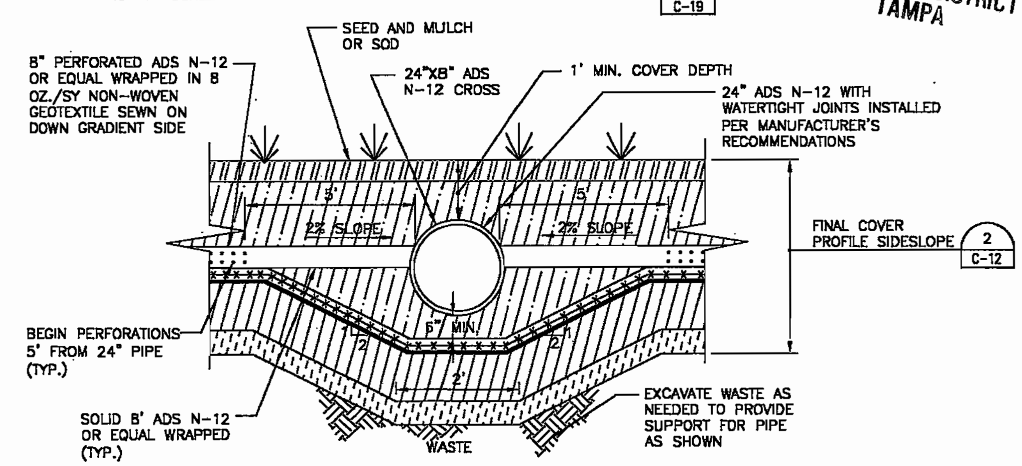
1. ALL PIPE SHALL BE ADS N-12 WITH WATER TIGHT JOINTS OR EQUAL.
2. ALL PIPE FITTINGS SHALL BE PREFABRICATED.
3. PIPE, FITTINGS, AND FABRIC FORMED CONCRETE LINING SHALL BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS.
4. DRAINAGE FLAP AND DRAINAGE STONE NOT SHOWN FOR CLARITY. SEE DETAIL 2 THIS SHEET FOR TYPICAL FLAP CONSTRUCTION AT TOE OF SLOPE.



SECTION C

NOT TO SCALE

C / C-11



TOE DRAIN TIE-IN TO 24" DOWNDRAIN

NOT TO SCALE

7 / C-05

A	4/2010	ISSUED FOR APPROVAL
ISSUE	DATE	DESCRIPTION

HDR Engineering, Inc.
2601 Cattlemen Rd., Ste. 106
Sarasota, Fl 34232-6212
(941) 342-2700
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PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-018

THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY — FLORIDA

PHASE 1 CLOSURE DETAILS

0 — 1" — 2"

FILENAME		SHEET	
SCALE	AS SHOWN		00C-12

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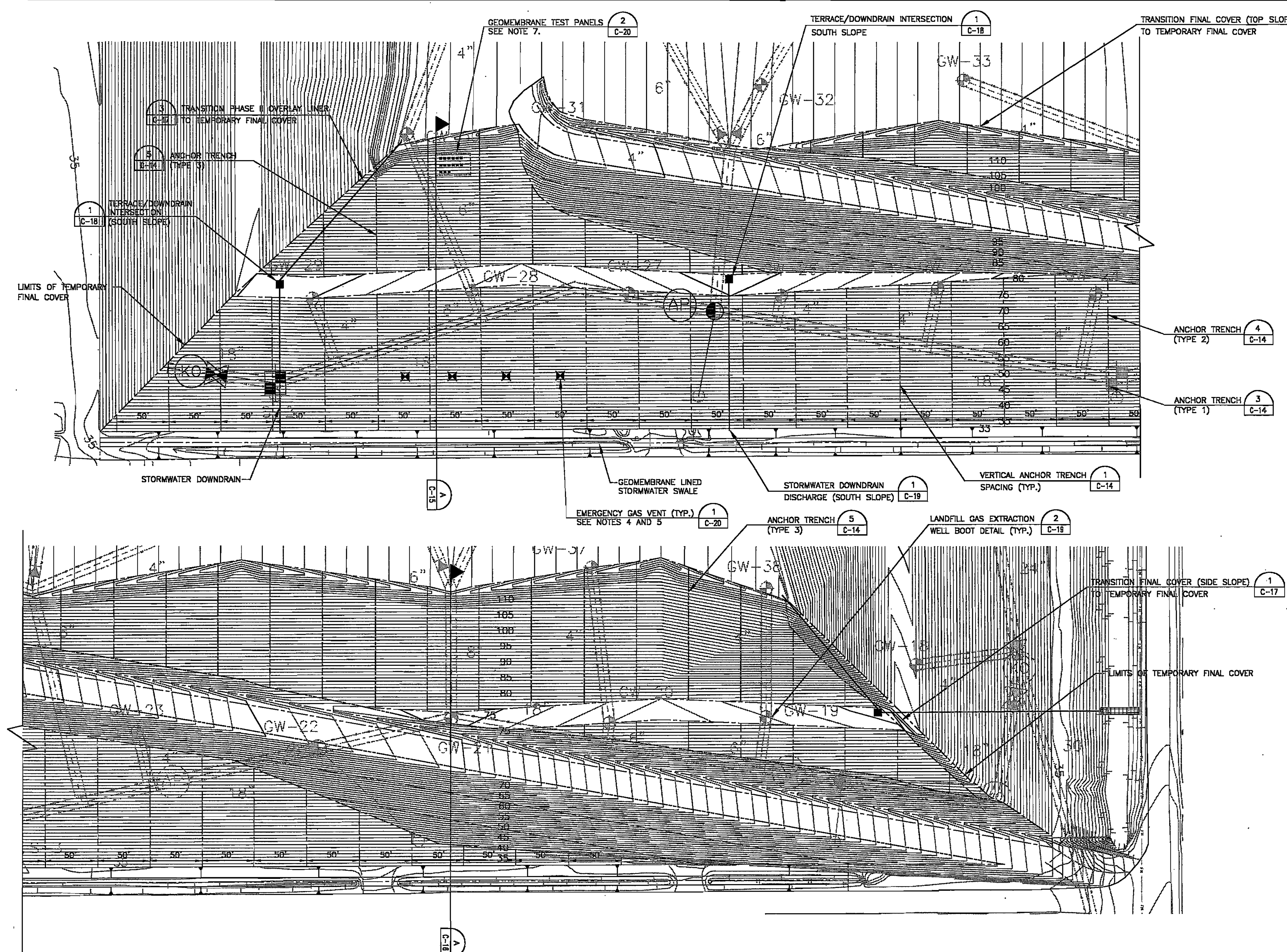

N

GRAPHIC SCALE

0 50 100 200

SCALE IN FEET
1" = 100'
AND AS SHOWN

NOTES:

1. TOPOGRAPHY WITHIN PHASES I THROUGH IV AREAS COMPILED BY KUCERA INTERNATIONAL, INC., OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
2. LOCATION OF ANCHOR TRENCHES SHALL BE ADJUSTED IN THE FIELD BASED ON ACTUAL LOCATION OF GAS WELLS AND LFG ACCESS POINTS.
3. THE ANCHOR TRENCH LOACTIONS SHOWN ARE CONCEPTUAL AND SUBJECT TO CHANGE BASED ON CONTRACTORS APPROVED PANEL LAYOUT.
4. THE CONTRACTOR SHALL INSTALL EMERGENCY GAS VENTS FOR EACH PANEL. PLEASE NOTE THAT NOT ALL VENTS ARE SHOWN ON THIS DRAWING.
5. THE EMERGENCY GAS VENTS ARE GENERALLY CLOSED WITH A CAM GROOVE FITTING WHICH WILL BE OPENED MANUALLY IN THE EVENT OF PRESSURE BUILD UP. THE ACTIVE GAS COLLECTION SYSTEM MAY BE CONNECTED TO THESE VENTS IF DEEMED NECESSARY IN THE FUTURE FOR CONTINUOUS GAS EXTRACTION.
6. LANDFILL GAS COLLECTION SYSTEM LAYOUT BASED ON DESIGN SUBMITTED TO FDEP ON DECEMBER 29, 2008 BY HDR ENGINEERING, INC.
7. FIFTEEN 60-MIL TPO GEOMEMBRANE TEST PANELS TO BE PROVIDED IN DESIGNATED LOCATION.

LEGEND

GW-56	LFG WELLS
	℄ ANCHOR TRENCH (TYPE 3)
	℄ ANCHOR TRENCH (TYPE 2)
	℄ ANCHOR TRENCH (TYPE 1)
	LFG ACCESS POINT
	REMOTE WELLHEAD
	PROPOSED GAS VENT

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

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CA00004213

ISSUE	DATE	DESCRIPTION
A	4/2010	ISSUED FOR APPROVAL

PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. YANOSCHAK
REVIEWED BY	M. ROBERTS
CIVIL DESIGN	K. PERERA
DRAWN BY	M. AUSTIN
PROJECT NUMBER	001916-92323-018

THOMAS. M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

SARASOTA COUNTY

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE
PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

PHASE I TEMPORARY FINAL COVER LAYOUT AND ACHOR TRENCH PLAN

0 1" 2"

FILENAME 00C-13_rev.dwg
SCALE N.T.S.
SHEET 00C-13

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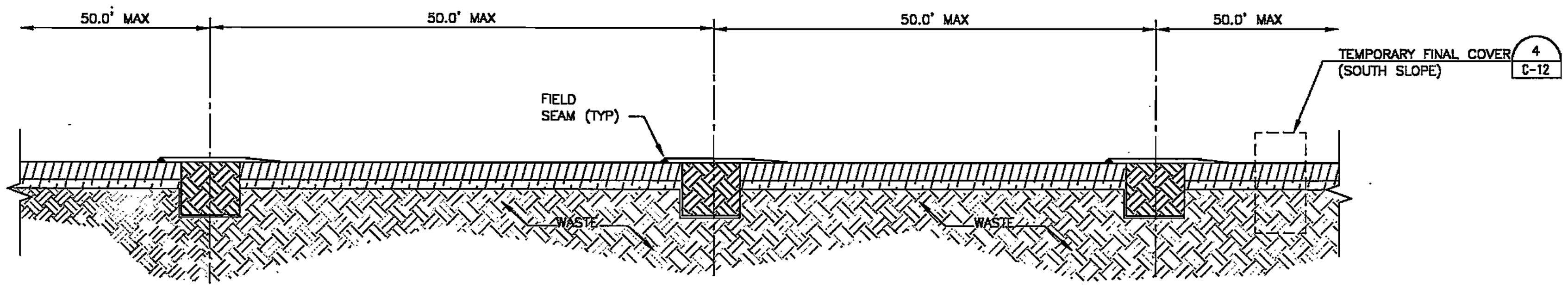
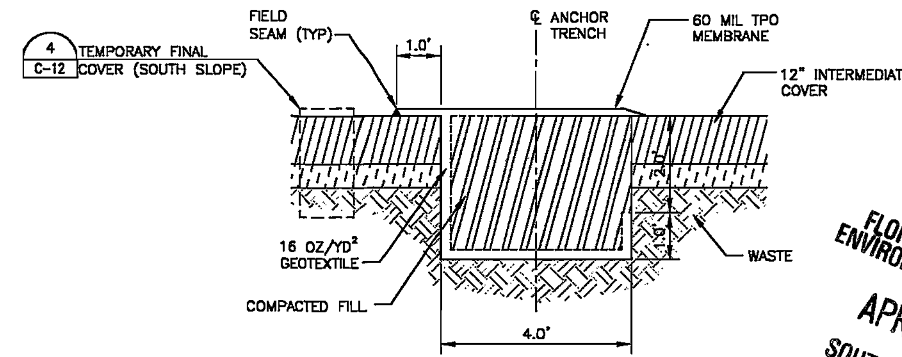


VERTICAL ANCHOR TRENCH SPACING 1 C-13 C-14
N.T.S.

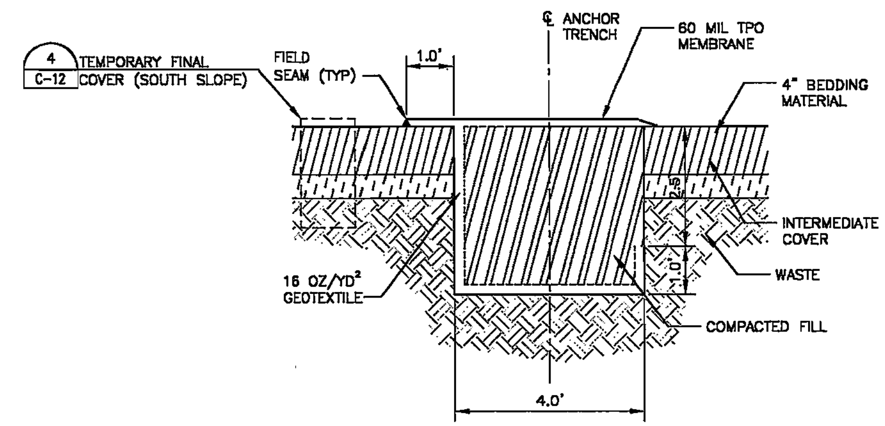


ANCHOR TRENCH (TYPE 1) – 3-FT DEPTH 3 C-13
N.T.S.

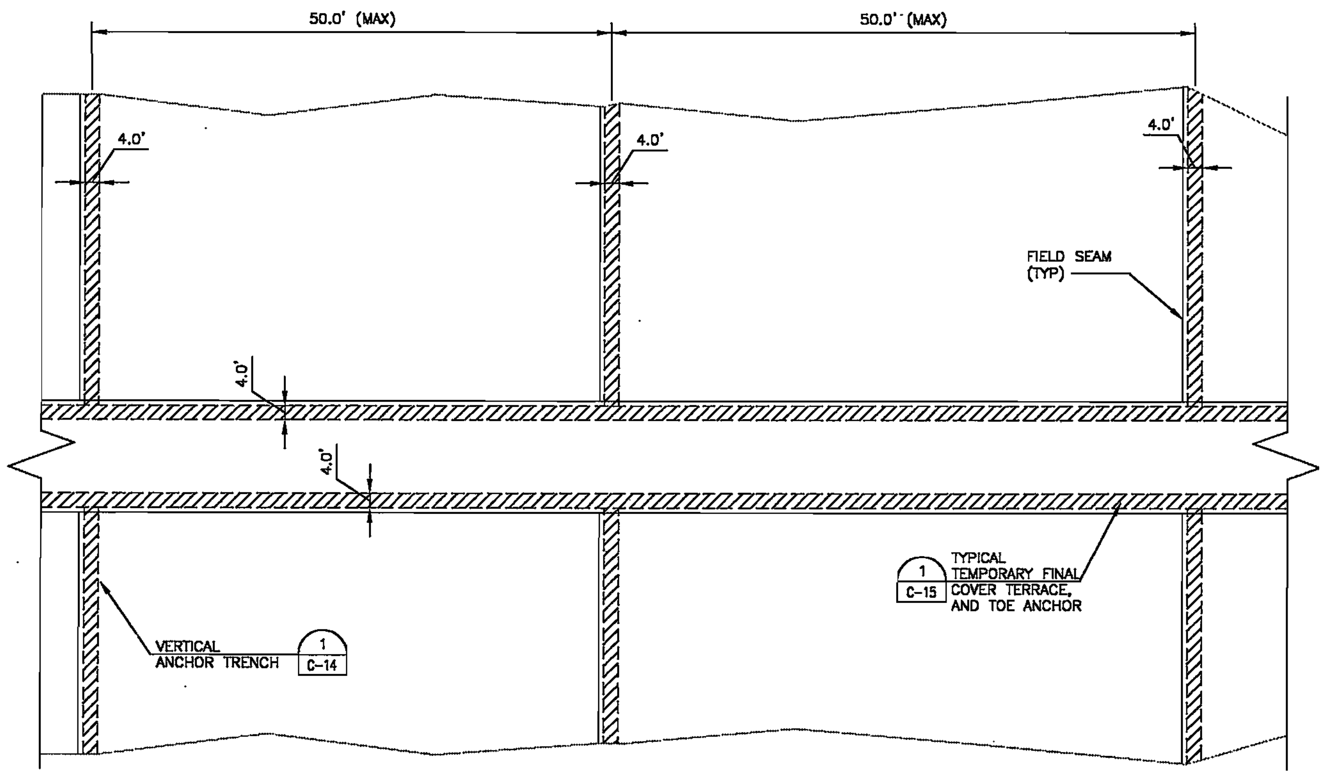
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

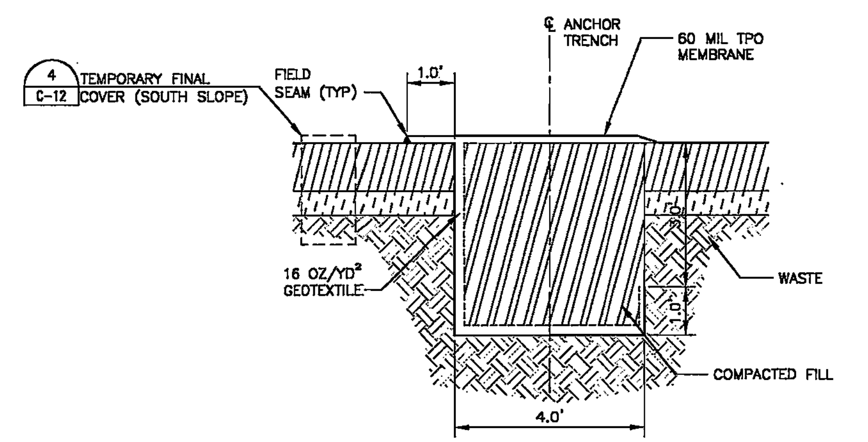
NOTES:

1. MAXIMUM CENTER TO CENTER DISTANCE OF VERTICAL ANCHOR TRENCHES SHALL NOT EXCEED 50 FT. ON 3:1 SIDESLOPES. HORIZONTAL ANCHOR TRENCHES SHOWN IN THE 2:1 SIDESLOPES SHALL NOT EXCEED 25 FT IN THE UPPER 1/3 OF SIDESLOPE AND 32 FT BELOW THE UPPER 1/3 OF THE SIDESLOPE.
2. THE CENTER TO CENTER DIMENSIONS SHOWN ARE CONCEPTUAL AND SUBJECT TO CHANGE BASED ON CONTRACTORS APPROVED PANEL LAYOUT.
3. DURING INSTALLATION OF TEMPORARY FINAL COVER (INCLUDING HORIZONTAL AND VERTICAL TRENCHES) THE CONTRACTOR SHALL MINIMIZE THE AMOUNT OF OPEN TRENCHES FOR ODOR AND STORMWATER CONTROL.
4. CONSTRUCTION ACTIVITIES SHALL BE SEQUENCED TO ALLOW GEOMEMBRANE TO BE PLACED IN THE ANCHOR TRENCH IMMEDIATELY FOLLOWING THE EXCAVATION OF THE ANCHOR TRENCH.
5. AS SOON AS CONSTRUCTION QUALITY ASSURANCE (CQA) PERSONNEL HAVE APPROVED THE DIMENSIONS, ALL OPEN TRENCHES SHALL BE BACKFILLED WITH SOIL AT THE END OF THE DAY.
6. CONTRACTOR SHALL USE CLEAN BACKFILL FOR ANCHORS. ANY SOLID WASTE REMOVED DURING EXCAVATION MUST BE PROPERLY DISPOSED OF IN ADJACENT ACTIVE LANDFILL CELL.
7. WEDGE WELD END OF GEOMEMBRANE PANEL TO BEGINNING OF NEW GEOMEMBRANE PANEL AND CONTINUE DOWNSLOPE. FLAP OF WEDGE WELD TO BE ON TOP IN THE DOWNSLOPE DIRECTION.
8. WELDS CONNECTING DOWNSLOPE SHEETS SHALL BE DOUBLE WEDGE WELDS, AND SHALL HAVE A MINIMUM 10 FT. VERTICAL OFFSET BETWEEN ADJACENT PANEL WELDS.
9. HOT ARC WELDS SHALL BE USED ONLY WHEN WEDGE WELDS ARE NOT FEASIBLE.
10. SEE SHEET 00C-13 FOR PLACEMENT OF TYPE 1, 2, AND 3 ANCHOR TRENCHES FOR VERTICAL ANCHOR TRENCHES.



ANCHOR TRENCH (TYPE 2) – 3.5-FT DEPTH 4 C-13
N.T.S.





ANCHOR TRENCH (TYPE 3) – 4-FT DEPTH 5 C-13
N.T.S.

TYPICAL ANCHORING PLAN 2 C-14
N.T.S.

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SARASOTA COUNTY

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE
PERMIT DRAWINGS

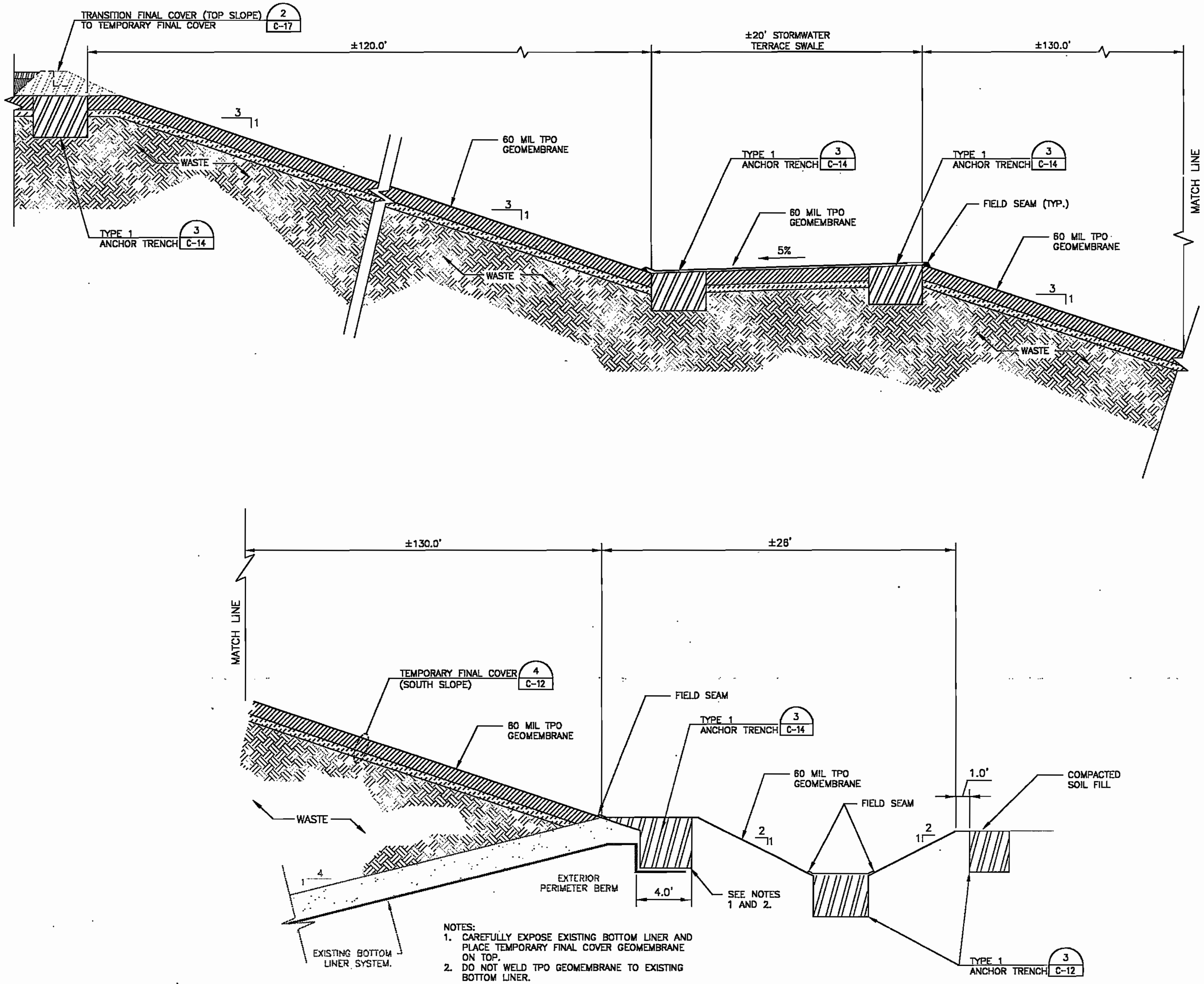
SARASOTA COUNTY — FLORIDA

PHASE I TEMPORARY FINAL COVER ANCHOR TRENCH SECTIONS AND DETAILS

0 1" 2"

FILENAME	00C-14.dwg
SCALE	N.T.S.

SHEET **00C-14**



NOTES:
1. CAREFULLY EXPOSE EXISTING BOTTOM LINER AND PLACE TEMPORARY FINAL COVER GEOMEMBRANE ON TOP.
2. DO NOT WELD TPO GEOMEMBRANE TO EXISTING BOTTOM LINER.

TYPICAL TEMPORARY FINAL COVER TERRACE AND TOE ANCHOR (A / 00C-13)
N.T.S.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

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HDR
HDR Engineering, Inc.
8420 BayCenter Dr. Ste. 400
Tampa, Fl 33609-3444
(813) 282-2300
CA00004213

ISSUE	DATE	DESCRIPTION
A	4/2010	ISSUED FOR APPROVAL

PROJECT MANAGER	R. SIEMERING
REVIEWED BY	T. YANOSCHAK
REVIEWED BY	M. ROBERTS
CIVIL DESIGN	K. PERERA
DRAWN BY	M. AUSTIN
PROJECT NUMBER	001916-92323-018

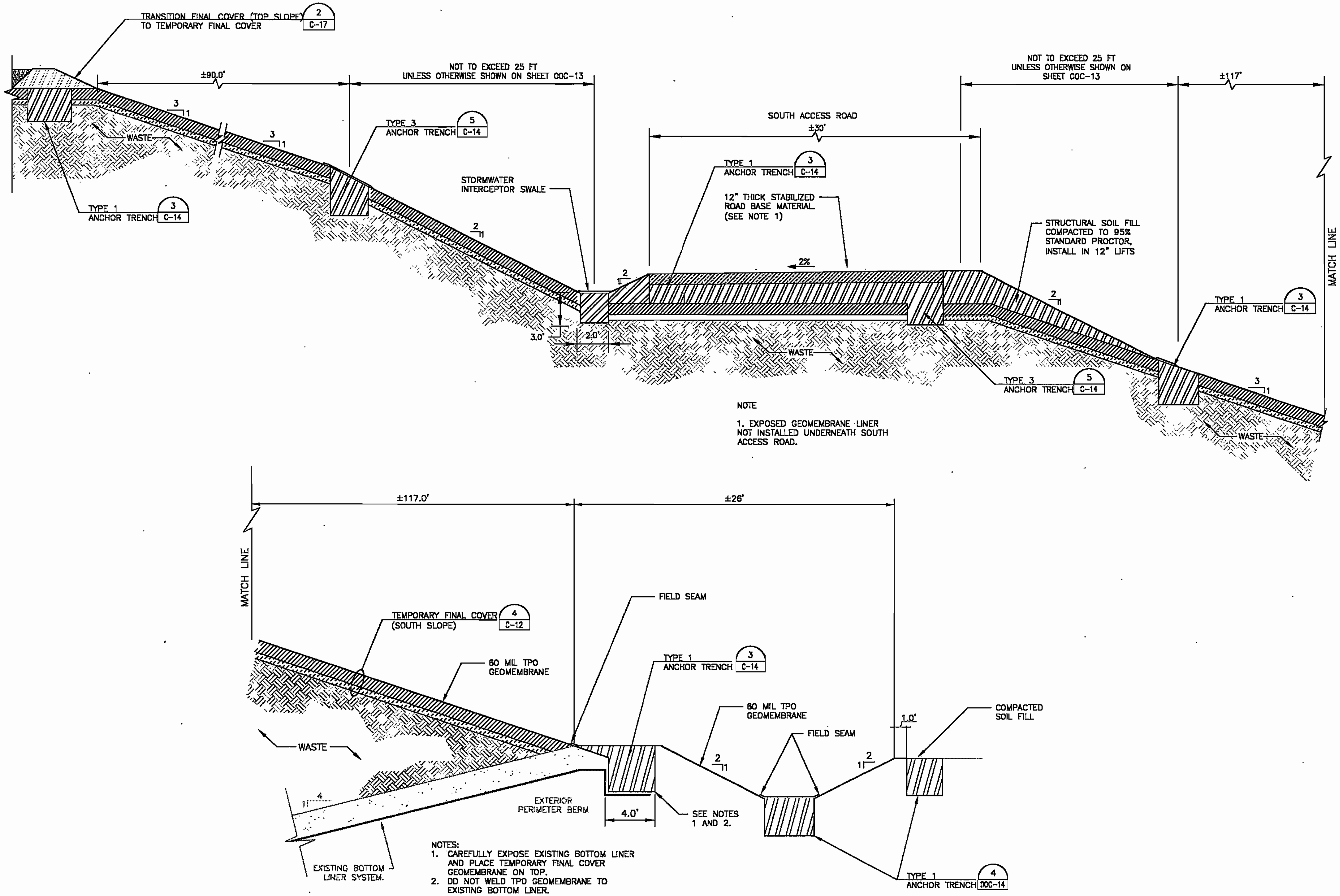
THOMAS. M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS
SARASOTA COUNTY FLORIDA

PHASE I TEMPORARY FINAL COVER ANCHOR TRENCH SECTIONS AND DETAILS

0 1" 2"

FILENAME 00C-15.dwg
SCALE N.T.S.
SHEET 00C-15



TYPICAL TEMPORARY FINAL COVER ALONG SOUTH ROAD SIDE SLOPE (A / 00C-13)

N.T.S.

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PROJECT NUMBER	001916-92323-018

THOMAS. M. YANOSCHAK, P. E.
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SARASOTA COUNTY

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY — FLORIDA

PHASE I TEMPORARY FINAL COVER ANCHOR TRENCH SECTIONS AND DETAILS

0 1" 2"

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SCALE	N.T.S.
SHEET	00C-16

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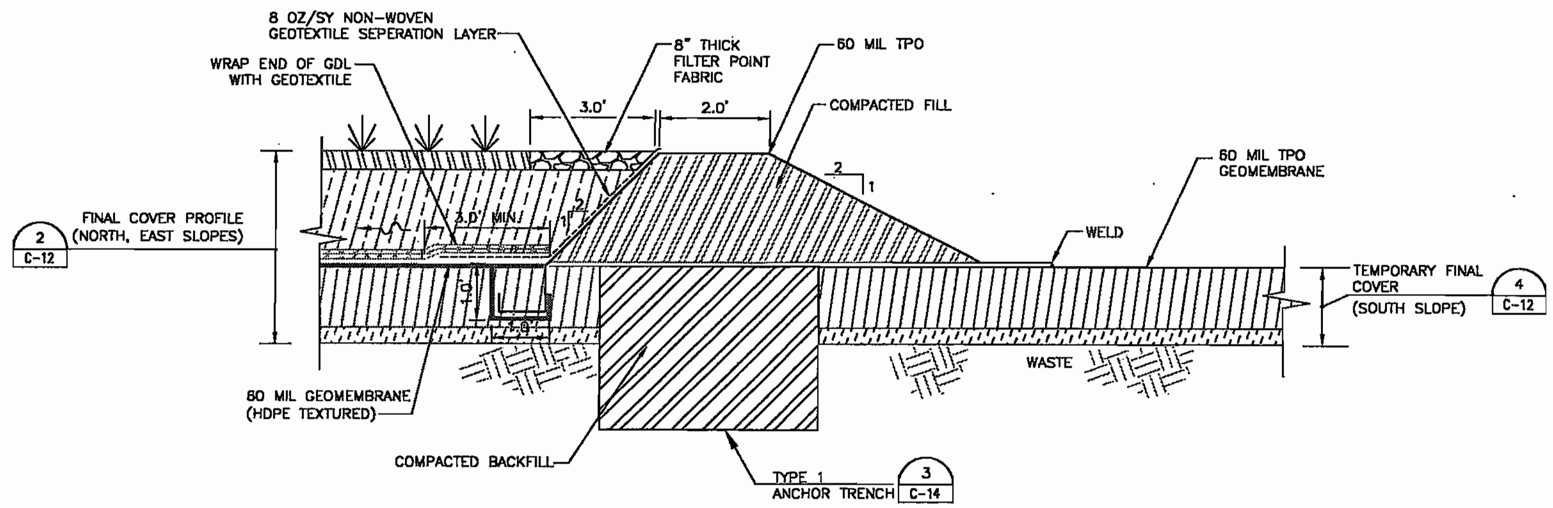
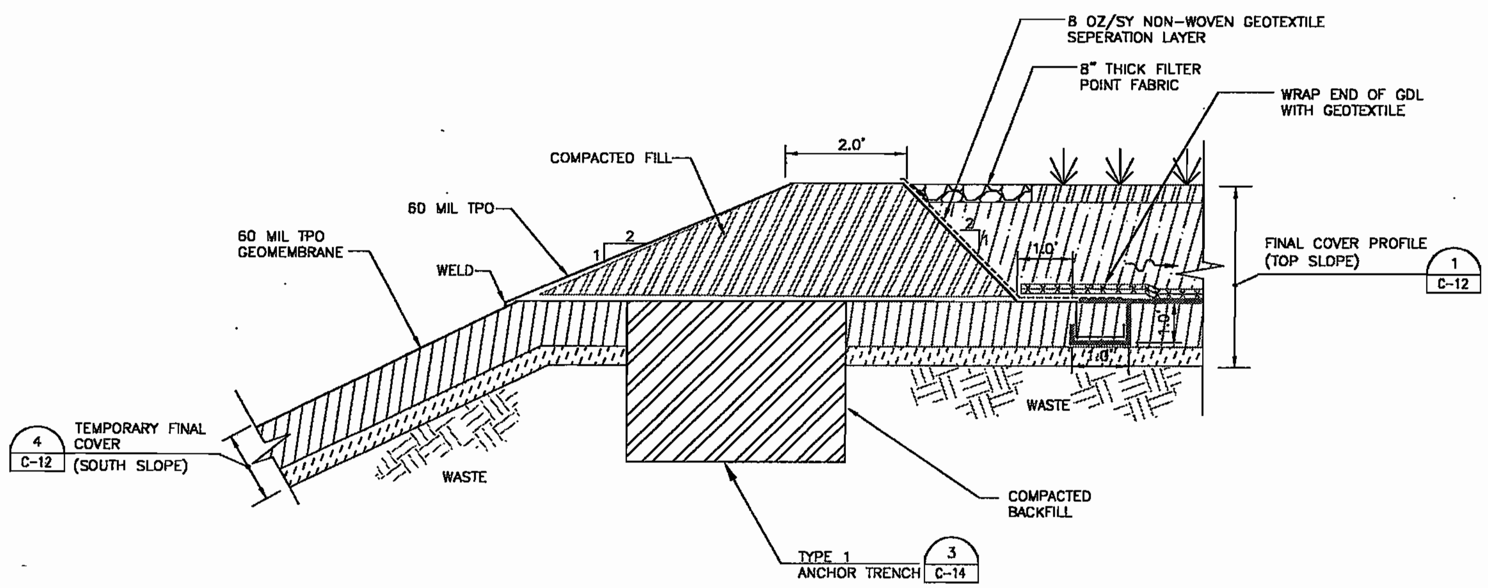


TRANSITION FINAL COVER (SIDESLOPE)
TO TEMPORARY FINAL COVER

NOT TO SCALE

1 C-13

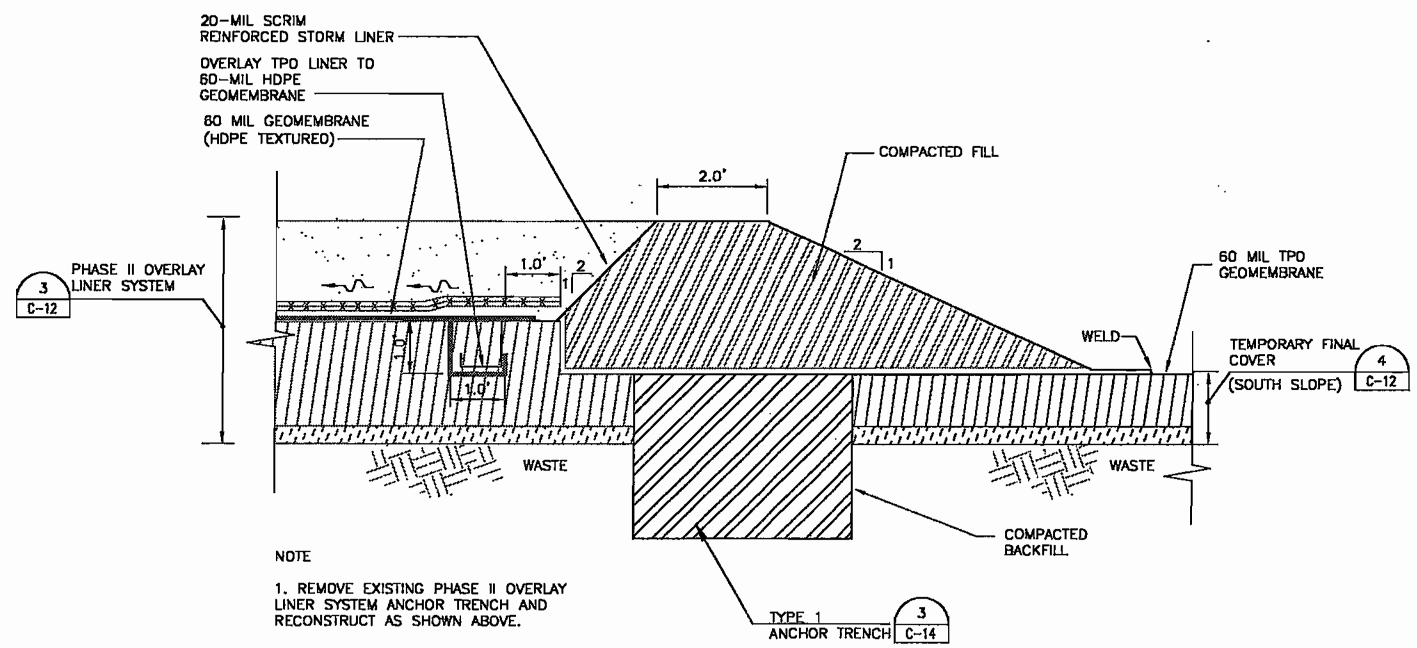
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA



TRANSITION FINAL COVER (TOPSLOPE)
TO TEMPORARY FINAL COVER

NOT TO SCALE

2 C-13 C-15



NOTE

1. REMOVE EXISTING PHASE II OVERLAY LINER SYSTEM ANCHOR TRENCH AND RECONSTRUCT AS SHOWN ABOVE.

TRANSITION PHASE II OVERLAY LINER
TO TEMPORARY FINAL COVER

NOT TO SCALE

3 C-13

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Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

PHASE I TEMPORARY FINAL COVER CLOSURE DETAILS

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SCALE	AS SHOWN
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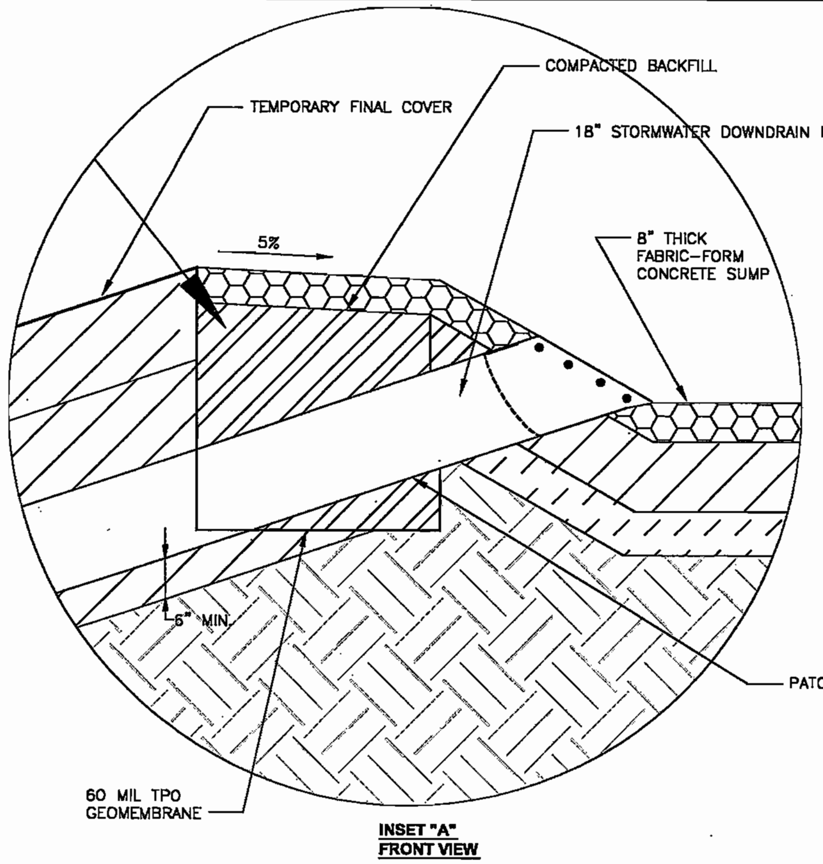
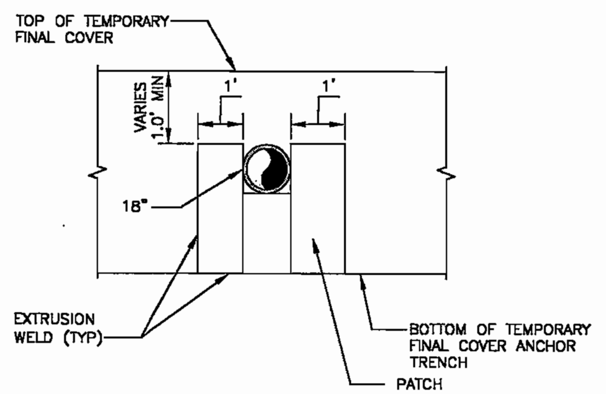


INSET "A"
FRONT VIEW



SIDE

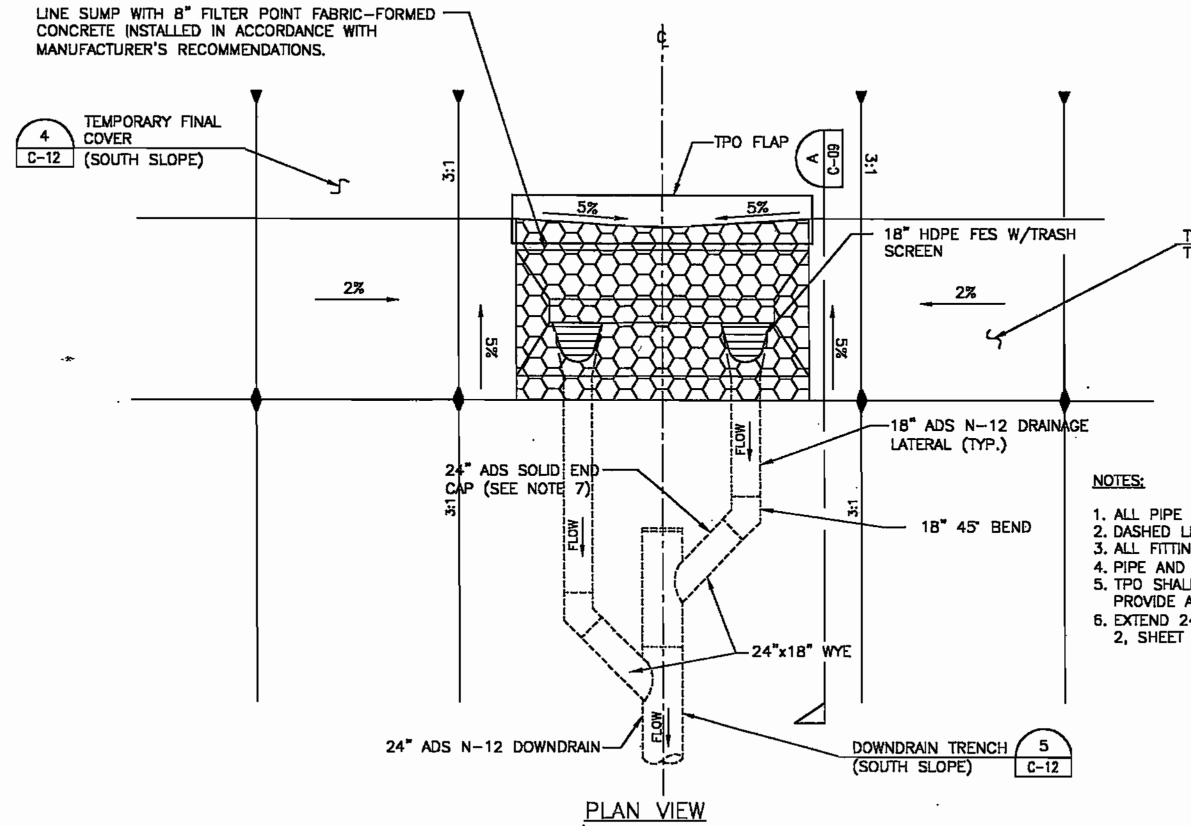
NOTES:

1. CONTRACTOR TO USE CAUTION WHEN EXCAVATING AROUND EXISTING UNDERGROUND PIPING SYSTEM.
2. CUT GEOMEMBRANE AROUND EXISTING PIPE.
3. PLACE GEOMEMBRANE PATCH AROUND PIPE PENETRATION, OVERLAP MIN. 1' ON EACH SIDE AND EXTRUSION WELD ALL SEAMS.

TYPICAL TEMPORARY FINAL COVER ANCHOR TRENCH PENETRATION DETAIL

NOT TO SCALE

2 C-18 C-19



PLAN VIEW

NOTES:

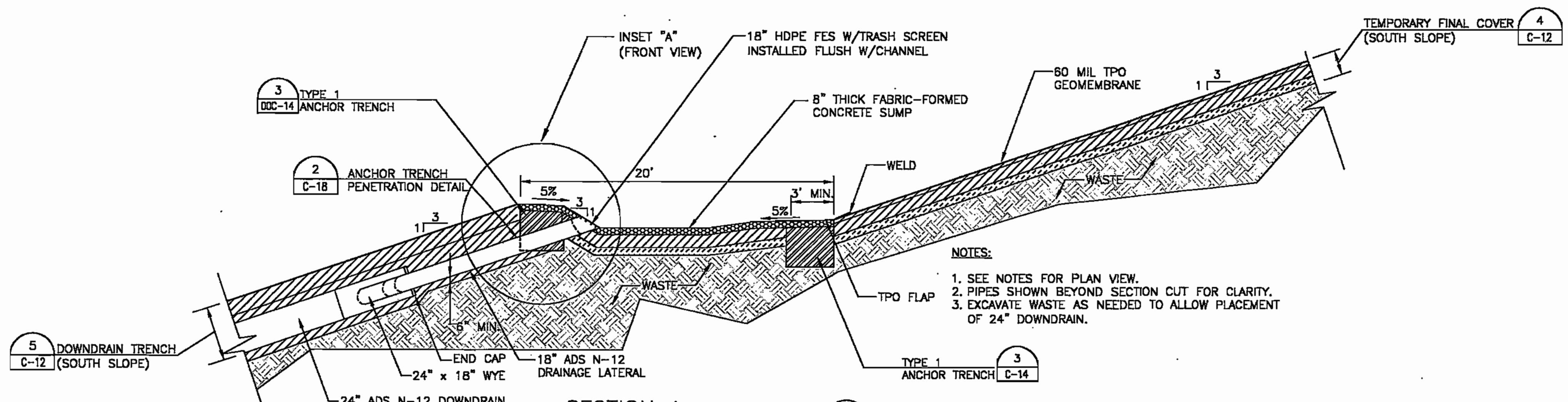
1. ALL PIPE SHALL BE ADS N-12 WITH WATER TIGHT JOINTS.
2. DASHED LINES REPRESENT BURIED PIPE.
3. ALL FITTINGS SHALL BE PRE-FABRICATED.
4. PIPE AND FITTINGS SHALL BE INSTALLED TO MANUFACTURER'S RECOMMENDATIONS.
5. TPO SHALL BE CONNECTED TO CONCRETE PAD USING S.S. BATTEN AND BOLTS TO PROVIDE A WATER TIGHT CONNECTION.
6. EXTEND 24" PIPE BEYOND SUMP WHERE REQUESTED ON PLANS SIMILAR TO DETAIL 2, SHEET C-09.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

TERRACE/DOWNDRAIN INTERSECTION (SOUTH SLOPE)

NOT TO SCALE

1 C-05 C-13



NOTES:

1. SEE NOTES FOR PLAN VIEW.
2. PIPES SHOWN BEYOND SECTION CUT FOR CLARITY.
3. EXCAVATE WASTE AS NEEDED TO ALLOW PLACEMENT OF 24" DOWNDRAIN.

SECTION A

NOT TO SCALE

A C-18

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SARASOTA COUNTY

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS

SARASOTA COUNTY — FLORIDA

PHASE I TEMPORARY FINAL COVER CLOSURE DETAILS

0 1" 2"

FILENAME

SCALE AS SHOWN

SHEET 00C-18

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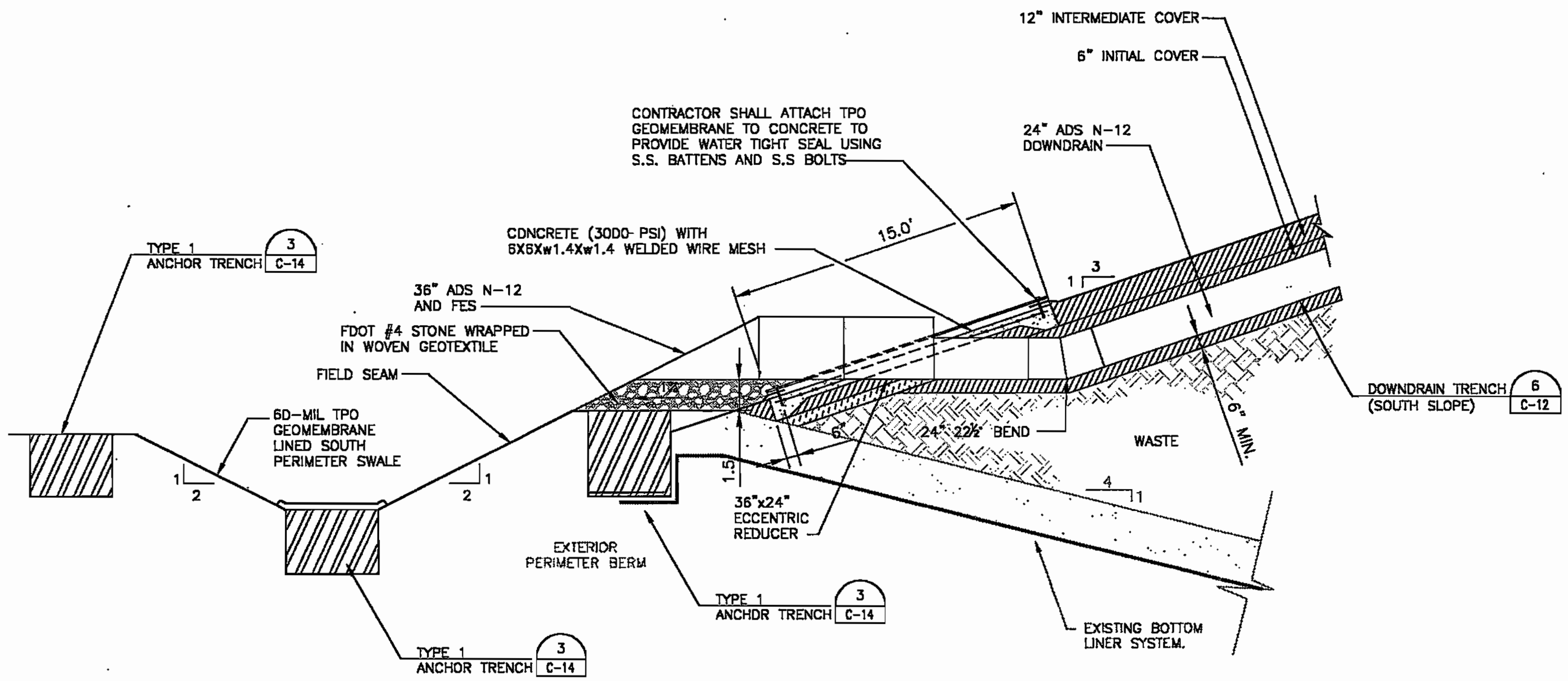
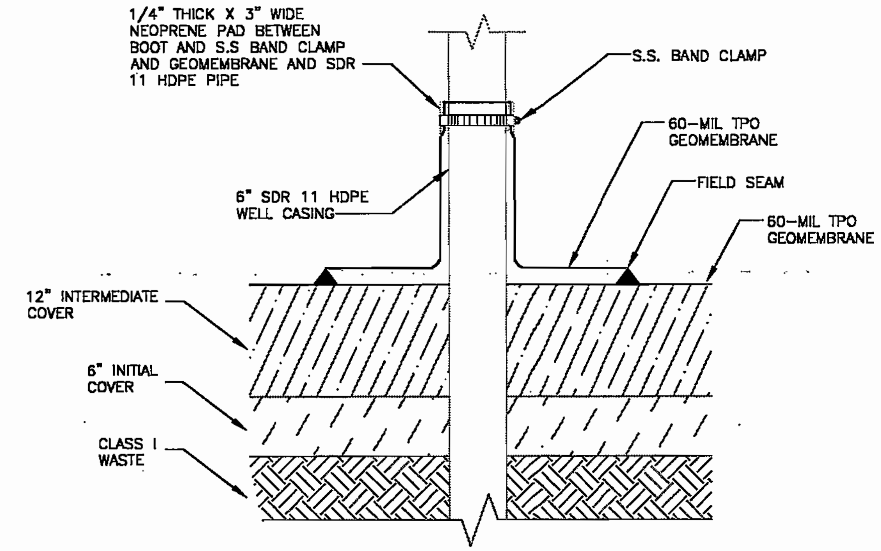


NOTES:

1. ALL PIPE SHALL BE ADS N-12 WITH WATER TIGHT JOINTS OR EQUAL.
2. ALL PIPE FITTINGS SHALL BE PREFABRICATED AND SHALL BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS.
3. CAREFULLY EXPOSE EXISTING BOTTOM LINER AND PLACE TPO GEOMEMBRANE ON TOP.
4. DO NOT WELD TPO GEOMEMBRANE TO EXISTING BOTTOM LINER.
5. ANNULAR SPACE BETWEEN CONCRETE AND PIPE SHALL BE FILLED WITH LINK SEAL OR APPROVED EQUAL.

STORMWATER DOWNDRAIN DISCHARGE (SOUTH SLOPE) 1 C-13
NOT TO SCALE



NOTES:

1. EXTRUSION WELD LINER AROUND PIPE FOR ACCESS POINTS AND U-TRAPS.

LANDFILL GAS EXTRACTION WELL BOOT DETAIL 2 C-13
NOT TO SCALE

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SARASOTA COUNTY

Central County Solid Waste Disposal Complex
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SARASOTA COUNTY FLORIDA

PHASE I TEMPORARY FINAL COVER CLOSURE DETAILS

0 1" 2"
FILENAME
SCALE AS SHOWN
SHEET **00C-19**

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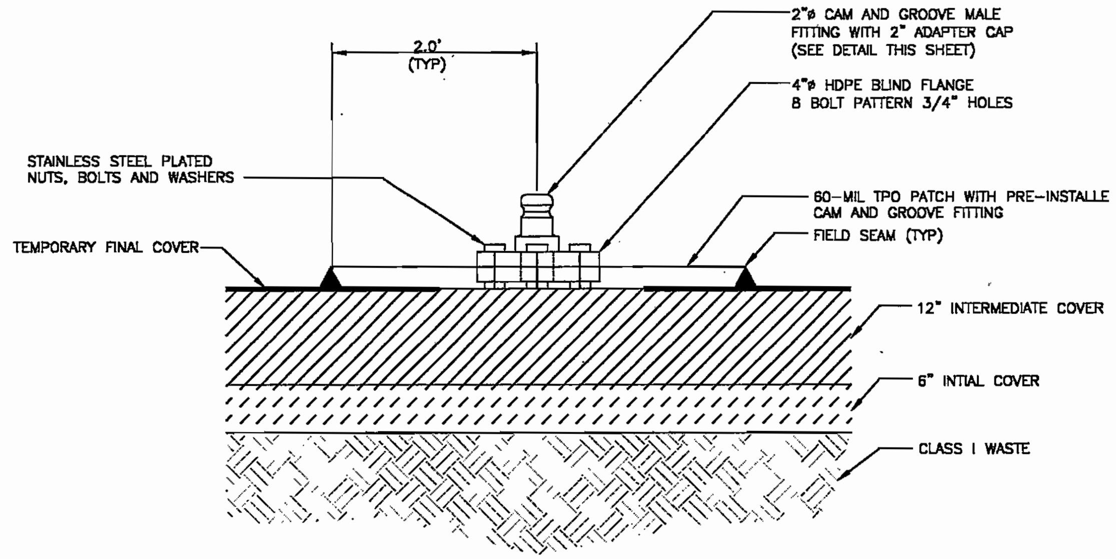
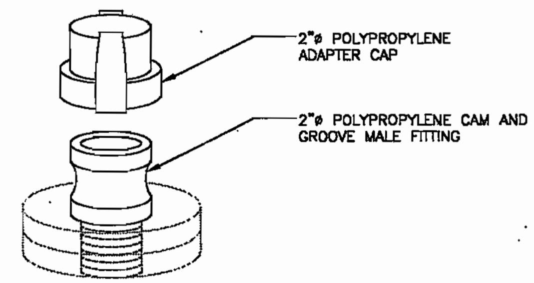


EMERGENCY GAS VENT

NOT TO SCALE

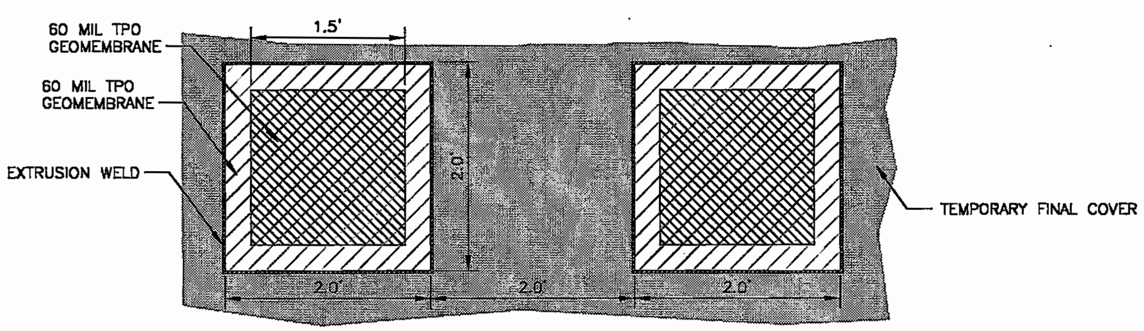
1 / 00C-13



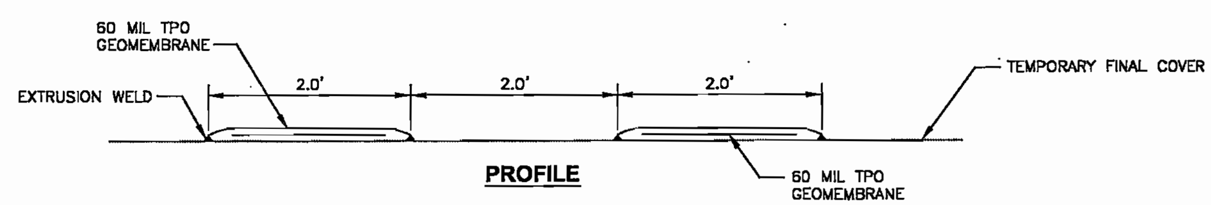
CAM AND GROOVE FITTING DETAIL

NTS – ALL DIMENSIONS APPROXIMATE

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA



PLAN



PROFILE

GEOMEMBRANE TEST PANELS

NOT TO SCALE

2 / 00C-13

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SARASOTA COUNTY — FLORIDA

PHASE I TEMPORARY FINAL COVER CLOSURE DETAILS

0 1" 2"

FILENAME

SCALE AS SHOWN

SHEET **00C-20**

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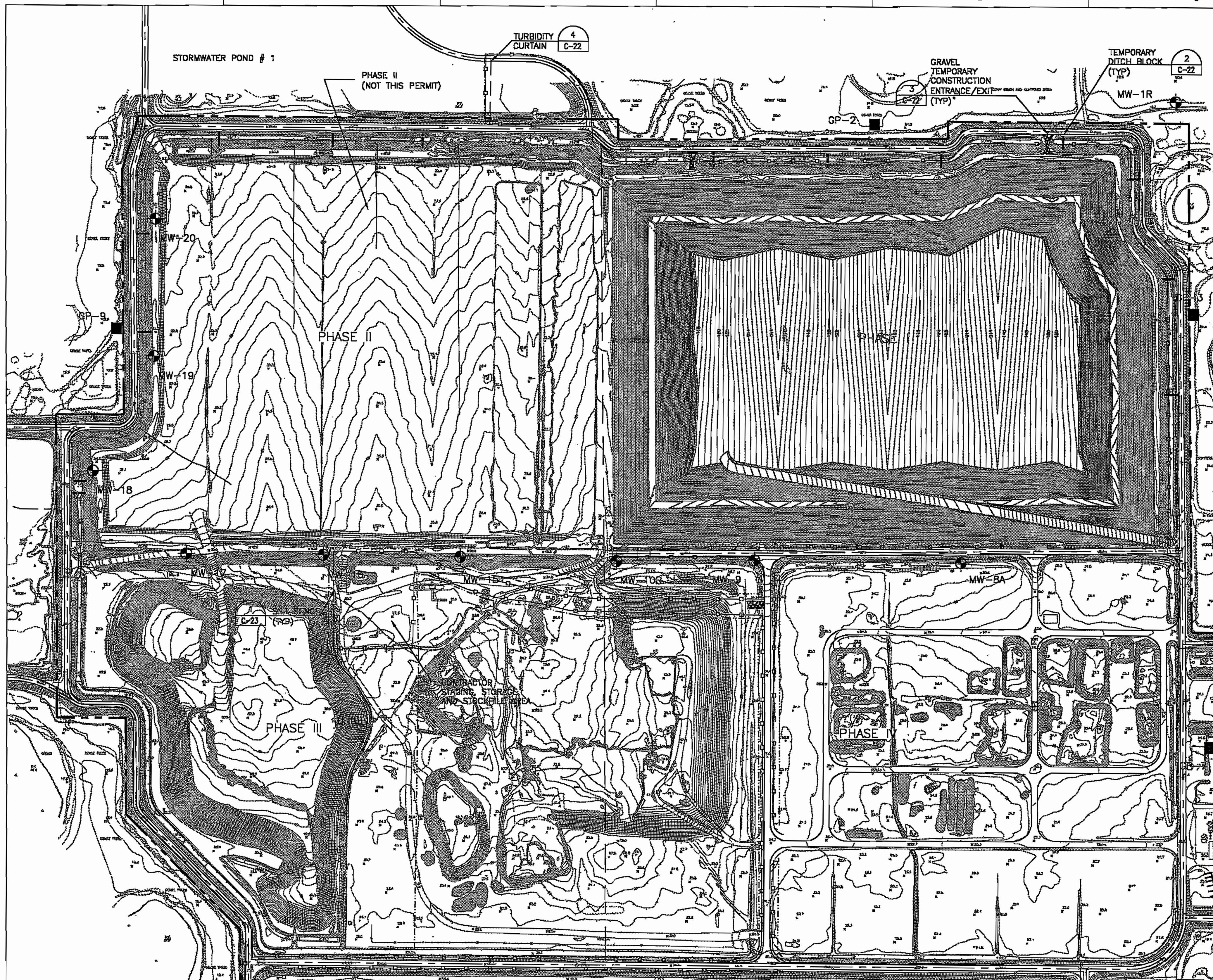

N

SEDIMENT AND EROSION CONTROL NOTES

1. SOIL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSTALLED IN STRICT ACCORDANCE WITH STANDARDS IN THE CONSTRUCTION DOCUMENTS AND APPLICABLE ENVIRONMENTAL REGULATIONS.
2. ALL STORM WATER MANAGEMENT AND EROSION CONTROL MEASURES SHALL BE INSTALLED AND MADE OPERATIONAL PRIOR TO COMMENCEMENT OF EARTHWORK ACTIVITIES.
3. CONTRACTOR, OWNER AND ENGINEER WILL EVALUATE THE EXISTING CONDITION OF THE PERIMETER DRAINAGE CHANNELS AT START OF WORK. CONTRACTOR WILL BE RESPONSIBLE FOR MAINTAINING THE CHANNEL AND PONDS AND RESTORING THEM TO THE ORIGINAL CONDITION AT START OF WORK PRIOR TO DEMOBILIZING.
4. EROSION CONTROL MEASURES SHALL BE INSTALLED AND MAINTAINED TO THE SATISFACTION OF THE ENGINEER. FAILURE TO DO SO WILL RESULT IN STOPPAGE OF ALL OTHER WORK UNTIL SAID MEASURES COMPLY WITH ACCEPTABLE STANDARDS.
5. STABILIZATION MEASURES SHALL BE INITIATED AS SOON AS PRACTICABLE IN PORTIONS OF THE SITE WHERE CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED, BUT IN NO CASE MORE THAN 6 WEEKS AFTER THE CONSTRUCTION ACTIVITY IN THAT PORTION OF THE SITE HAS TEMPORARILY OR PERMANENTLY CEASED, UNLESS ACTIVITY IN THAT PORTION OF THE SITE WILL RESUME WITHIN 8 WEEKS.
6. ADDITIONAL TEMPORARY DITCHES AND/OR DIVERSIONS MAY BE REQUIRED TO PERFORM CONSTRUCTION. WHERE SUCH MEASURES ARE REQUIRED, THEY SHALL BE CONSTRUCTED SO AS TO DIRECT RUNOFF FROM DISTURBED AREAS TO APPROPRIATE TEMPORARY CONTROL FEATURES. NO ADDITIONAL PAYMENT SHALL BE MADE FOR ADDITIONAL MEASURES REQUIRED TO CONTROL EROSION.
7. ALL SEDIMENT CONTROL MEASURES SHALL BE INSPECTED AT LEAST ONCE EVERY SEVEN CALENDAR DAYS AND AFTER ANY STORM EVENT OF GREATER THAN ONE-HALF INCH OF PRECIPITATION DURING ANY 24 HOUR PERIOD. ALL SEDIMENT CONTROL FEATURES SHALL BE MAINTAINED UNTIL FINAL STABILIZATION HAS BEEN OBTAINED.
8. RESTORE AND STABILIZE ALL DISTURBED AREAS INCLUDING STOCKPILES AND STORAGE AREAS. PERFORM PERMANENT SEEDING IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS.
9. BETWEEN SUBSTANTIAL COMPLETION AND FINAL COMPLETION OF THE WORK, THE CONTRACTOR SHALL REMOVE ALL SEDIMENT FROM THE EROSION CONTROL MEASURES THAT RECEIVED DRAINAGE DURING CONSTRUCTION.
10. ANY ERODED MATERIALS SHALL BE PROMPTLY REMOVED FROM ROADWAYS, DRIVES, WALKS, DITCHES, WATER COURSES, DRAINAGE CULVERTS, AND/OR STRUCTURES.
11. SILT FENCE, STRAW BALE BARRIERS, ETC. SHALL BE CHECKED REGULARLY FOR UNDERMINING OR DETERIORATION. CONTRACTOR SHALL REPLACE AS REQUIRED.
12. ALL TEMPORARY EROSION CONTROL AND SEDIMENT CONTROL MEASURES SHALL BE REMOVED UPON SATISFACTORY COMPLETION OF WORK AND SITE STABILIZATION.
13. CONTRACTOR SHALL PERFORM PRE-CONSTRUCTION AND POST-CONSTRUCTION TOPOGRAPHIC SURVEY OF STORMWATER POND #1 BOTTOM (EXCLUDING LITTORAL SHELF AREAS) ON 50' MAXIMUM GRID. CONTRACTOR SHALL EXCAVATE SEDIMENT FROM PONDS AFTER SITE STABILIZATION WHEREVER POST-CONSTRUCTION SURVEY INDICATES POND BOTTOM IS MORE THAN 1' ABOVE AS-BUILT ELEVATIONS. CONTRACTOR SHALL NOT BE PAID FOR EXCAVATED SEDIMENT THAT ACCUMULATES DURING CONSTRUCTION.

GENERAL NOTES

1. TOPOGRAPHY WITHIN PHASES I THROUGH IV AREAS COMPILED BY KUCERA INTERNATIONAL, INC. OF WILLOUGHBY, OHIO USING PHOTOGRAMMETRICMETHODS FROM AERIAL PHOTOGRAPHS DATED JUNE 1, 2009.
2. APPROXIMATE LOCATION OF PHASE I LEACHATE FORCEMAIN OBTAINED FROM RECORD DRAWINGS BY CAMP DRESSER & McKEE, INC. DATED APRIL 1998. VERIFY LOCATION IN FIELD.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

LEGEND

- GP-1 GAS PROBE
- MW-1DR GROUNDWATER MONITORING WELL
- VEGETATION
- WATERWAY
- SPECIAL EXCEPTION BOUNDARY
- EXISTING ROADWAY
- PHASE BOUNDARY
- TURBIDITY CURTAIN
- EXISTING PHASE I LEACHATE FORCEMAIN (SEE NOTE 2)
- SILT FENCE
- LIMITS OF CONSTRUCTION

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REVIEWED BY	T. M. YANOSCHAK
CIVIL DESIGN	C. RESTREPO
DRAWN BY	L. KARSHNER
PROJECT NUMBER	001916-88765-01B

THOMAS M. YANOSCHAK, P. E.
CERTIFICATE NO. 44200

SARASOTA COUNTY

Central County Solid Waste Disposal Complex
PHASE I CLASS I LANDFILL CLOSURE
PERMIT DRAWINGS

SARASOTA COUNTY FLORIDA

SEDIMENTATION AND EROSION CONTROL PLAN

0 1" 2"

FILENAME

SCALE 1"=200'

SHEET 00C-21

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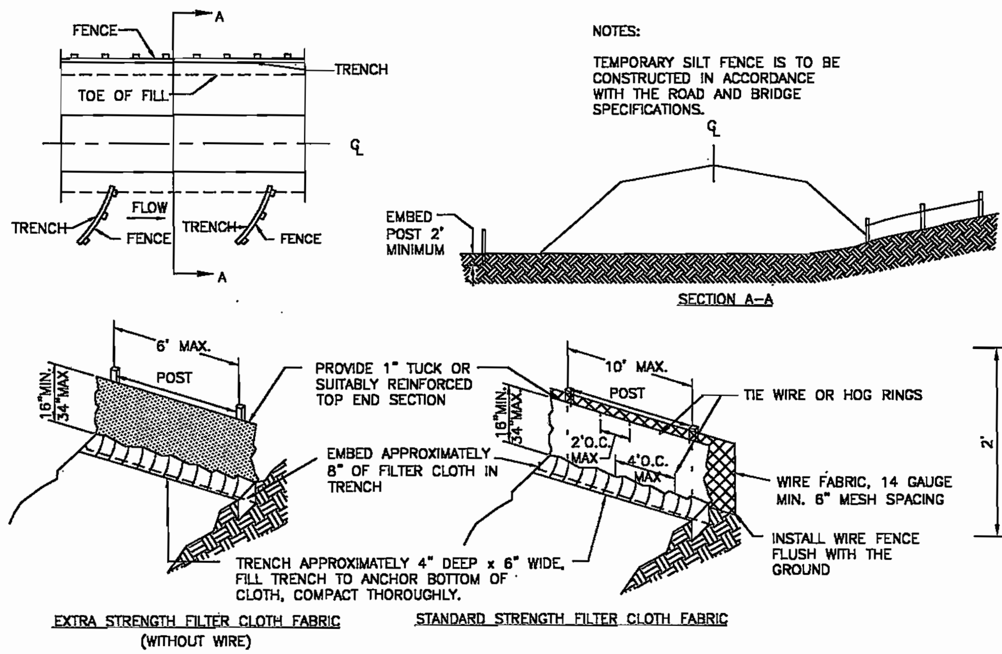
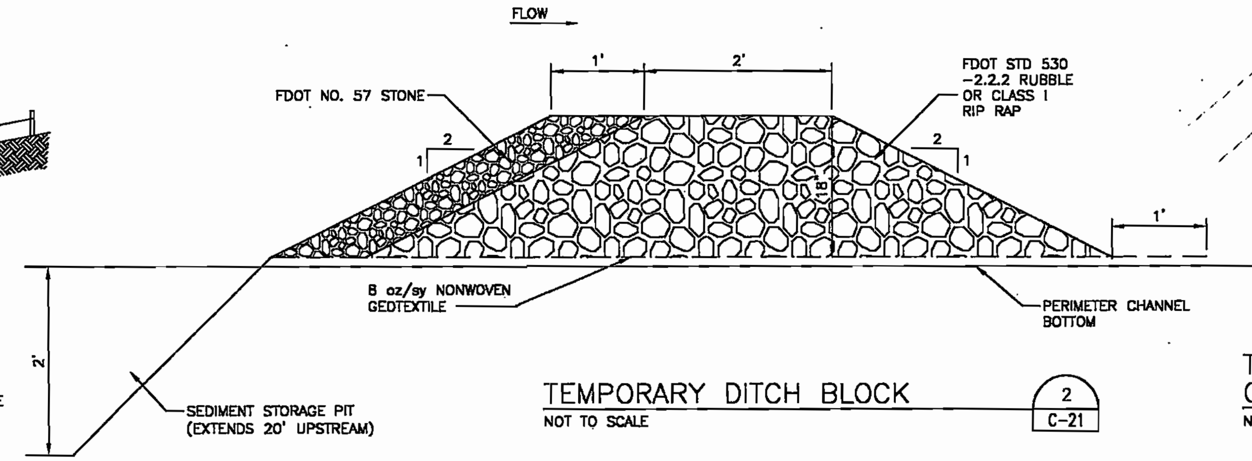


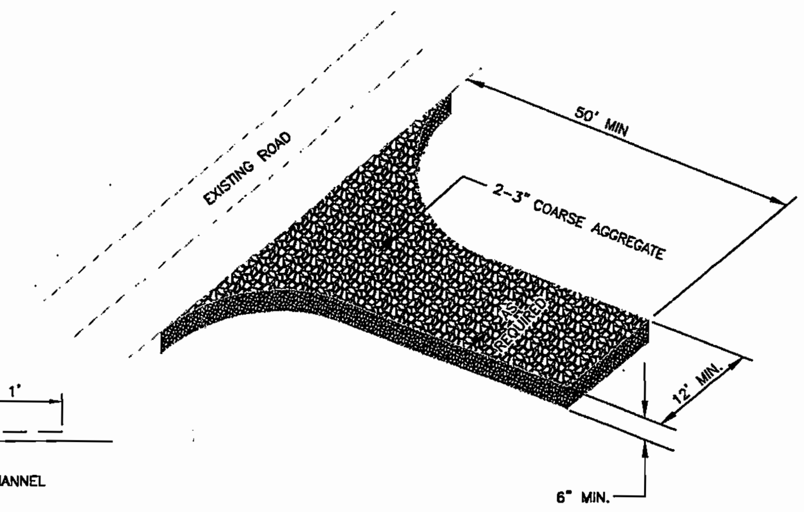
NOTES:

TEMPORARY SILT FENCE IS TO BE CONSTRUCTED IN ACCORDANCE WITH THE ROAD AND BRIDGE SPECIFICATIONS.

SILT FENCE (1 / C-21)
NOT TO SCALE



TEMPORARY DITCH BLOCK (2 / C-21)
NOT TO SCALE



TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT (3 / C-21)
NOT TO SCALE

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

CONSTRUCTION SPECIFICATIONS

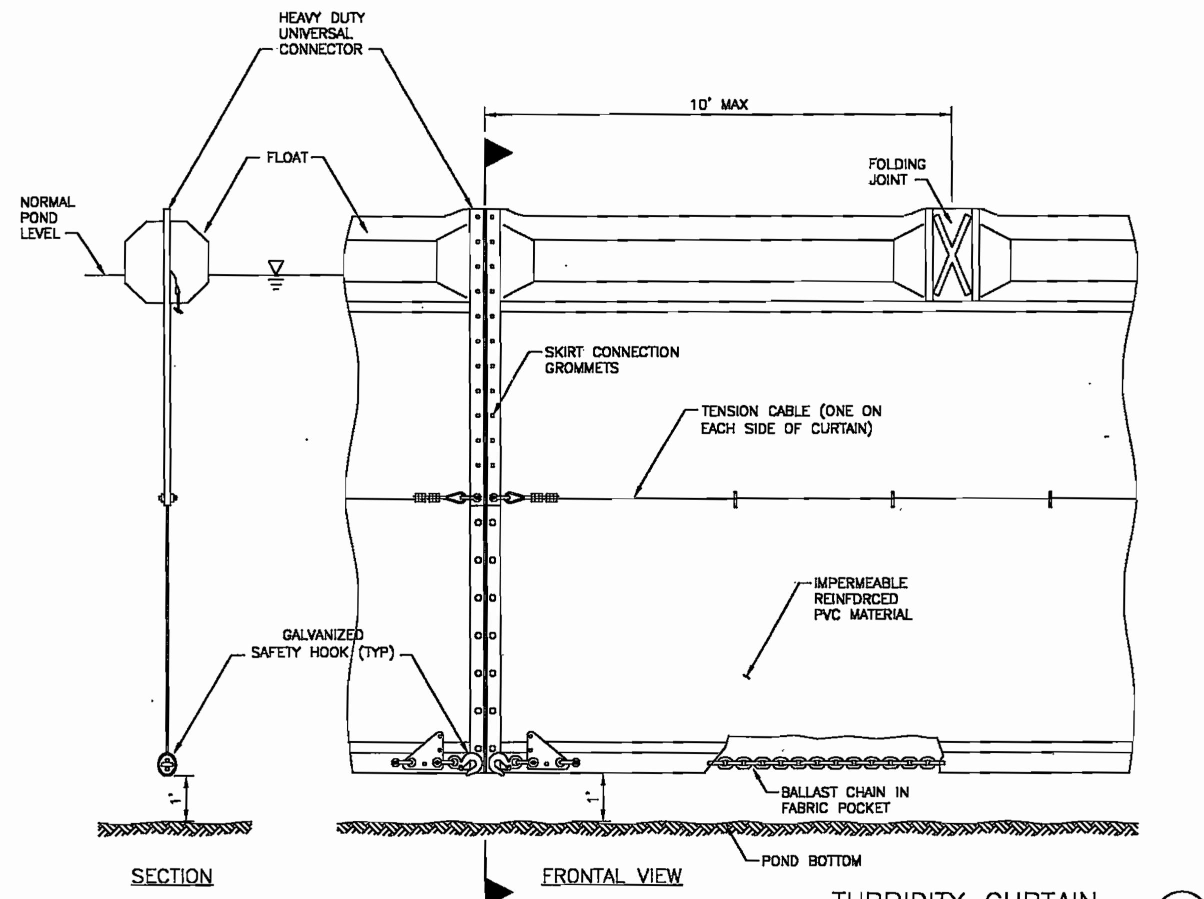
MATERIALS

1. SYNTHETIC FILTER FABRIC SHALL BE A PERVIOUS SHEET OF POLYPROPYLENE, NYLON PLOYESTER, OR ETHYLENE YARN AND SHALL BE CERTIFIED BY THE MANUFACTURER OR SUPPLIER AS CONFORMING TO THE FOLLOWING REQUIREMENTS:

PHYSICAL PROPERTY	TEST	REQUIREMENTS
FILTERING EFFICIENCY	ASTM D-5141	75% (MIN)
TENSILE STRENGTH AT 20% (MAX.) ELONGATION*	VTM-52	EXTRA STRENGTH- 50 LBS./LIN. IN. (MIN.) STANDARD STRENGTH- 30 LBS./LIN. IN. (MIN.)
FLOW RATE	ASTM D-5141	0.3 GAL./SQ. FT./MIN.
ULTRAVIOLET RADIATION	ASTM D-4355 AND G-28	90% (MIN.)

* REQUIREMENTS REDUCED BY 50% AFTER 6 MONTHS OF INSTALLATION.

2. SYNTHETIC FILTER FABRIC SHALL CONTAIN ULTRAVIOLET RAY INHIBITORS AND STABILIZERS TO PROVIDE A MINIMUM OF 6 MONTHS OF EXPECTED USABLE CONSTRUCTION LIFE AT A TEMPERATURE RANGE OF 0 F TO 120 F.



TURBIDITY CURTAIN (4 / C-21)
NOT TO SCALE

NOTES

1. CONTRACTOR SHALL INSPECT TURBIDITY CURTAIN ACCORDING TO INSPECTION SCHEDULE AND REPAIR ANY OBSERVED DAMAGE.
2. CONTRACTOR SHALL MEASURE SEDIMENT LEVELS IMMEDIATELY UPSTREAM OF CURTAIN AFTER ANY STORM EVENT OF GREATER THAN ONE-HALF INCH OF PRECIPITATION DURING ANY 24 HUOR PERIOD. SEDIMENT SHALL BE REMOVED OR CURTAIN MOVED FURTHER DOWNSTREAM IF SEDIMENT LEVEL REACHES BOTTOM OF CURTAIN.

TURBIDITY CURTAIN SPECIFICATIONS

CURTAIN MATERIAL: IMPERMEABLE REINFORCED PVC
MIN. TENSILE STRENGTH - 300 LB/IN
MIN. FABRIC WT. - 13 OZ/SY
TEAR STRENGTH - 80 LBS
TENSILE STRENGTH AFTER ABRASION - 200 LB/IN
RESISTANT TO MARINE GROWTH, ULTRA VIOLET LIGHT, AND MILDEW
ALL FABRIC SHALL BE HEAT SEALED.

FLOATS: SOLID, CLOSED-CELL, PLASTIC FOAM SEALED IN FABRIC POCKET. PROVIDE BUOYANT RATIO > 5
MAX. LENGTH 10'

BALLST CHAIN: NON-CORROSIVE
2 LB/IN WEIGHT

TENSION CABLE: GALVANIZED OR STAINLESS STEEL WIRE ROPE

MOORING: AS RECOMMENDED BY MANUFACTURER FOR PROPOSED APPLICATION

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2521 Cattleman Rd., Ste. 108
Sarasota, Fl 34232-6212
(941) 342-2700
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PHASE I CLASS I LANDFILL CLOSURE PERMIT DRAWINGS
SARASOTA COUNTY — FLORIDA

SEDIMENTATION AND EROSION CONTROL DETAILS

0 1" 2"
FILENAME
SCALE: AS SHOWN
SHEET: 00C-22

APPENDIX B
PHASE I CLOSURE LONG TERM CARE PLAN

Sarasota County
Solid Waste Operations

Central County Solid Waste Disposal Complex Phase I Closure and Long Term Care Plan

April 2010

THOMAS M. YANOSCHAK
LICENSE
No. 44200
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

4/30/10

Prepared by
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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Closure and Long-Term Care Plan (Plan) is to provide general guidelines and procedures for the closure requirements, closure construction, inspection, maintenance, repairs, monitoring, and record keeping for Phase 1 of the Class I Landfill located at the Central County Solid Waste Disposal Complex (CCSWDC) located in Nokomis, Florida. This Plan is being submitted in support of the Phase I Closure Construction Permit Application.

This Plan provides a combination of recommendations and Florida Department of Environmental Protection (FDEP) requirements. Only those permit items pertinent to the closure and routine maintenance and/or operation of the closed landfill and the stormwater system have been identified and discussed.

The Plan contains a general discussion of the following: (1) closure requirements specified in 62-701.600, F.A.C., and (2) long-term care requirements specified in 62-701.620(2), F.A.C., which include a description of the procedures for erosion control, filling areas of subsidence or other depressions, maintenance of stormwater management system, leachate collection and management, groundwater monitoring and monitor well maintenance, maintenance of vegetative cover, and general maintenance of the facility, and provisions and anticipated source of cover material and vegetation for long term care, consistent with the information provided in support of the financial assurance long-term care estimates required by Rule 62-701.630, F.A.C.

An overall site plan of the CCSWDC is provided on Sheet C-01 of the Closure Design Drawings located in Appendix A of the Phase I Closure Construction Permit Application. The site plan shows the locations of the various components of the CCSWDC including existing Phase I and future phases of the Class I landfill.

2.0 CLOSURE REQUIREMENTS

In accordance with the requirements of 62-701.600, F.A.C., the following describes the procedures that will be followed and the information that is required for the closure of Phase I of the Class I Landfill at the CCSWDC.

2.1 Schedule Requirements

This Closure and Long Term Care Plan is being prepared for the final closure of Phase I of the CCSWDC Class I landfill. A permit application has been approved for the Phase II expansion of the Class I landfill which will be contiguous to the west slope of Phase I. It is anticipated that Phase II will be in operation at the time of Phase I closure.

2.2 Permit General Requirements

This Plan is part of a closure construction permit application for Phase I of the CCSWDC Class I landfill which is being submitted to the FDEP at least 90 days before final receipt of waste within Phase I in accordance with FAC 62-701.600(3).

This Plan includes the following items:

- Closure report.
- Closure design plan.
- Closure operation plan.
- Closure procedures.
- Plan for long-term care.
- Demonstration of financial responsibility.

2.3 Closure Report Requirements

This Closure Report addresses closure of Phase I of the CCSWDC Class I landfill in accordance with 62-701.600(4), F.A.C.

2.3.1 General Information

The CCSWDC facility currently operates under FDEP permit number 130542-007-SO/01 dated November 18, 2008 which expires on November 18, 2013.

The CCSWDC site encompasses approximately 6,150 acres located two miles east of I-75 and three miles south of S.R. 72 in central Sarasota County. The Class I landfill is located within a 550 acre special exception area which is located at the approximate center of the site. Ultimately, the Class I landfill will consist of five phases encompassing approximately 295 acres. A vicinity map showing the location of the CCSWDC site is provided on the cover sheet of the Closure Design Drawings contained in Appendix A of this permit application.

Permitting for Phase I of the CCSWDC Class I landfill began in the mid 1980's and the facility began receiving waste in June 1998. Phase I consists of approximately 55 acres of disposal area located within five cells. Phase I is expected to reach its useable permitted capacity in approximately January 2011 assuming current disposal rates and in-place waste densities are maintained.

To ensure uninterrupted operation of the Class I landfill, a permit application for Phase II was initially submitted in February 2007. Phase II construction was completed on October 2009 and it is anticipated to be operational before the usable capacity of Phase I is exhausted. Phase II consists of approximately 54 acres of disposal area located directly west of Phase I.

A legal description of the property on which the Class I landfill is located was provided with the Phase II permit application. The legal description has not changed therefore this information is not being resubmitted.

Only wastes allowed by the operation permit are disposed within the CCSWDC Class I landfill. These include residential and commercial waste, C&D debris, shredded or cut tires, treated biomedical waste, yard trash, water treatment sludge, industrial waste, industrial sludge, agricultural waste, and domestic sludge.

2.3.2 Geotechnical Investigation Report

A geotechnical investigation report for Phase I was conducted as part of the original permit application for the CCSWDC site. Additional geotechnical analyses were performed when a permit modification was submitted to increase the waste side slopes to 3H:1V with a single 20-foot wide bench located approximately half way up the slope, which is the currently permitted configuration of the Phase I slopes. These analyses demonstrated that the foundation conditions beneath Phase I and the Phase I bottom liner were sufficient to support the waste mass at full build out. No additional geotechnical investigations were conducted for the Phase I closure construction permit application, however, final cover stability analyses were performed for the specific final cover design proposed for Phase I and are included in Attachment O.1 of the Engineering Report.

2.3.3 Water Quality Monitoring Plan

An addendum to the CCSWDC Water Quality Monitoring Plan (WQMP) was submitted with the Phase II Expansion Construction/Operation Permit Application that expanded the previously permitted monitoring system to include the Phase II expansion area. No changes to the amended water quality and leachate monitoring requirements are anticipated for the Phase I closure.

2.3.4 Land Use

Information on land use for the CCSWDC property and surrounding properties was provided with the Phase II Expansion Construction/Operation Permit Application. This information included identification of adjacent landowners; zoning; present land uses; and roads, highway right-of-way, or easements. This information has not changed and therefore is not being resubmitted with the closure permit application.

2.3.5 Landfill Gas Migration

The Phase I bottom liner system consists of a composite liner with a 60 mil High-Density Polyethylene (HDPE) geomembrane liner overlying 12 inches of compacted soil with a maximum hydraulic conductivity of $1x10^{-8}$ cm/sec. The bottom liner system serves as an effective barrier to prevent the migration of landfill gas into the surrounding soils as demonstrated by the absence of methane gas being observed within the gas probes surrounding Phase I during quarterly monitoring.

Currently, landfill gas is allowed to vent passively from Phase I to the atmosphere. Landfill gas accumulating in the leachate collection system is flared from one of eight solar powered candlestick flares located along the north and south sides of the Phase I landfill. Quarterly monitoring has indicated that combustible gases have not exceeded 25 percent of the Lower Explosive Limit (LEL) in on-site structures and 100 percent of the LEL at the property boundary.

An active landfill gas collection system is currently being constructed for Phase I. The active system will be installed and functioning prior to the closure of Phase I, which will further diminish the potential for landfill gas migration from the landfill. Landfill gas probes will be monitored following Phase I closure to ensure that landfill gas migration is not occurring.

2.3.6 Effectiveness of Landfill Design

Phase I of the CCSWDC Class I landfill has effectively met Sarasota County's waste disposal needs since it began receiving waste in June 1998.

Geotechnical investigations conducted in the landfill area during Phase I and Phase II permitting did not indicate any subsurface conditions such as solution features or poor soils that could make the site unsuitable for use as a landfill. During Phase II permitting, however, FDEP became concerned that routine videotaping of the leachate collection pipes within Phase I indicated the camera would repeatedly become submerged as it traversed the length of the pipe. The apparent cause of this submergence is differential settlement of the foundation soils that caused "dips" to develop along the pipe which do not freely drain the leachate. The design slope of the Phase I leachate collection pipes of 0.2 percent was apparently inadequate to compensate for the differential settlement that occurred within the foundation soils. As a result, FDEP has indicated that a vertical expansion over the top of Phase I will not be allowed. FDEP is also requiring a side slope liner system consisting of a 60 mil HDPE geomembrane to be constructed on the west slope of Phase I where Phase II will abut the existing landfill. The minimum slope for the Phase II leachate collection pipes has been increased to 0.55 percent to avoid similar adverse effects from developing within Phase II.

Elevated arsenic concentrations in excess of FDEP's groundwater standards have been observed from samples obtained from detection wells MW-8A, MW-9, MW-10R, and MW-11R which are located along the south and west perimeter of Phase I. The County negotiated a consent agreement with FDEP that allowed the permitting of Phase II to continue while a site assessment takes place to evaluate the source of these elevated arsenic levels. Data obtained to date indicates that the elevated arsenic concentrations are not due to a breach of the Phase I bottom liner system.

Stormwater runoff from Phase I that does not come into contact with waste is directed to a perimeter stormwater ditch where it flows to Stormwater Pond No. 1, located northwest of Phase I. Stormwater that comes in contact with waste is considered leachate and is contained for treatment. The clean runoff is detained in the pond to reduce turbidity and to reduce peak flows prior to discharge into Old Cow Pen Slough. The components of the CCSWDC stormwater control system were installed during Phase I construction. During Phase II permitting, jurisdiction over the CCSWDC stormwater control system was transferred from the Southwest Florida Water Management District to FDEP. The FDEP issued Environmental Resource Permit No. 58-0272622-001 on May 2, 2008 for the system. The stormwater control system at the site appears to be functioning as intended based on inspections by HDR and FDEP staff and results of surface water sampling which meet regulatory criteria.

The landfill gas controls employed within Phase I are effective in preventing gas migration as discussed in Section 2.3.5 of this Plan.

Initial cover consisting of a minimum of 6 inches of compacted soil or an approved alternate cover is placed daily over the active face of the landfill in accordance with the approved Operations Plan. A minimum of 1 foot of approved intermediate cover is placed in addition to the initial cover in areas that will not receive another lift of waste or final cover within 180 days. Intermediate covered areas that will not be landfilled or covered with final cover within 6 months are sodded (external slopes) or seeded and mulched (internal and top slopes) to avoid slope erosion. These cover methods have been effective in controlling erosion within Phase I and controlling leachate generation.

Only permitted wastes are disposed within Phase I of the Class I landfill. There is no evidence that the previously mentioned elevated levels of arsenic within the groundwater at the site are a result of the acceptance of any particular type of waste.

2.4 Closure Design Plan

The Closure Design Plan for Phase I consists of the Closure Design Drawings provided in Appendix A and the discussions provided within the following subsections.

2.4.1 Closure Phasing

Revised operational fill sequence plans were submitted to FDEP in January 2008 and subsequently approved. The purpose of the revised fill sequence plans was to recover airspace within the side slopes of Phase I which were constructed at slopes less than the maximum permitted slope of 3H:1V. The recovery of the airspace on the side slopes and the need to keep Phase I operational until Phase II was constructed made it impractical to close Phase I in stages. It is therefore anticipated that final closure of all of Phase I will occur after Phase II is operational, which is estimated to begin in January 2011.

The west and south sides of Phase I will eventually have additional waste placed against them when Phases II and III are constructed, respectively. Placement of final cover will therefore be limited to the top slope, and to the north and east sides of Phase I where no future lateral expansions are planned.

A temporary final cover consisting of a 60 mil TPO geomembrane will be installed on the south slope of Phase I. The temporary final cover would remain in place until Phase III is operational. A side slope liner system consisting of a 60 mil HDPE geomembrane was constructed on the west slope of Phase I as part of Phase II construction. The FDEP required the side slope liner system for the west side of Phase I due to concerns about the functioning of the leachate collection system within Phase I.

The extent of the proposed closure of Phase I is shown on the Phase I Closure Cover Key Sheet, provided on Sheet C-06 of the Closure Design Drawings.

2.4.2 Drawings Showing Existing Topography and Final Grades

The most recent topographic information for the Phase I area was obtained on June 1, 2009. This information is shown on the Existing Site Conditions plan provided on Sheet C-04 of the Closure Design Drawings.

The proposed final closure grades are shown on Phase I Final Build-Out drawing provided on Sheet C-05 of the Closure Design Drawings.

2.4.3 Approved Design Dimensions

The proposed final closure dimensions shown on Sheet C-05 of the Closure Design Drawings are consistent with the FDEP approved design dimensions for Phase I. Closure construction will begin after Phase I is filled to approximate permitted capacity.

2.4.4 Final Elevations

Final elevations before settlement of the final cover for Phase I are shown on Sheet C-05. The maximum elevation of the final cover is 121 feet NGVD which is consistent with the maximum permitted elevation. Geotechnical studies conducted as part of the original Phase I permit application and a subsequent permit modification to increase the side slopes to 3H:1V demonstrated that the foundation soils were capable of supporting the weight of the landfill constructed to the proposed final elevations.

2.4.5 Side Slope Design

The proposed side slope design for the Phase I closure is provided on the Phase I Final Build-Out plan provided on Sheet C-05 of the Closure Design Drawings and detail sheets C-09 through C-12. The maximum side slope is 3H:1V which is consistent with FAC 62-701.600(5)(e). A 20-foot wide reverse sloping drainage terrace is provided approximately mid way up the side slope as a means of collecting stormwater from the slopes and directing it to a series of 24-inch diameter downdrains that discharge within the perimeter drainage channels. A berm will also be constructed along portions of the perimeter of the top slope of the landfill to direct runoff to the downdrains. Energy dissipation is provided by filter point fabric formed concrete and the backsplash in the swale at the discharge point of the downdrains to avoid scour within the perimeter drainage channels. Calculations demonstrating that the drainage terrace and downdrains are adequately sized for the 25-year storm are included in Attachment O.2 of the Engineering Report.

Placement of final cover is limited to the top, and to the north and east sides of Phase I where no future lateral expansions are planned. These areas will be covered with sod immediately after construction of the final cover and will significantly reduce the amount of erosion that will occur on the side slopes as demonstrated by the soil loss calculations provided in Attachment O.2 of the Engineering Report. A temporary final cover will be placed on the south slope of Phase I providing stormwater and erosion control. Calculations are provided in Attachment O.3 of the Engineering Report. The temporary final cover is detailed in the Closure Design Drawings.

Access for maintenance of the Phase I final cover will be provided by a permanent access road that will be located on the south slope as shown on Sheet C-07 of the Closure Design Drawings. The drainage terrace will provide a means for vehicles to access the side slope for repairs and maintenance.

2.4.6 Final Cover Design

As previously indicated, placement of final cover will be limited to the top, and to the north and east sides of Phase I where no future lateral expansions are planned. The proposed Phase I final cover profiles are provided on Sheet C-12 of the Closure Design Drawings. The final cover (north and east side slopes) includes, from the top down: sod, 6 inches of topsoil, 18 inches of protective cover soil, a double sided geocomposite drainage layer, a 40 mil Linear Low Density Polyethylene (LLDPE) geomembrane liner that is textured on both sides, and a minimum 12-inch thick intermediate cover layer to support the geosynthetics. The final cover (top slope) includes a 40 mil smooth LLDPE geomembrane. The components of the final cover system shall meet the requirements of FAC 62-701.600(5)(g) as demonstrated by the technical specifications for the components contained in Appendix D of this permit application.

The interface stability of the final cover system is demonstrated by the Final Cover Stability Analysis provided in Attachment O.1 of the Engineering Report. Stability analyses evaluating the potential for deep seated rotational or translational failures through the waste and the final cover were previously provided with the permit modification to increase the side slopes of Phase I to 3H:1V.

A temporary final cover will be constructed on the south slope of Phase I and will remain in place until Phase IV is operational. The temporary final cover will improve the operations of Phase I by reducing leachate generation, providing better odor control, stormwater runoff control, erosion control, and landfill gas collection efficiency. The temporary final cover profile is provided on Sheet C-12 of the Closure Design Drawings and includes, from the top down, a 60 mil TPO (green) geomembrane cover and 12 inches of intermediate cover.

Several criteria were assessed to determine the most suitable material for an exposed geomembrane cover design including resistance to degradation due to exposure to direct sunlight, strength to handle wind uplift, durability to withstand walking or low ground pressure vehicles, birds, and falling debris. Temporary Final Cover design calculations are provided in Attachment O.3 of the Engineering Report.

Constructing the continuous exposed geomembrane of the temporary final cover under the south access road base presents several design difficulties. This includes proper road cushioning to prevent geomembrane damage and prevention of stormwater intrusion between the exposed geomembrane and road base. Therefore, the exposed geomembrane on the south side of Phase I was designed to incorporate the south access road as part of its anchoring system as shown in the Closure Design Drawings. The south access road has been designed to shed runoff to the stormwater interceptor swale located adjacent and north of the road, therefore, no hydraulic head on the liner system beneath the road is expected.

2.4.7 Final Cover Installation Plans

Final cover installation plans for Phase I are provided in the Closure Design Drawings. Final cover will be placed over all areas of Phase I that have received waste with the exception of the west slope, where a 60 mil HDPE side slope liner was installed as part of the Phase II expansion, and the south slope, where a 60 mil TPO geomembrane liner will be installed for temporary closure until Phase III is operational. As previously discussed, the final cover and temporary final cover has been designed to minimize infiltration of rainfall and subsequent generation of leachate.

The final cover will be installed in accordance with the Construction Quality Assurance (CQA) Plan provided in Appendix C of the Closure Construction Permit Application. The CQA Plan meets the requirements of FAC 62-701.400(7) and (8).

The final cover will be vegetated with bahia sod (or equal) to control erosion and provide a moisture infiltration seal. The sod will be a native species of drought resistant grass that will have roots that will not penetrate the final cover.

The final cover has been designed to maximize runoff and minimize erosion considering total fill height and expected subsidence caused by decomposing waste, and has been designed to prevent ponding or low spots.

Borrow soil required for maintenance of the Phase I final cover during the remaining operational life of the CCSWDC Class I landfill and the post closure care period will be obtained from the borrow area located adjacent to the CCSWDC site. In the event that the borrow area is no longer available, the County will make arrangements for material to be obtained from other off site sources. The borrow soil will be used to repair erosion damage, filling areas of subsidence or other depressions, maintaining berms, and general maintenance of the facility.

2.4.8 Stormwater Control

The constructed stormwater management and control system for the CCSWDC is shown on Sheet C-01, Overall Site Plan and Phasing Plan of the Closure Design Drawings. The design consists of perimeter drainage ditches bordering each phase that drain to one of several stormwater ponds located on site. Phase I drains entirely to Stormwater Pond No. 1 which is located northwest of Phase I. This stormwater system will be maintained throughout active operations at the landfill and will serve as the stormwater management system after final closure of the site. Details of the stormwater controls that will be installed during Phase I final cover and temporary final cover construction are provided on Sheets C-9 through C-12, C-18, and C-19 of the Closure Design Drawings.

During Phase II permitting, jurisdiction over the CCSWDC stormwater control system was transferred from the Southwest Florida Water Management District to FDEP. The FDEP issued Environmental Resource Permit (ERP) No. 58-0272622-001 on May 2, 2008 for the system. The ERP is valid for Phases I and II of the CCSWDC Class I landfill. The stormwater management and control system will be operated in accordance with the ERP requirements during Phase I closure construction and after construction is completed.

2.4.9 Access Control

The CCSWDC facility will remain in operation after Phase I closure is completed; therefore the current measures for limiting access to the facility will be maintained. Access to the Class I Landfill is controlled at the Knights Trail Road entrance with the use of gates. The entire facility is fenced.

2.4.10 Proposed Final Use

Currently, there are no planned final uses identified for Phase I of the CCSWDC Class I Landfill except for the potential possibility of a landfill gas to energy facility. Any final uses will be permitted through FDEP prior to their implementation.

2.4.11 Gas Management System

See Section 2.3.5 of this Closure and Long Term Care Plan for a description of the existing and proposed landfill gas management system for Phase I of the CCSWDC Class I landfill.

2.5 Closure Operation Plan

This Closure Operation Plan is provided as part of the closure permit application. The information provided below is required by FAC 62-701.600(6).

2.5.1 Actions Required to Close Landfill

Phase I closure activities will begin after Phase I is filled to permitted capacity and landfill operations begin in Phase II. Construction will not begin until a closure construction permit is obtained from FDEP. Prior to final cover construction, elements of the landfill gas collection and control system that are to be installed below the final cover and temporary final cover liner will be installed. These components include vertical extraction wells, headers and laterals. Sedimentation and erosion control measures will also be installed in accordance with the Closure Design Drawings. Grading of the side slopes will then take place to ensure that a minimum of 18 inches of soil exists above the waste (6 inches of initial cover and 12 inches of intermediate cover) and to provide a smooth surface suitable for placement of the 40 mil LLDPE (top, north, and east slopes) and 60 mil TPO (south slope) geomembrane liners. At this time, trenches of the 24-inch diameter downdrains will be excavated into the waste and backfilled with a minimum of 18 inches of compacted soil to support the geomembrane liner. Also the permanent access road shown on Sheet C-07 of the closure design drawings will be graded to the design elevations shown.

The 40 mil textured LLDPE geomembrane liner will be installed on the north and east side slopes, a 40 mil smooth LLDPE geomembrane liner will be installed on the top slope, and a 60 mil TPO geomembrane liner will be installed on the south slope after the grading of the subgrade is complete. The final covers and temporary final cover geomembranes will be tied into the overlay liner system geomembrane that would already be installed on the west slope of Phase I as shown in the closure design drawings. A detail of this tie-in is provided on Sheet C-17. The final cover Geocomposite Drainage Layer (GDL) will be installed over the final cover geomembrane with careful attention to daylight the GDL to allow drainage at the top of the landfill, drainage bench, and base of the landfill as shown on detail sheets C-09 and C-11. The final cover GDL will be kept hydraulically separate from the overlain liner system GDL in order to avoid the mixing of leachate with infiltrated stormwater.

The protective cover soil will be installed over the geosynthetic components of the final cover which have been already installed, inspected, and tested. At this time, final grading of the access road, drainage bench, and stormwater berms located at the top of the landfill will occur. Installation of the downdrain pipes and energy dissipaters will also take place. After all protective cover is installed; 6 inches of topsoil will be installed over the top, north, and east closure area. The access road will be paved with stone. Sod will be placed over the topsoil.

After the final cover is in place, the final elements of the landfill gas collection system and stormwater management system will be installed. Removal of the sedimentation and erosion control measures that were installed for Phase I closure construction will take place after it is evident that the Phase I closure side slopes have been stabilized. Any accumulated sediment resulting from the closure project will be removed from drainage benches, perimeter stormwater channels, and stormwater pond.

2.5.2 Preliminary Phase I Closure Schedule

Phase I closure construction is currently estimated to begin in January 2011 based on anticipated waste disposal rates, compacted waste densities, and remaining airspace estimates. Certification of closure completion is estimated to occur in July 2011. These dates may change due to fluctuations in any of the previously mentioned variables

Long term care of the Phase I closure is anticipated to extend through the remaining life of the CCSWDC Class I landfill (approximately 34 years) in addition to the 30 year regulatory post closure period that will begin after all phases of the landfill are closed.

The long-term-care permit shall be renewed every 10 years until the monitoring well analyses have stabilized and the FDEP notifies the County in writing that the permit renewal will not be required.

2.5.3 Supporting Documents

This Closure Operation Plan is prepared as part of the Central County Solid Waste Disposal Complex Class I Landfill Phase I Closure Construction Permit Application dated April 2010 and prepared by HDR Engineering, Inc.

Other supporting documents to this Closure Operation Plan include the current FDEP Operation Permit No. 130542-007-SO/01 for the CCSWDC Class I landfill, the current FDEP Environmental Resource Permit (ERP) No. 58-0272622-001 and associated documents supporting these permits.

2.5.4 Demonstration of Financial Responsibility

Sarasota County currently demonstrates financial responsibility for the closure and long term care of Phase I of the CCSWDC Class I landfill using a financial test.

2.5.5 Water Quality Monitoring Plan

Discussion of the Water Quality Monitoring Plan required by FAC 62-701.510 for the Phase I closure is provided in Section 2.3.3 of the Closure and Long Term Care Plan.

2.5.6 Gas Management System

Discussion of the gas management system required by FAC 62-701.530 for the Phase I closure is provided in Section 2.3.5 of the Closure and Long Term Care Plan.

2.5.7 Additional Equipment and Personnel Needed for Closure

Closure construction for installation of the landfill gas system and final cover for Phase I will be performed by qualified contractors selected through the County's procurement system. Sarasota County will also retain the services of consulting engineering companies to perform Construction Quality Assurance (CQA) services and Engineer of Record (EOR) services which will include construction oversight and certification.

The administration of the Phase I closure project is not anticipated to require the County to hire additional personnel or purchase additional construction equipment.

2.6 Temporary Final Cover

The temporary final cover to be constructed on the south slope of Phase I will provide positive drainage of all stormwater runoff and reduce erosion of cover soils, a reduction in leachate generation, odor control, and landfill gas collection efficiency. The exposed geomembrane cover will be installed when the south side has reached interim final grades and after permit has been issued. A 60 mil TPO geomembrane will be installed on the intermediate interim cover. A 1 foot minimum soil layer (on top of the 6 inches of initial cover) will be maintained between the waste and the exposed geomembrane cover. The intermediate cover will have a maximum permitted slope of 3H:1V except at the tack on berm road where slopes are 2H:1V.

In order to facilitate Phase I maintenance operations, the Phase I closure will incorporate an access road located on the south slope as shown on Sheet C-05 of the closure design drawings. A 12 inches stabilized road base material will provide an all weather driving surface. The access road will be placed over additional compacted structural fill on top of the south slope interim final grade. The cross slope on the access road will drain inwards to a TPO lined stormwater interceptor swale. The temporary final cover geomembrane will be placed on top of the slope of the south access road fill grade but will not be placed underneath the access road.

Temporary final cover system design included evaluation of the following components: geomembrane material, anchors, emergency gas venting, maintenance access, and stormwater management.

2.6.1 Geomembrane Material

Several criteria were assessed to determine the most suitable material for an exposed geomembrane cover design including:

- Resistance to degradation due to exposure to direct sunlight,
- Strength to handle wind uplift,
- Minimize expansion and contraction due to atmospheric temperature changes and
- Durability to withstand walking birds and falling debris.

Based on the evaluation criteria, a 60 mil TPO geomembrane is suitable for this purpose. In general, material will be field seamed during construction. The exposed surface of the geomembrane will be patina green color in order to avoid excessive solar heating and to reduce negative visual impacts.

2.6.2 Anchor Design

The temporary final cover anchor design considerations include material properties and wind uplift forces. Physical variables used in the anchor trench design include effective suction, velocity of wind, distances between anchor trenches, thickness of the material, percent strain at yield, stress at yield, geomembrane stiffness coefficient, interface friction between geomembrane and 16 oz/sy geotextile and seam strength.

HDR reviewed storm events and high wind events published by National Climatic Data Center (NCDC) for Sarasota County from October 1960 to October 2008. The highest reported wind velocity within Sarasota County is 82 mph in 1993. According to Florida Building Code 2008, the basic wind speed to be used to calculate wind loads is 130 mph for Sarasota County. The temporary final cover for Phase I has been designed for an 130 mph wind event.

In addition to the wind, the other important parameter that causes expansion and contraction of the material is the temperature variation. The highest reported temperature within the State of Florida is 109 degrees F in June 1931. The lowest reported temperature within the State of Florida is -2 degrees F in February 1899. HDR conservatively assumed these extreme events when calculating maximum initial stresses and strains due to change in temperature.

A geomembrane can resist uplift under the influence of gravity if its weight per unit area and depth of anchor trench backfill is at least equal to the suction pressure for a given wind velocity. Calculations, provided in Attachment O.3 of the Engineering Report, show that a 60 mil, TPO geomembrane provides adequate resistance to uplift caused by an 130 mph wind event. Vertical intermediate anchor trenches are required at a maximum of 50 FT intervals. In addition, horizontal anchors are provided at grade change locations and liner terminations to provide additional support. These are secondary anchor trenches provided to accommodate site configuration and calculations were not performed to verify wind uplift. It should be noted that no vertical anchors will be installed within the 2H:1V slopes. Instead horizontal anchors are designed at 25 FT interval for the top 1/3 of the temporary final cover side slope and 32 FT interval outside the top 1/3 of the side slope.

2.6.3 Landfill Gas

There are 12 gas extraction wells that will be located within the proposed temporary final cover area. The proposed extraction wells will penetrate the temporary final cover. All temporary final cover penetrations will be booted to the pipe and will allow for waste settlement over time. The extraction wells will avoid build up of gas pressure below the geomembrane. Furthermore, emergency gas vents will be located at each geomembrane panel to avoid build up of gas pressure below the geomembrane. These vents are generally closed with a removable end cap which will be opened manually in the event of pressure buildup. The active gas collection system may be connected to these vents if deemed necessary in the future for continuous gas extraction.

2.6.4 Maintenance Access Road

The south access road will provide the primary means of access to Phase I and the temporary final cover area. It will be difficult for individuals to walk on top of the exposed geomembrane installed on 3:1 or 2:1 slopes. Precaution shall be taken if walking on top of the slopes greater than 5% at all times. This is extremely important during rain events when the slick surface and runoff can lead to hazardous conditions. The temporary final cover will not be installed underneath the south access road. The stabilized material used for the road construction will minimize infiltration of stormwater into the landfill.

2.6.5 Stormwater Management

There will be 2 stormwater downdrain access points along the south terrace. The terrace is longitudinally sloped at 2% along the slope to facilitate the flow of stormwater to the downdrains. At the toe of the slope, stormwater will run along the lined south perimeter swale. Two 24" RCP will connect the south perimeter swale to the east perimeter swale allowing continuous flow to Pond 1 located northwest of Phase I.

The south perimeter swale was redesigned to accommodate a 25yr-24hr storm up to a maximum elevation of 32 ft which corresponds to the lowest elevation of the existing road located south of Phase I. The total area contributing to the south swale is 7.5 acres which will create a peak flow of 41.2 cfs. The maximum stage of flow within the south perimeter swale based on the design storm is 31.98 ft, therefore, the swale will be able to hold 25yr-24hr storm. The south perimeter swale will be lined with 60 mil TPO geomembrane to eliminate soil erosion. Stone size of 4" to 8" will be installed above 16 OZ/SY geotextile at all downdrain exits as energy dissipators.

2.6.6 Inspection and Material Testing

Detailed routine inspections will be conducted quarterly to assess exposed geomembrane quality, geomembrane interface with other landfill areas, and damage. Several locations of the temporary final cover will be monitored to evaluate the movement of the geomembrane due to creep and/or settlement. Inspections will also be conducted after extreme weather conditions, such as high wind events, heavy rain events, and hail storms. In addition to visual inspections, routine testing for degradation of original material properties may be conducted annually. During construction of the temporary final cover, material samples (coupons) will be seamed on top the geomembrane for testing the effects of exposure on the material properties. Coupons will be sent to a qualified laboratory to test material properties, including thickness and tensile strength.

Evaluation of the temporary final cover will be performed annually for the total time the temporary final cover is used. The criteria used to evaluate geomembrane performance will be taken into three categories:

- Material strength (tensile);
- Material thickness, and
- Resin test.

Coupons will be sent to a qualified laboratory to test these material properties. It is important to note that the coupons will not be directly cut from the geomembrane covering the south slope but will be obtained from the coupons seamed on top of the geomembrane. It should be noted that these tests will be conducted to evaluate the material for Owner's information only since this is a temporary closure. The test methods to be used in the evaluation of the geomembrane are as follows:

- Breaking strength — ASTM D4885;
- Elongation at break — ASTM D4885
- Material thickness — ASTM D5994
- Ozone resistance — ASTM D1149

2.6.7 Repair Procedure

All repairs will be done in accordance with the specifications, provided in Appendix D. Surplus liner material will be maintained on site for potential damage repair allowing the site personnel to repair damage as quickly as possible. However, liner contractor contact information will also be kept on file. If geomembrane tears, seam failures, or similar damage is found during inspection, site personnel will immediately place sandbags, tires or similar items to completely cover the damage and prevent propagation of the problem. If appropriate, small sheets of geomembrane will be placed over the damaged area before placing sandbags. This temporary repair will be completed within 48 hours of detection. The County will contact a certified liner contractor to permanently repair the damaged area.

3.0 CLOSURE PROCEDURES

The following section describes the procedures that will be followed in accordance with 62-701.610, F.A.C., for closure of Phase I of the CCSWDC Class I Landfill.

3.1 Survey Monuments

Survey monuments are not required for Phase I of the CCSWDC Class I landfill since the final elevation of the landfill will be more than 20 feet above the natural land surface.

3.2 Final Survey Report

A final survey report or aerial map of the constructed Phase I closure will be conducted in compliance with 62-701.610(3), F.A.C. The final survey report or aerial map will be prepared by a registered land surveyor and will be submitted to the FDEP to verify that the final contours and elevations are in accordance with the plans approved in the closure permit. The contours in the final survey will be shown at no greater than 5-foot intervals.

3.3 Closure Construction Certifications

In accordance with 62-701.610(4), F.A.C., a signed, dated, and sealed Certificate of Closure Construction Completion by the engineer of record will be submitted to the FDEP upon completion of Phase I closure construction. This certificate will indicate any deviations from the permitted closure plans.

3.4 Declaration to the public

After closure operations are inspected and approved for the entire CCSWDC Class I landfill by the FDEP, the Sarasota County Solid Waste Department will file a declaration to the public in the deed records of Sarasota County. The declaration will include a legal description of the property and a site plan specifying the area actually filled with solid waste. The declaration will not be submitted after closure of Phase I since the landfill will remain in operation.

3.5 Official date of closing

The requirements identified in Sections 3.2, 3.3, and 3.4 (above) will be submitted to the FDEP after landfilling ceases at the CCSWDC site and all phases are closed. Upon receipt, the FDEP will notify the Sarasota County Solid Waste Department in writing that the notice of termination of operations and closure of the facility has been received. The official date of the landfill closing will be the date of the FDEP letter.

3.6 Closed Landfill use

No use has been designated for the closed Phase I landfill area. In accordance with 62-701.610(7), F.A.C., Sarasota County will consult with the FDEP before conducting activities at the closed landfill.

Sarasota County acknowledges that the FDEP retains regulatory control over any activities that may affect the integrity of the environmental protection measures of the landfill.

3.7 Relocation of Wastes

If at any time after closure the Sarasota County Solid Waste Department intends to relocate waste within the footprint of the landfill, a permit modification application will be submitted to the FDEP for approval.

4.0 LONG-TERM CARE REQUIREMENTS

The Sarasota County Solid Waste Department will be responsible for monitoring and maintaining the Phase I closure area in accordance with the FDEP-approved closure plan for a minimum of 30 years from the date of closing of the entire Class I landfill. The long-term-care period may be extended by FDEP to be consistent with 62-701.620(1), F.A.C.

If the landfill site is sold or leased to another authority, Sarasota County will ensure that the long-term care requirements of the permit are adhered to by contractual agreement or by retention of access rights. Any lease or transfer of property will include specific conditions to delineate the following responsibilities:

- Sarasota County is responsible for closure and shall maintain any required proof of financial responsibility until the person acquiring ownership, possession, or operation of the landfill establishes the required proof of financial responsibility with FDEP.
- Responsibility for the continuance of monitoring, maintenance, and correction of deficiencies or problems.
- Mineral rights attached to the property and the rights to any recoverable materials that may be buried on the property or landfill gases that may be produced. An FDEP permit shall be required if any onsite operations subsequent to closing of a landfill involve disturbing the landfill.

Sarasota County is obligated to retain the right of entry and to make provisions for access to the landfill property and the closed area of the landfill for the long-term-care period for inspection, monitoring, and maintenance of the site. Supervising the closed landfill is the responsibility of a person experienced in the closure requirements of a solid waste management facility.

Closed landfill areas, if disturbed, are a potential hazard to public health, groundwater, and the environment. Therefore, FDEP retains regulatory control over any activities that may affect the integrity of the environmental protection measures, such as the landfill cover, drainage, monitoring system, or stormwater controls. Consultation with the FDEP is required before conducting activities at the closed landfill.

The closure permit will be renewed every 10 years until the groundwater monitoring well analyses have stabilized and the FDEP notifies the applicant in writing that renewal is not required. Sarasota County, in accordance with 62-701.620(3)(a) through (d), F.A.C., will demonstrate the required stabilization criteria.

An inspection checklist that Sarasota County proposes to use monthly is included in Attachment 1. The checklist is used to ensure compliance with the long-term-care requirements and provide a log of landfill inspection activities including inspection and maintenance of the stormwater management system, landfill cap, groundwater and gas monitoring systems, gas vents, and other site structures. It is intended that this form will also be used during the interim period after Phase I is closed and before the 30-year long-term care period begins after closure of the entire Class I landfill. The checklist form is completed and signed by the individual conducting the monthly inspection. Items requiring attention are noted on the form and brought to the attention of the Sarasota County landfill manager.

4.1 Maintenance and Repair of Final and Temporary Final Cover System.

The Sarasota County Solid Waste Department will inspect and maintain the Phase I closure area to minimize impacts to the function and/or integrity of the final cover system. The County will provide for site access control, erosion control, grass cover maintenance, and prevention of ponding. Primary focus during the inspection will be the condition of the surface vegetation, landfill cap, gas collection and monitoring system, stormwater system, and monitoring devices. Monitoring of groundwater and landfill gas is addressed in Part L and Part N, respectively, of the Phase I Closure Construction Permit Application.

Table 1 is a schedule for notification if corrective actions are required. Records of discovery will also be kept on the Inspection Checklist (Attachment 1).

Table 1 Schedule for Notification and Corrective Actions

Activity	Initial Notification	Written Notification/Corrective Action Plan	Corrective Action
Sinkhole within 500 ft	Within 24 hours of discovery	Within 7 days of discovery, including description, location, size shown on plan sheet, corrective action plan	Based on proposed schedule
Fire/Explosion	Within 24 hours of discovery	Within 7 days of discovery, including remedial measures and schedule of activities	Based on proposed schedule
Damage to Facilities/Failure of Systems	Within 24 hours of discovery with explanation	Within 7 days of discovery, including details of damage/failure, remedial measures, schedule of repairs	Based on proposed schedule
Damage to Groundwater Monitoring System	Within 24 hours of discovery with explanation	Within 7 days of discovery, including details of damage/failure, remedial measures, schedule of repairs	Based on proposed schedule
Damage to Stormwater system	Within 24 hours of discovery with explanation	Within 7 days of discovery, including details of damage/failure, remedial measures, schedule of repairs	Within 30 days of written notification
Erosion of Final Cover System> 6-inches in depth	N/A	Description on Inspection Log	Within 72 hours of discovery
Leachate not accepted by Disposal Facility	Same as Written Notification	Within 3 days of cessation of leachate acceptance, including explanation of contingency measures and schedule of disposal	Within 7 days of cessation of acceptance

4.2 Grass

Grass cover maintenance will include mowing, fertilizing, seeding, mulching, and filling areas of subsidence. Mowing, fertilizing, seeding, mulching, and filling will continue to be performed as needed. The following is a general schedule and description of grass maintenance activities.

4.2.1 Mowing

The height of the grass will also be observed during monthly inspections. If the grass is found to be approximately 18 inches high, mowing will be scheduled before the next inspection. Caution will be exercised while mowing to keep heavy equipment away from the gas vents and monitoring devices and exposed geomembrane cover.

4.2.2 Fertilizing

The general recommendations for commercial fertilizer are 12-8-2 formulation (nitrogen-potassium-phosphorus), of which 60% of the nitrogen is to be in the urea-formaldehyde form and in conformance with state laws. It should be applied in the early spring (March) and mid-summer (July) on an as-needed basis. The spread rate should be 8 to10 pounds per 1,000 square feet, or as instructed on the package. The local USDA extension office should be called to verify these recommendations.

4.2.3 Seed and Sod

Damaged areas or other areas where grass cover is sparse must be reseeded or sodded. Sod is generally recommended for use in all areas such as on steep slopes and in highly eroded or bare spots. Sod should be staked in place with sod pegs where necessary.

Seeding, if done on relatively flat areas, should be performed in the early spring and late fall as needed in the following manner:

<u>Early spring</u>

- Scarified bahia with 20% bermuda seed.
- Minimum percent pure seed - 95
- Minimum percent germination and hard seed - 80
- Bahia seed will not germinate until overnight temperatures stay above 70° Fahrenheit.

<u>Late fall - Italian rye</u>

- Minimum percent pure—95
- Minimum percent germination and hard seed—90
- Seed will not germinate until overnight temperatures stay below 70° Fahrenheit and above 40° Fahrenheit.
- Bahia Sod—16-inch-by-24-inch slabs with 1-1/2-inch root bed

4.2.4 Seed Rates

The following are general recommendations for maintenance and replacement growth. High erosion areas and bare patches should be seeded more heavily. Spread rates may vary for different grass seeds from different suppliers. The instructions on the seed bags should be followed. Maintenance seeding should be used where the grass is healthy and full. Replacement seed rates should be used on bare or thin grass growth areas.

Maintenance Seed Rates

- Spring ½ pound per 1,000 square feet
- Fall ½ pound per 1,000 square feet

Replacement Seed Rates

- Spring 3-5 pounds per 1,000 square feet
- Fall 3-5 pounds per 1,000 square feet

4.2.5 Watering

Sarasota County should water newly established grass as required to maintain the health of the grass until it matures; daily watering should never be necessary. If the blades of the grass begin to wilt and loose resiliency when walked on, water needs to be applied. The water that is applied should be clean.

4.3 Erosion Control

Avoiding erosion is probably the most cost-effective means of protecting the closure cap. A relatively minor eroded area combined with a severe storm event can cause degradation of the final cover. The best way to avoid erosion is to maintain a healthy stand of grass and keep drainage swales free of silt and sediment. Cleaning the drainage swales will prevent overflow and backflow and reduce the risk of erosion from these causes. Large amounts of silt or sediment removed from the drainage swales may indicate damage to the closure cap. Soil for erosion control and maintenance of the cap system will be obtained from the on-site borrow area.

4.4 Stormwater Structures

All stormwater structures should be clean of all silt or soil deposits. All soil settlement surrounding these items should be brought to the attention of the Solid Waste Operations Manager and then repaired in a manner consistent with the surrounding area. Grass should be maintained, replaced, reseeded, and mowed as indicated in the section on grassing. The drainage swales will be cleaned annually as needed.

4.5 Landfill Cap

Post-closure maintenance of the cover system is to include inspecting the system in those landfill areas that have a differential settlement of 5 feet or more in a horizontal distance of 100 feet. The system shall be repaired in those areas as necessary. Any differential settlement at the landfill is to be corrected to allow drainage paths to remain intact. Differential settlement is defined as one area of the closure subsiding or settling faster than the surrounding area. Differential level checks will be performed if evidence of settlement is detected during routine site inspections. Differential level check information will be kept on file and will be made available for FDEP review.

If the final cover requires replacement, repair will follow the original design specifications. Repairs to the final cover will be under the supervision of a professional engineer. Accounts of all repairs to the final cover system and test results will be documented in Daily Observation Reports and maintained by the Sarasota County Solid Waste Department. Repairs to any layer of the final cap system shall be in accordance with the Construction Quality Assurance (CQA) Plan and specifications for landfill cover construction included in Appendices C and D, respectively, of the closure permit application. FDEP will be notified of any damage to cover system that requires repairs.

4.6 Landfill Access and Landfill Signs

The boundary of the landfill property is fenced. Access to the site is to be restricted to prevent unauthorized entry and dumping. As part of the routine check-list procedure, all of the fencing and signage is inspected for damage and repaired, repainted, and replaced if necessary to maintain the integrity of these items.

If any of the landfill monuments are severely damaged or destroyed, corrective actions will be taken.

The site roadways are also inspected as part of the routine checklist procedure. If any of the access roads are severely damaged, corrective actions will be taken to maintain passable and safe roads on the site.

4.7 Management of Monitoring Devices

This section includes descriptions of procedures for maintaining and repairing groundwater and gas monitoring devices. The locations of the monitoring devices are shown on Figure 1 of the Water Quality Monitoring Plan Addendum, Revised April 2009, provided in Appendix C of the Phase II permit application (Permit No. 130542-007-SO/01, submitted April 2009). No changes to the Water Quality Monitoring Plan are requested for the Phase I closure. Groundwater monitoring is to continue at the Facility with the potential for periodic revisions following evaluation of the laboratory reports.

4.7.1 Groundwater Monitoring Wells

If a monitoring well becomes inoperable, Sarasota County will notify the FDEP within 24 hours and follow up with written notice within 7 days, as shown in Table 2. The written notice will provide a detailed description of the problem that has occurred and what remedial actions will be taken. If deemed necessary, the damaged monitor well will be properly abandoned and a new well will be constructed close to the abandoned well. Monitoring well design and replacement will be approved by the FDEP before abandonment and installation. Copies of the well abandonment permit and site inspection prepared by the Southwest Florida Water Management

District (SWFWMD) will be provided to FDEP for abandoned wells. Upon completion of the construction of the monitoring well, the following information will be provided to the FDEP.

- Well Identification.
- Driller's Lithologic Log.
- Latitude/Longitude.
- Total Well Depth.
- Aquifer Monitored.
- Casing Diameter.
- Screen Type and Slot Size.
- Casing Type and Length.
- Elevation at Top of Pipe.
- SWFWMD Well Construction Permit Number.
- Elevation at Land Surface.

The newly constructed monitor well will be developed and included in the routine monitoring.

Groundwater monitoring will only be conducted by an individual trained in groundwater monitoring and reported to the FDEP as required by the closure permit. Care should be taken when equipment is near any monitor well so that no damage is done.

4.7.2 Gas Monitoring

Gas monitoring is to continue at the Class I landfill in accordance with the Water Quality Monitoring Plan Addendum, Revised April 2009, and provided in Appendix C of the Phase II permit application, which is incorporated into this document by reference. Soil monitoring probes will be replaced and repaired in accordance with 62-701.530, F.A.C. FDEP will be notified of maintenance repair activities.

4.8 Record-Keeping Requirements

Records of information used to develop or support the permit applications and any supplemental information submitted to the FDEP shall be kept for the design life of the landfill. Records of monitoring information, including calibration and maintenance records, all original chart recordings for continuous monitoring instrumentation, and copies of all reports required by permit, will be kept for at least 10 years. Background water quality records will be kept for the design life of the landfill. Annual estimates of the remaining life and capacity and site life will be maintained. Annual estimates will be based on a summary of the heights, lengths, and widths of the solid waste disposal units and will be submitted annually to the FDEP. Records more than 5 years old, which are required to be retained, may be archived provided they can be retrieved within 7 days.

4.8.1 Records of Monitoring

Records of water quality monitoring information are to include the following:

- Facility name and WACS identification number, and identification number of the surface water and groundwater monitoring points.
- The date, exact place, and time of sampling or measurements.
- The person responsible for performing the sampling or measurements.
- Water levels before sampling.
- The date(s) analyses were performed.
- The person responsible for performing the analyses.
- The analytical techniques or methods used and method detection limits and applicable water quality standards.
- STORET code numbers for parameters analyzed.
- The results of such analyses.
- Electronic data.

Water quality monitoring reporting and evaluations, including routine sampling events, will be consistent with the pertinent requirements of 62-701.510(9), F.A.C.

Biennial reporting will be performed by a professional engineer or hydrogeologist experienced in hydrogeologic investigations. The biennial report will be updated at the time of permit renewals. The biennial report will meet requirements of 62-701.510(a), F.A.C., and will include the following:

- Tabular displays of data.
- Trend analyses.
- Comparisons of shallow-, middle-, and deep-zone wells.
- Correlation of parameters and discussions of data correlations.
- Interpretations of groundwater contour maps and flow rates.
- Evaluation of the adequacy of water quality monitoring frequency and sampling locations.

4.8.2 Inspection Forms

Inspections of the final cover and stormwater system will be documented and kept on file at the Sarasota County Solid Waste Operations Office.

Deficiencies observed in the fencing and security, access roads, monitoring devices, stormwater system, or final cover system will be documented by Sarasota County during inspections of the landfill. The extent of damaged areas, the extent of the areas repaired, and a detailed description of the repair work will be recorded.

ATTACHMENT 1

CCSWDC INSPECTION LOG

SOLID WASTE LANDFILL OPERATIONS

CENTRAL LANDFILL PHASE I - MONTHLY INSPECTIONS OR AFTER MAJOR STORM EVENTS

*** * * NOTICE * * ***

Inspection Date: ______________________

Inspection conducted by: ______________________

Other Participants: ______________________

REQUIREMENTS:

THIS SECTION PROVIDES AN OOPORTUNITY FOR THE COUNTY INSPECTOR TO ADD A NARRATIVE EXPLAINING ANY REQUIREMENTS IDENTIFIED AS "NOT OK" AT THE TIME OF THE INSPECTION. SOME REQUIREMENTS MAY BE IDENTIFIED AS "OK" BUT ARE DISCUSSED FURTHER IN THE "AREA OF CONCERN" SECTION OF THE NARRATIVE

ITEM	OK	Not OK	Unk	N/A
1) Site access controlled? (Check any that are Not OK) ______ Fences, gates, locks OK? ______ Locks on gates OK?				
2) Access roads OK?				
3) Road signage OK?				
4) Any unauthorized waste stored?				
5) Stormwater system OK? (Check any that are Not OK) ______ Silting ______ Slopes ______ Erosion in ditches ______ Inlets ______ Piping ______ Berms ______ Letdowns ______ Grout filled fabric ______ Ditches/culvert				
6) Final cover OK?				
7) Any damage to cap?				
8) Settlement being properly filled?				

Explain NOT OK and Areas of Concern:

1) ______________________

2) ______________________

3) ______________________

4) ______________________

5) ______________________

6) ______________________

7) ______________________

8) ______________________

ITEM	OK	Not OK	Unk	N/A
9) Little/no ponding of water on footprint?				
10) Signs of erosion?				
11) Vegetation OK?				
12) Any seeps?				
13) Exposed cover OK? (Check any that are Not OK) ______ Gas accumulating under liner ______ Holes or cracks in liner				
14) Lift and pump stations, forcemains OK?				
15) Leachate seeps?				
16) Groundwater wells OK?				
17) Gas wells OK?				
18) Gas collection OK?				
19) Gas pressure not causing problems with cover?				
20) System components of gas extraction system OK?				
21) Pipes OK on gas extraction system?				
22) Any odors?				

Explain NOT OK and Areas of Concern:

9) ______________________________

10) ______________________________

11) ______________________________

12) ______________________________

13) ______________________________

14) ______________________________

15) ______________________________

16) ______________________________

17) ______________________________

18) ______________________________

19) ______________________________

20) ______________________________

21) ______________________________

22) ______________________________

Please respond to the above comments in __________ days of receipt

Signature/Date: ______________________ Signature/Date ______________________

Contractor Rep County Inspector

NOTE: By signing this document, the Contractor Representative only acknowledges receipt of this Inspection Report and is not admitting to the accuracy of any of the items identified by the County Inspector as "NOT OK" or

APPENDIX C
CONSTRUCTION QUALITY ASSURANCE PLAN

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
APR 30 2010
SOUTHWEST DISTRICT TAMPA

Sarasota County
Solid Waste Operations

Central County Solid Waste Disposal Complex Phase I Closure Construction Quality Assurance Plan

April 2010

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HDR Project No. 0096-125174-002

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SECTION 1.0
INTRODUCTION

1.1 PURPOSE

This Construction Quality Assurance (CQA) Plan is a document that contains requirements for testing materials and monitoring construction of the Sarasota Central County Solid Waste Disposal Complex Class I landfill– Phase I Closure, including the responsibilities of CQA personnel, documentation control, and reporting procedures.

The plan was prepared to provide the Owner, Design Engineer, CQA Engineer, and the Contractor the means to govern the construction quality; to satisfy environmental protection requirements for current solid waste management regulations; and utilize state-of-the-art construction practices and testing procedures to adequately document proposed construction activities. The proposed construction, testing, and documentation procedures are also intended to provide the necessary safeguards and provisions accepted by the Owner upon completion. The roles of each party have been sufficiently defined and the level of responsibility explained. The proposed final cover system will be constructed in accordance with the design, the construction documented, and respective components approved and certified for acceptance.

More specifically, this CQA Plan addresses the soils and geosynthetics components of the final and temporary final cover system. Specific work elements include the following:

- Initial Cover
- Intermediate Cover
- Final Cover liner which consists, from bottom to top, of
    - 40-mil LLDPE liner (smooth and textured),
    - geocomposite drainage layer
- Protective cover
- Pipes and fittings
- Vegetative Layer
- Top Soil
- TPO Geomembrane for Temporary Final Cover

The CQA Engineer has the primary responsibility of implementing and managing the CQA program described in this plan. When construction is complete, the CQA organization will prepare a construction certification report that will include information generated through the CQA program and will document the extent to which construction was performed in accordance with the contract documents.

The CQA Plan is intended to be a supporting document to improve the overall implementation of the work. The CQA Plan may be more or less specific than the Project Plans and Specifications, and conflicts may exist between the documents. The Contractor is instructed to bring discrepancies to the attention of the Design Engineer or CQA Engineer for resolution. The Design Engineer has the sole authority to determine resolution of discrepancies existing within the Contract Documents. Unless otherwise determined by the Design Engineer, the more stringent requirement shall be the controlling resolution.

1.2 REFERENCE DOCUMENTS

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

- Florida Department of Environmental Protection (FDEP) Chapter 62-701.400; 62-701.600
- Project Plans and Specifications
- Manufacturer's Quality Assurance Manuals (where applicable)
- Contractor's Construction Quality Control Plan
- EPA/600/R-93/182
- ASTM International - Current Edition

1.3 DEFINITIONS

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

Contract Documents – All contractor submittals, construction plans, as-built plans, construction specifications, QA plan, safety plan and project schedule.

CQA Organization – The company and persons including CQA Engineer, CQA Inspector, and CQA Laboratories whose primary responsibility is to implement the CQA Plan.

CQA Plan – The document contained herein, entitled Central County Solid Waste Disposal Complex Phase I Closure Construction Quality Assurance Plan prepared for Sarasota County Solid Waste Operations by HDR Engineering, Inc.

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

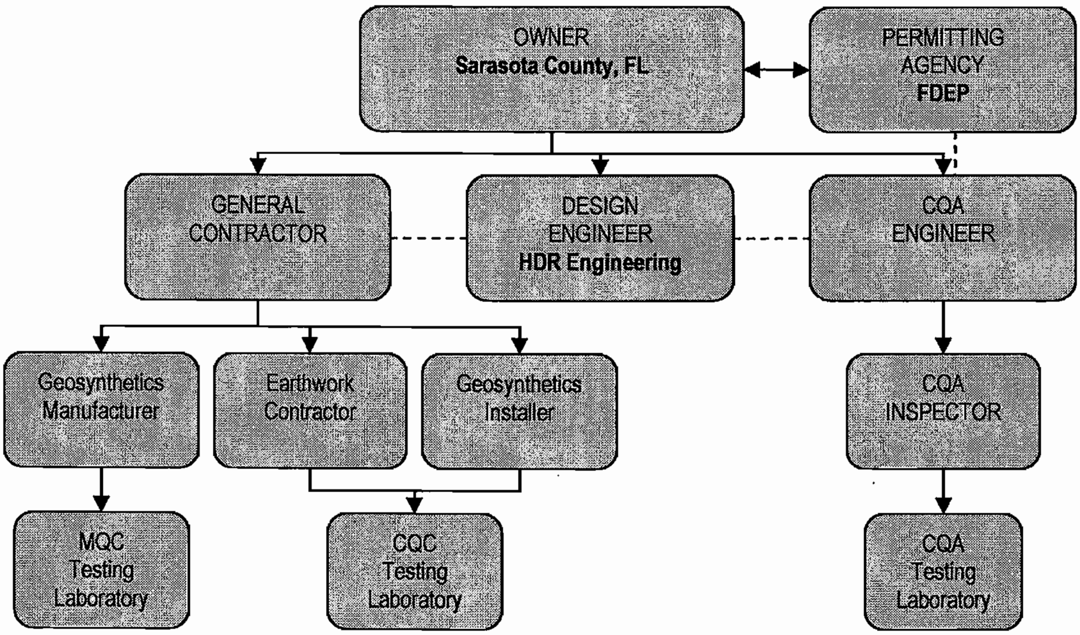
Quality Control - Actions taken by the geomembrane manufacturer and installer to ensure that the geosynthetic materials and workmanship meet the requirements of the Project Plans and Specifications.

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

SECTION 2.0
RESPONSIBILITY AND AUTHORITY

The principal organizations involved in permitting, designing and construction of the solid waste disposal facility include the permitting agency, facility owner/operator, Design Engineer, CQA organization, and Contractor. The principal organizations, their areas of responsibility and lines of authority as delineated for the CQA Plan are shown in the organization chart below and described fully in this section. This establishes the necessary lines of communication that will facilitate an effective decision making process during implementation of the CQA Plan.

Figure 1
CQA/CQC Organization Chart



2.1 PERMITTING AGENCY

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

2.2 FACILITY OWNER/OPERATOR

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

2.3 DESIGN ENGINEER

HDR Engineering, Inc. is the Design Engineer and is primarily responsible for designing the landfill closure for the solid waste disposal facility that fulfills the requirements from the Owner and the FDEP. Design activities shall not end until construction of the closure is completed. The Design Engineer may be requested to change some component designs if unexpected site conditions are encountered or changes in construction methodology occur that could adversely affect landfill construction. Implementation of the CQA Plan provides assurance that these unexpected changes or conditions will be detected, documented, and addressed during construction.

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

2.4 CONSTRUCTION QUALITY ASSURANCE ORGANIZATION

2.4.1 Construction Quality Assurance Engineer (CQA Engineer)

The CQA Engineer is a party, independent of the manufacturer and the contractor, with responsibility for implementing this CQA plan. The CQA Engineer is responsible to the Owner but will function independently of the Owner and Contractor. At a minimum, the CQA Engineer is a Florida Registered Professional Engineer who possesses adequate formal academic training in engineering and managerial experience to successfully oversee and implement construction quality assurance activities for solid waste disposal facilities. The CQA Engineer is responsible for the following:

- Reviewing design criteria, permit conditions, the Contractor's Construction Quality Control (CQC) plan, and project plans and specifications for clarity and completeness so that the CQA plan can be implemented.
- Educating CQA Inspectors on CQA requirements and procedures.
- Scheduling and coordinating CQA activities including sampling for conformance testing.

- Confirming that regular calibration of testing equipment is properly conducted and recorded.
- Reviewing and interpreting test data and reports.
- Rejecting defective work and verifying that corrective measures have been implemented.
- Certifying construction completion.
- Providing signed, sealed final report and record drawings to the FDEP after owner review and approval stating that the final cover and temporary final cover systems have been installed in substantial conformance with the Project Plans and Specifications.

2.4.2 Construction Quality Assurance Inspector (CQA Inspector)

In order to assist the CQA Engineer in providing full-time on-site oversight and monitoring services, a CQA Inspector will be named. The CQA Inspector is a person(s) or firm(s) independent of the Contractor and Geomembrane Installer and authorized by the CQA Engineer and Owner to manage and oversee the execution of the work. The CQA Inspector shall possess formal academic training in soils engineering, engineering geology or other closely associated discipline. All completed work is subject to approval of the CQA Engineer.

The following minimum qualifications must be met by the CQA Inspector:

- The CQA Inspector must have been in business for at least ten (10) continuous years of operation immediately prior to the date of this project.
- The CQA Inspector must have inspected and tested a minimum of five (5) liner projects consisting of at least 10,000,000 square feet of LLDPE, TPO and/or HDPE liner.
- The CQA Inspector shall provide one full-time Qualified Engineering Technician and other trained technicians to perform the required tests and inspections of the liner system.
- The Qualified Engineering Technician is qualified representative of the CQA Inspector, who is an engineering technician with a minimum of four years of directly related experience or a graduate engineer/geologist with one year of directly related experience.
- The CQA Inspector shall provide certified technicians to perform full time observation and documentation of activities related to the CQA of the liner system construction.
- The CQA Inspector must have registered full-time Professional Engineers on staff to sign, seal, and certify that the project was constructed in accordance with the contract documents.

The CQA Inspector's responsibilities include:

- Performing independent on-site inspection of the work in progress to assess compliance with the facility design, Project Plans and Specifications.
- Verifying that the equipment used in testing meets the test requirements and that the tests are conducted according to the standardized procedures defined by the CQA Plan.
- Reviewing design criteria, and Project Plans and Specifications for CQA requirements and procedures.
- Scheduling and coordinating inspection activities.
- Directing and supporting the inspection personnel in performing observations and tests by:
    - submitting test samples for analysis by the CQA laboratory,

- confirming that regular calibration of testing equipment is properly conducted and recorded,
- confirming that the testing equipment, personnel, and procedures do not change over time or making sure that any changes do not adversely impact the inspection process,
- recording and maintaining comprehensive documentation of the liner system construction, and
- verifying that the raw data are properly recorded, validated, reduced, summarized, and interpreted in accordance with the CQA Plan and the Project Plans and Specifications.

- Providing to the CQA Engineer reports on the inspection results including:
  - review and interpretation of all data sheets and reports,
  - identification of work that the CQA Inspector believes should be accepted, rejected, or uncovered for observation, or that may require special testing, inspection, or approval,
  - rejection of defective work and verification that corrective measures are implemented, and
  - verification that the Contractor's construction quality control plan is in accordance with the site-specific CQA Plan.

2.4.3 Construction Quality Assurance Laboratory (CQA Laboratory)

The CQA Laboratory will be independent of the geosynthetic manufacturer and installer. The CQA Laboratory will be qualified and responsible for material conformance testing for soil, geomembrane, geocomposite, and for destructive seam tests on the installed geomembrane. The CQA Engineer and CQA Inspector will be responsible for coordinating with the laboratory, sampling the geosynthetics or arranging for sampling at the manufacturing facility, and reviewing conformance testing.

- The CQA Laboratory shall possess testing equipment which is capable of testing the interface friction between the liner system components in accordance with ASTM standards.
- The CQA Laboratory shall possess testing equipment which is capable of testing LLDPE and TPO liner seams for peel and shear according to ASTM standards.
- The CQA Laboratory shall be familiar with ASTM, NSF and other applicable test standards. It shall have performed a minimum of 100 sets of peel and shear tests on seams of material the same type as specified.

2.5 CONSTRUCTION CONTRACTORS

2.5.1 Construction Contractor

It is the responsibility of the Contractor to construct the landfill final cover and temporary final cover system in strict accordance with design criteria, Project Plans and Specifications, using the required construction procedures and techniques. The chosen Contractor will be registered in accordance with applicable local, state, and federal requirements and will have prior landfill-related experience.

The Construction Contractor's responsibilities include but are not limited to:

- Constructing the final cover and temporary final cover system in strict accordance with the contract documents including Project Plans and Specifications using the necessary construction procedures and techniques.
- Formulating and implementing a Construction Quality Control (CQC) Plan in accord with requirements of the technical specification.
- Contracting with subcontractors, such as manufacturers and specialty installers, and coordinating their activities.
- Supplying required materials and supporting QC documentation either directly or through subcontractors.
- Discussing procedures for locating and protecting construction materials and for implementing methods for preventing damage of the materials from inclement weather or other adverse effects.
- Coordinating activities with the CQA Engineer and CQA Inspector and providing the CQA organization with all necessary documentation as detailed in this plan.
- Updating original construction drawings and specifications to reflect any deviation from the original plans and furnishing as-built record drawings and all required quality control documentation.
- Planning and monitoring construction site health and safety procedures.
- Approving shop drawings prior to submission to the CQA Engineer.
- Determining and verifying:
  - field measurement,
  - field construction criteria,
  - catalog numbers and similar data, and
  - conformance to Project Plans and Specifications.
- Coordinating each submittal with other submittals and with the requirements of work and of the Project Plans and Specifications
- Notifying the CQA Engineer in writing, at time of submission, of any variance in the submittals from the requirements of the Project Plans and Specifications. Any such deviations permitted by the Design Engineer will require modifications to the Project Plans and Specifications.

2.5.2 Site Supervisor

The Construction Contractor will be represented in the field by a Site Supervisor. The Site Supervisor is responsible for the following:

- Scheduling and coordinating work including subcontractors.
- Informing the CQA Inspector and CQA Engineer of any discrepancies between the Project Plans and Specifications and field conditions.
- Coordinating with the CQA Inspector and CQA Engineer.
- Attending project meetings.
- Maintaining a daily log of construction and quality control activities.
- Implementing and verifying CQC procedures.

- Submitting proposed alternative materials or construction methods for approval before acquisition and use.
- Construction.

2.5.3 Geomembrane Installation Contractor (Geomembrane Installer)

The Geomembrane Installer may be a general contractor, a subcontractor to the general construction contractor, or a specialty contractor hired directly by the Owner. The Geomembrane Installer has not been chosen at this time. The selected contractor will have experience in installing at least 10 million square feet of geosynthetics.

The Geomembrane Installer or their CQC Consultant will be responsible for the following:

- Coordinating with the general contractor and CQA Inspector.
- Handling, storing, placing, and installing manufactured materials.
- Implementing and verifying a manufacturer and installer QC plan.

2.5.4 Thermoplastic Polyolefin Geomembrane Installer

Thermoplastic Polyolefin (TPO) geomembrane installer will demonstrate 5 years continuous experience with a minimum 5,000,000 square feet of TPO geomembranes. The installer will be trained and certified by at least one of the named manufacturers in this Specification (not necessarily the manufacturer supplying materials for this Project).

Geomembrane Installer Personnel Qualifications:

- Installation Superintendent shall have worked in a similar capacity on at least five geomembrane liner jobs similar in size and complexity to the project described in the Contract Documents.
- The Master Welder shall have completed a minimum of 5,000,000 square feet of TPO geomembrane seaming work using the type of seaming apparatus proposed for use on this Project.
- Other welders shall have seamed a minimum of 1,000,000 square feet of TPO geomembrane.

SECTION 3.0
INTERMEDIATE AND PROTECTIVE SOIL COVER

This section contains procedures and tests, which must be implemented in order to ensure the soil components of the final and temporary final cover systems meet the design standards. This is a critical component of the Construction Quality Assurance Plan. All required tests and sampling procedures within this section shall be performed in accordance with generally accepted engineering procedures. Table 3-1 contains a listing of applicable test procedure standards for the intermediate and protective cover soils.

3.1 INTERMEDIATE SOIL COVER

3.1.1 Preconstruction

Soil materials to be used as intermediate cover shall consist of select borrow material meeting all requirements specified in Specification Section 02200, Earthwork. The borrow material for intermediate cover must be of approved regular on-site borrow or borrow excavation unless otherwise specified or noted on drawings. If fill comes from off-site location, Contractor must submit the source test data to the CQA Inspector for approval a minimum of 48 hours prior to intended use.

Table 3- 1
Intermediate and Protective Cover Test Procedure Standards

STANDARD	TEST DESCRIPTION
ASTM D422	Method for Particle-Size Analysis of Soils
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12, 400 ft-lb/ft^2)
ASTM D2922	Test Methods for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)
ASTM D2487	Test Method for Classification of Soils for Engineering Purposes (United Soil Classification System)
ASTM D2488	Practice for Description and Identification of Soils (Visual-Manual Procedure)
ASTM D3017	Test Method for Water Content of Soil and Rock In-Place by Nuclear Methods (Shallow Depth)
ASTM D2216	Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
ASTM D2937	Test Method for Density of In-Place Soils by Drive-Cylinder Method

Soil for the intermediate cover should be free of deleterious material (organics, sticks, roots, waste, etc.) and rock fragments, boulders or cobbles greater than three inches in size. Fines content of installed soil shall be a maximum of 50% (passing #200 sieve) and monitored as specified in the Project Plans and Specifications. Soil shall classify as SP, SW, SC, SM, SP-SM, or SP-SC in accordance with ASTM D2487 or ASTM D2488.

The intermediate cover layer shall be placed and compacted in accordance with specification section 02200, Earthwork, Part 3.6.E. The CQA Inspector shall test materials and monitor compliance with requirements of the Project Plans and Specifications. All observations and tests shall be conducted at locations selected by the CQA Inspector who has been assigned responsibility for verification and documentation of the element in question.

3.1.2 Construction

The following is an outline of the minimum construction requirements for the intermediate cover. For more detailed information, see the specification Sections 02200, Earthwork, 02775, LLDPE Geomembrane Liner System, and 02771 TPO Geomembrane .

- Strip vegetation from existing cover soils and dispose at a location designated by Owner.
- Verify that a minimum of 18 inches of cover soils exist after stripping operations. Add additional soil as needed to fill surface depressions and achieve a minimum thickness of 18 inches. Surface shall be smooth without irregularities unless shown on the drawings.
- Approval from CQA Inspector with regard to suitability of soils and acceptable subgrade.
- Atmospheric conditions observed and recorded by the CQA Inspector and appropriate actions taken when unsuitable weather conditions exist.
- Dust control continuous throughout the intermediate cover operations.
- Verify grade control is established to control thickness of material placed.
- Verify final grading completed in accordance with specification Section 02200, Earthwork.
- Intermediate cover compacted to specified requirements provided in Section 02200.
- Surface of intermediate cover soils proof-rolled in accordance with technical specification Section 02200 Part 3.2.F.
- Verify minimum thickness of the soils and geomembrane materials is achieved in accordance with the specifications.
- Provide as built survey of intermediate cover sealed by a professional land surveyor illustrating construction of all design features.
- Approval from CQA Inspector with regard to final surface smoothness and uniformity. Any objects protruding from the final surface or coarse fragments within the surface material that may damage the geomembrane will be removed.
- The required thickness of intermediate cover will be verified by survey methods or hand auger methods on an established grid system with not less than one verification point per 10,000 square feet of surface.

Table 3- 2
Intermediate Cover Conformance and Construction Testing

TEST DESCRIPTION	STANDARD	TEST FREQUENCY
Intermediate Cover		
Density, Nuclear Method	ASTM D2922	1 per 1,500 yd^3
Moisture Content, Nuclear Method	ASTM D3017	1 per 1,500 yd^3
Sand Cone or Drive Cylinder Method	ASTM D2937	1 per 20 nuclear tests
Oven Moisture Content Verification	ASTM D2216	1 per 20 nuclear tests
Moisture Density Relations	ASTM D698	1 per 20,000 yd^3 *
Sieve Analysis	ASTM D422	1 per 20,000 yd^3 *

* Increase frequency as needed to ensure each soil type is tested.

3.2 PROTECTIVE COVER

3.2.1 Preconstruction

Soil materials to be used as the 24-inch thick protective cover over the geomembrane (including 6-inch thick topsoil cover) shall consist of select borrow material meeting all requirements specified in Specification Section 02200, Earthwork. The borrow material for protective cover must be of approved regular on-site borrow or borrow excavation unless otherwise specified or noted on the drawings. If cover soil comes from off-site location, the Contractor must submit the source test data to the CQA Inspector for approval a minimum of 48 hours prior to intended use.

Soil for the bottom 18 inches of protective cover should be free from deleterious material (organics, sticks, roots, etc.) and rock fragments, boulders or cobbles greater than three inches in size. The upper 6 inches of protective cover shall meet the same criteria except that the soil shall contain sufficient organics to promote vegetative growth.

The protective cover layer shall be placed and compacted in accordance with the specification Section 02200, Earthwork, Part 3.6.E. The CQA Inspector will observe that placement of the soil material is done in a manner to protect the geocomposite. The CQA Inspector shall test materials and monitor compliance with requirements of the Project Plans and Specifications. All observations and tests shall be conducted at locations selected by the CQA Inspector who has been assigned responsibility for verification and documentation of the element in question.

Table 3- 3
Protective Cover Conformance and Construction Testing

TEST DESCRIPTION	STANDARD	TEST FREQUENCY
Intermediate Cover		
Density, Nuclear Method	ASTM D2922	1 per 1,500 yd^3
Moisture Content, Nuclear Method	ASTM D3017	1 per 1,500 yd^3
Sand Cone or Drive Cylinder Method	ASTM D2937	1 per 20 nuclear tests
Oven Moisture Content Verification	ASTM D2216	1 per 20 nuclear tests
Moisture Density Relations	ASTM D698	1 per 20,000 yd^3 *
Sieve Analysis	ASTM D422	1 per 20,000 yd^3 *

* Increase frequency as needed to ensure each soil type is tested
Note: Testing is not required for topsoil layer

3.2.2 Construction

Protective cover should be stable for construction and maintenance traffic. Care will be exercised in placement so as not to shift, wrinkle or damage the underlying geosynthetic layers, and the placement methods will be documented by the Contractor and CQA Inspector.

The protective cover shall be placed under the direct supervision of the CQA Inspector. The Contractor shall utilize care to avoid damage to the geocomposite. No vehicular traffic will be permitted on the unprotected liner system except low ground pressure equipment necessary for the deployment and installation of liner system. The loose thickness of the initial lift of protective cover shall not be less than 12 inches and spread with low ground pressure equipment (maximum pressure 10psi). Fill shall be placed by equipment starting at the toe of slope and spreading toward the top of slope. Material shall not be placed over standing water or ice.

The following is an outline of the minimum construction requirements for the protective cover. For more detailed information, see specification section 02200, Earthwork:

- Approval from CQA Inspector with regard to suitability of soils.
- Atmospheric conditions observed and recorded by the CQA Inspector and appropriate actions taken when unsuitable weather conditions exist.
- Dust control continuous throughout protective cover operations.
- Verify the underlying geocomposite construction is complete before material installation.
- Verify grade control is established to control thickness of material placed.
- For placement of material over geosynthetics, monitor 12-inch minimum thickness of material below spreading equipment and the spreading equipment has a ground pressure rating equal to or less than 10psi. During placement of material, identify geocomposite damaged during material installation and establish that the damage is repaired.
- Monitor haul road thickness over geocomposite and verify that equipment hauling and placing material over geocomposite meets equipment specifications.
- Monitor placement of material over piping and verify that pipe is not damaged by occasionally uncovering piping.

- Monitor equipment speed over material.
- Verify lower 18 inches of protective cover compacted to specified requirements. Do not compact topsoil layer beyond tracking it in.
- Verify final grading completed in accordance with specification section 02200, Earthwork.
- Verify minimum thickness is achieved in accordance with specifications.
- Install sod in accordance with specifications.
- Approval from CQA Inspector with regard to final surface smoothness and uniformity.
- Provide as-built survey of protective cover sealed by a professional land surveyor illustrating construction of all design features.

The required thickness of protective cover will be verified by survey methods or hand auger on an established grid system with not less than one verification point per 10,000 square feet of surface.

SECTION 4.0
GEOMEMBRANE LINER

This section covers the work necessary to construct and test the geomembrane lining system, which will consist of a 40 mil Linear Low Density Polyethylene (LLDPE) liner material (top, north and east slopes) in accordance with specification Section 02775, LLDPE Geomembrane Liner Systems and a 60 mil Thermoplastic Polyolefin (TPO) Geomembrane (south slope) in accordance with specification Section 02771, TPO Geomembrane. The geomembrane material and installation will be in accordance with specification Sections 02775 and 02771. The LLDPE and TPO liner materials shall be new, first quality products designed and manufactured specifically for the purposes of the Work and shall have satisfactorily demonstrated, by prior use, to be suitable and durable for such purposes. All LLDPE geomembranes will be textured on both sides (except for the top slope which will require a 40 mil smooth LLDPE) and shall be an unmodified LLDPE containing no plasticizers, fillers, chemical additives, or extenders. The only other compound ingredients to be added to the LLDPE geomembrane resin shall be anti-oxidants and heat stabilizers required for manufacturing. The LLDPE geomembranes shall be supplied as a single ply continuous sheet with no factory seams and in rolls with a minimum width of 22 FT. The roll length shall be maximized to provide the largest manageable sheet for the fewest field seams. The requirements for the TPO geomembrane will meet the minimum requirement as illustrated in specification Section 02771.

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

The geomembrane liner shall conform to the testing requirements of GRI Standard GM17 - "*Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes*" (Geosynthetic Research Institute; Philadelphia, PA) and requirements of Section 02771 for TPO geomembrane.

4.1 PRECONSTRUCTION

4.1.1 Certification of CQA Plan Conformance

Prior to start of work, the Geosynthethics Manufacturer and the Geomembrane Installer, each, shall submit for approval by the CQA Inspector documented evidence of its ability and capacity to perform this Work. Each shall have successfully manufactured and/or installed a minimum of ten (10) million square feet of similar lining material in solid waste containment structures.

The Contractor shall submit written certification by the Geosynthetics Manufacturer that the lining materials conform to the requirements of the CQA Plan. The Contractor shall submit the name and qualifications of its project superintendent that will be on the project whenever lining materials are being handled and/or installed plus the names and qualifications of senior installation personnel on the project.

All manufacturer and Geomembrane Installer qualifications shall be submitted in accordance with technical specification Sections 02775 and 02771 Part 1.2.B.

4.1.2 Geomembrane Installer's and Manufacturer's QC Program

The Geosynthetics Manufacturer and the Geomembrane Installer, each, shall submit a complete description of its quality control (QC) program, as applicable, for manufacturing, handling, installing, testing, repairing and providing a completed lining in accordance with requirements of the CQA Plan and contract documents. The description shall include, but not be limited to, polymer resin supplier, product identification, acceptance testing, fabrication and production testing, installation testing, documentation of changes, alterations and repairs, retests and acceptance.

The following quality control tests will be performed on the geomembrane by the CQA inspectors.

Table 4- 1
MQC Conformance Testing for LLDPE Geomembranes

STANDARD	TEST DESCRIPTION	FREQUENCY OF TESTING
ASTM D6693, Type IV, 2 ipm	Standard Test Method for Determining Tensile Properties of Non-reinforced Polypropylene and Non-reinforced Flexible Polypropylene Geomembranes	Every 20,000 lbs
ASTM D1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting	Every 45,000 lbs
ASTM D1505/D792	Standard Test Method for Density of Plastics by the Density-Gradient Technique	Every 200,000 lbs
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer	One per rail car compartment
ASTM D1603	Standard Test Method for Carbon Black Content in Olefin Plastics	Every 20,000 lbs
ASTM D3895	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry	Every 200,000 lbs
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products	Every 45,000 lbs
ASTM D5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics	Every 45,000 lbs
ASTM D5994[1]	Standard Test Method for Measuring Core Thickness of Textured Geomembrane	Every roll
ASTM D5199[2]	Standard Test Methods for Measuring Normal Thickness of Geotextiles and Geomembranes	Every roll
GRI GM12	Asperity Height	Every other roll

1. Textured Geomembrane Only.
2. Smooth Geomembrane Only.

Table 4- 2
MQC Conformance Testing for TPO Geomembranes

STANDARD	TEST DESCRIPTION	FREQUENCY OF TESTING
ASTM D751	Thickness	Per roll
ASTM D5261	Mass per Unit Area	Once per day or 200,000 lb
ASTM D4885	Tensile Properties	Once per day or

STANDARD	TEST DESCRIPTION	FREQUENCY OF TESTING
		20,000 lb
ASTM D751	Tear Resistance	Once per day or 45,000 lb
Visual	Scrim Orientation	Every Lot or Every Scrim Roll

4.1.3 Geomembrane Installer's Installation Plan

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

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

The Contractor and Geomembrane Installer shall submit for approval, by the CQA Inspector, certification that the surface(s) on which the lining will be placed is acceptable. Installation of the lining shall not commence until this certification is furnished to the CQA Inspector.

The Geomembrane Installer shall provide on-site technical supervision and assistance at all times during installation of the lining system. The Geomembrane Installer and Contractor, as applicable to each, shall submit for approval by the CQA Inspector written certification that the lining system was installed in accordance with the Manufacturer's recommendation, the CQA Plan, Project Plans, Specification Sections 02775 and 02771, and approved submittals.

The CQA Engineer will initiate a pre-installation meeting with the Geomembrane Installer, Contractor, and CQA Inspector prior to installation of the lining system. Topics for review/discussion shall include, as a minimum, Project Plans and Specifications, approved submittals, and training and qualification procedures for Contractor personnel.

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

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

4.1.4 Contractor's Geomembrane Preconstruction Material Submittals

The Contractor will provide the CQA organization with the following items for review and testing:

- Geomembrane proposed for the project for slope stability verification testing as outlined in this CQA Plan.
- Manufacturer's description (cut sheet) of the proposed geomembrane documenting it will meet or exceed specified requirements.
- Available historical data documenting that the proposed geomembrane will meet specified interface friction angle.
- Written instructions for storage, handling, installation, seaming, and repair of the proposed geomembrane.

Before shipment of the geomembrane, the CQA organization shall review all approved pre-construction submittals. Pre-construction submittals should be submitted a minimum of four weeks in advance to allow time for review and approval by the CQA organization.

The Contractor shall submit certifications that the LLDPE and TPO geomembrane material delivered to the site meets the requirements of the Specification and that the LLDPE and TPO geomembrane was received and accepted in undamaged condition from shipper.

4.1.5 CQA Conformance Testing

The geomembrane material will be sampled at the site by the CQA Inspector or at the manufacturing plant by a third party under the direction of the CQA organization. The sample will be taken across the entire roll width and will be 3 feet long. Samplers will mark the machine direction and the manufacturer's roll identification number on the sample. Samplers will also assign a conformance test number to the sample and mark the sample with that number. The samples will be forwarded to a CQA testing laboratory for the conformance testing. The CQA Inspector will review all conformance test results and report any nonconformance to the Owner and CQA Engineer.

The following conformance tests will be performed on the LLDPE geomembrane at the frequencies indicated in the specifications.

Table 4- 3
CQA Conformance Testing for LLDPE Geomembranes

STANDARD	TEST DESCRIPTION	FREQUENCY OF TESTING
ASTM D6693	Standard Test Method for Determining Tensile Properties of Non-reinforced Polypropylene and Non-reinforced Flexible Polypropylene Geomembranes	Every 20,000 lbs
ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.	Every 500 LF of seam
ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the	One per project

STANDARD	TEST DESCRIPTION	FREQUENCY OF TESTING
	Direct Shear Method	

Table 4- 4
CQA Conformance Testing for TPO Geomembranes

STANDARD	TEST DESCRIPTION	FREQUENCY OF TESTING
ASTM D 5261	Mass per Unit Area	1 test per 100,000 ft^2
ASTM D 4637	Thickness	1 test per 100,000 ft^2
ASTM D 4885	Tensile Strength at Break	1 test per 100,000 ft^2
ASTM D 4885	Elongation at Break	1 test per 100,000 ft^2
ASTM D 5884	Tear Strength	1 test per 100,000 ft^2
ASTM D 4833	Puncture Resistance	1 test per 100,000 ft^2
ASTM G 155	Resistance to Xenon-Arc Weathering	1 test per 100,000 ft^2
ASTM D 1149	Ozone Resistance	1 test per 100,000 ft^2
ASTM D 4637	Thickness	1 test per 100,000 ft^2

Laboratory interface friction tests shall be conducted in general accordance with ASTM D5321, on the following interfaces:

- Textured LLDPE liner and geocomposite
- Textured LLDPE liner and intermediate cover soil
- TPO geomembrane and 16 oz/sy geotextile

The CQA Laboratory will perform three (3) direct shear tests at the project specific effective normal stresses. These tests will be performed using the Contractor's proposed geosynthetic materials for above interfaces following award of the construction contract to the selected Contractor. A sample of intermediate cover soil proposed for the project will also be obtained for testing. A minimum interface friction angle based on the landfill design will be required to maintain stability.

The Owner will pay for "Passing" tests. Costs of corrective action, costs of "Failing" tests and all associated costs of testing due to failing tests will be paid by the Owner and the cost reimbursed to the Owner by the Contractor. Materials not meeting the required shear strength will not be approved for use on this project.

4.2 CONSTRUCTION

4.2.1 Delivery, Storage and Handling

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

- Name of manufacturer.
- Product type.

- Product thickness.
- Manufacturing batch code.
- Date of manufacture.
- Physical dimensions.
- Roll number.

Lining materials delivered to the site shall be inspected for damage, unloaded, and stored with a minimum of handling. Each roll shall be wrapped in an opaque and waterproof layer of plastic during shipment and storage. The plastic wrap shall not be removed until deployment. Materials shall not be stored directly on the ground. The storage area shall be such that all materials are protected from mud, soil, dirt and debris. The stacking of lining shall not be higher than two rolls.

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

LLDPE or TPO geomembrane or plastic wrapping damaged as a result of storage or handling shall be repaired or replaced, as directed. LLDPE or TPO shall not be exposed to temperatures in excess of 60°C (140°F) or less if recommended by the Manufacturer.

No hooks, tongs or other sharp instruments shall be used for handling the LLDPE or TPO geomembrane. Rolls shall not be lifted by use of cables or chains in contact with the LLDPE or TPO geomembrane. LLDPE or TPO geomembrane shall not be dragged along the ground.

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

4.2.2 Geomembrane Subsurface Preparation

Before geomembrane installation, the CQA Inspector will document that the intermediate cover installation is complete and CQC and CQA documentation verifies that subsurface has been prepared in accordance with specification Sections 02775 and 02771.

4.2.3 Geomembrane Placement and Seaming

Prior to installation of the geomembrane, a site inspection will be conducted by the CQA Inspector and the Contractor to verify measurements, structures and surface conditions to support the geomembrane.

The Contractor and Geomembrane Installer will provide written documentation to the CQA Inspector that surfaces to receive the geomembrane have been inspected and are acceptable for installation of the lining.

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

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

The geomembrane will be installed as shown on the project plans and approved installation drawings. Placement of the geomembrane will be done such that good fit, without bridging, is provided on all covers and grade changes. Excessive slack will be avoided to minimize rippling during the soil cover operation. Geomembrane liner shall be handled and placed in a manner which minimizes wrinkles, scratches and crimps.

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

Extreme care will be taken during installation of the lining to be certain no damage is done to any part of the lining. Dragging of the geomembrane material on the prepared subgrade will be prohibited. Smoking will be prohibited for all personnel. All handling and installation procedures will be performed by workers wearing shoes with smooth soles. Shoes with soles that have patterns in relief shall be prohibited. No foot traffic will be allowed on the geomembrane except with approved shoes. No vehicular traffic will be allowed on the geomembrane except low ground pressure equipment necessary for the deployment and installation of the lining system. All motor driven equipment using fuel will have spark arrestors. No gasoline driven generators or cans of gas or solvent will be placed directly on the lining material. Under no circumstances will the lining be used as a work area to prepare patches or to store tools and supplies. If needed, a tarpaulin of approved material will be spread out as a work area.

During installation, the Contractor will be responsible for protecting the lining against adverse effects of high winds such as uplift. Sand bags will be used as required to hold the lining material in position during installation. Sand bags will be sufficiently close-knit to preclude fines from working through the bottom, sides or seams. Paper bags, whether or not lined with plastic, will not be permitted. Burlap bags, if used, must be lined with plastic. Bags that are split, torn, or otherwise losing their contents will be immediately removed from the work area and any spills immediately cleaned up. Metal or wire ties will not be used.

The geomembrane material will not be installed under adverse climatic conditions, unless the Contractor can demonstrate that his installation techniques adequately compensate for such adverse conditions and quality of workmanship is not compromised. Adverse climatic conditions occur when the air temperature measured 6 inches above the geomembrane surface is less than 32°F and decreasing, or more than 90°F; when the relative humidity is more than 80 percent; when it is raining; or when there is frost on the ground; or during conditions of excessive winds.

Geomembrane field seams will be lap seams as shown on approved plans and drawings. The lap seams will be formed by lapping the edges of geomembrane sheets a minimum of 3 inches unless otherwise specified in the approved plans and drawings. The contact surfaces of the sheets will be wiped clean to remove dirt, dust, moisture, and other foreign materials. Geomembrane shall not be welded when ambient temperatures are below 5°C or above 40°C without written consent of manufacturer and CQA Engineer or CQA Inspector. For fillet weld seams, bevel edge of geomembrane and clean oxidation from surfaces to receive extrudate by disk grinding or equivalent not more than one hour before seaming.

For the final cover system, lap seam intersections involving more than three thicknesses of lining material will be avoided, and all seam intersections will be offset at least 2 FT. No horizontal field seams will be allowed on the slope and sheets of lining material on the slopes will extend down slope to the perimeter anchor trench as shown on the drawings. For the temporary final cover system, wedge weld end of geomembrane panel to beginning of new geomembrane panel and continue downslope. Flap of wedge weld to be on top in the downslope direction as long as practically feasible. Welds connecting downslope sheets shall be double wedge welds, and shall have a minimum of 10 FT. vertical offset between adjacent panel welds. Wedge welds shall have a minimum of 4 IN overlap.

Geomembrane liners shall be welded using extrusion (LLDPE), hot air (TPO), single wedge or double wedge welding equipment (LLDPE and TPO). Extrusion welding equipment shall be provided with thermocouples and temperature readout devices which continuously monitor the temperature of the extrudate. Wedge welding equipment shall be provided with thermocouples and temperature readout devices which continuously monitor the temperature of the wedge. Geomembrane liners shall be welded continuously without fishmouths or breaks in the weld. Where fishmouths are unavoidable, the geomembrane sheet shall be slit to a point such that the sheet lies flat and with no remaining wrinkle. The two edges of the slit shall be welded together provided that the overlap for this weld shall be a minimum of 6 inches. Areas of the slit that do not achieve an overlap of 6 inches, including the terminus of the slit, shall be provided with a patch.

Any necessary repairs to the geomembrane will be made with the lining material itself, using approved welding systems, equipment and techniques. The patch size will be 6 inches larger in all directions than the area to be patched. All corners of the patch will be rounded. Torn or permanently twisted geomembrane shall be replaced at no expense to the County.

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

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

4.2.4 Emergency Gas Vents

Emergency gas vents will provide emergency pressure relief if the active gas collection system is shut down for an extended period of time or due to hotspots within the landfill. The active gas collection system serves as an integral part of the overall performance of the temporary final cover system, and the emergency gas vents are installed to provide backup relief if necessary. The emergency gas vents are designed to be directly connected to the active gas collection system if necessary to provide additional vacuum under the temporary final cover system. Typically, the emergency gas vents are capped until they are needed.

Each of the components of the emergency gas vents will be installed as specified in the Contract Documents. The vent installation observation will be performed during the construction of the cover system.

Post-construction inspection of the emergency gas vents will include the following:

- Observation to ensure that all system components have been installed as specified and according to the approved manufacturer's specifications and the engineering design.
- Testing to document that the vents perform in accordance with the contract documents.

4.2.5 Field Quality Control

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

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

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

During the field seaming operation, destructive samples will be removed from field seams by the Installer at locations selected by the CQA Inspector. Repairs to the field seams will be made in accordance with repair procedures specified in this CQA Plan. The samples will have a width of 12 inches plus the seam width and length of 48 inches. A minimum of one stratified sample per 500 feet of field seam will be made. All field seams will have a film tear bond in peel and shear and will meet the minimum pound per inch width seam strength specified in the specification Sections 02775 and 02271, LLDPE and TPO Geomembrane Liner Systems respectively. The bonded shear strength for fusion and extrusion welds must be greater than or equal to the appropriate values shown in the specifications. A sufficient amount of the seam must be removed in order to conduct field testing, independent laboratory testing, and archiving of enough material in order to retest the seam when necessary. The archived material will be kept at the CQA laboratory. Field testing shall include at least two peel tests per sample. CQA laboratory testing shall consist of five shear tests and five peel tests per sample. The Installer shall test the seam destructively at a frequency of one test per 500 linear feet of weld and shall test 10 percent of all repaired areas. Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the geomembrane (LLDPE) or hot air welding for TPO geomembrane. Capped sections shall be non-destructively tested. Additional destructive test samples may be taken if deemed necessary by the CQA Inspector.

All field-tested specimens from a destructive-test location must be passing in both shear and peel for the seam to be considered as passing. The CQA laboratory testing must confirm these field results. The CQA testing laboratory will save all test samples including specimens tested until notified by the CQA Engineer relative to their disposal. All specimens which have failed under test will be shipped immediately by express delivery to the CQA Inspector for determination of corrective measures to be taken, which includes retest or repair of failed section.

For destructive samples which have failed the passing criterion, the Installer will reconstruct all the field seams between any two previous passed seam locations which include the failed seam or will go on both sides of the failed seam location (10 feet minimum), take another sample each side and test both. If both pass, the Installer may patch or cap strip the seam between the passed samples. If either fails, the Installer will remove and replace the entire seam. In all cases, acceptable field seams must be bounded by two passed test locations. The decision of the CQA Engineer will be final.

The Installer shall test all patch welds using one of the following nondestructive tests: vacuum tests, or spark tests. The Installer shall also test patch welds destructively at a frequency of 10 percent or one test per welding personnel per day. This destructive testing may be accomplished using demonstration welds performed adjacent to the liner installation.

In the event capping of a field seam is required, the Installer will use a cover strip of the same thickness as the lining (and from the same roll, if available) and a minimum of 6 inch overlap away from the seam in all direction. It will be positioned over the center of the field seam and welded to the lining using a fillet weld each side.

All geomembrane sheets, seams, anchors, seals, and repairs will be visually inspected by the Installer for defects. Depending on seam welding equipment used, all seams and repairs will be tested continuously by a vacuum testing device, air pressure, or spark tests.

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

If the fillet weld, extrusion lap weld, hot air weld, or single hot-wedge fusion lap weld is used to weld seams, the Installer will further test all seams and repairs in the geomembrane by vacuum box. All vacuum box testing will be done in the presence of the CQA Inspector. The area to be tested will be cleaned of all dust, debris, dirt and other foreign matter. A soap solution will be applied to the test area with a paint roller and the vacuum of 5 psi air pressure will be induced and held at least ten seconds to mark for repair any suspicious areas as evidenced by bubbles in the soap solution.

If the double hot-wedge is used, the Installer will further test all seams in the geomembrane by using the air pressure test which consists of inserting a needle with gauge in the air space between welds. Air will be pumped into space at a pressure and held for a time as indicated in the specifications. If pressure does not drop more than the amount allowed in the specifications, then the seam is acceptable.

All costs of retesting of the geomembrane including reruns of field weld tests and all repairs will be at the Installer's expense.

The Installer shall assemble the quality control data required above into a final report of geomembrane installation. The report will contain all test data and a final layout of geomembrane liner which shows the location of all seams, patches and sample locations. In addition, the Installer shall submit resin tests, tests of sheet material, factory seam tests, daily seam test results, and daily results of production seam testing.

The Contractor will retain responsibility for the integrity of the geomembrane system until acceptance by the CQA Engineer. The geomembrane will be accepted by the CQA Engineer when:

- Written certification letters including as built record drawings, have been received by the CQA Engineer.
- Installation is completed.
- Documentation of completed installation, including all reports, is received and approved.
- Verification of adequacy of field seams and repairs, including associated testing, is complete.

Acceptance of the completed work will include receipt of all submittals and all work completed to the satisfaction of the CQA Engineer.

4.2.6 Geosynthetics Manufacturer's Warranty

The Geosynthetics Manufacturer's warranty shall be against manufacturing defects or workmanship and against deterioration due to ozone, ultraviolet or other normal weather aging. The warranty shall be limited to replacement of material only, and shall not cover installation of said material. It shall not cover damage due to vandalism, acts of animals or unusual acts of God. The warranty shall state that the furnished material meets all requirements of specification Section 02775 or Section 02271 and the Contract Documents, is free from manufacturing defects and is able to withstand normal weathering for a period of five years, prorated. Written warranties addressing the LLDPE and TPO geomembrane material shall be furnished by the contractor and shall be made to Sarasota County.

4.2.7 Installer's Warranty

The Installer shall furnish a written guarantee that the entire lining work constructed by him to be free of defects in material and workmanship and installed pursuant to the CQA Plan for a period of two (2) years following the date of acceptance of the work by the CQA Engineer. During the 23rd month, a pre-guarantee expiration inspection will be conducted to identify any necessary repair work covered by the guarantee. The Installer shall agree to make any repairs or replacements made necessary by defects in materials or workmanship in the Work which become evident within said guarantee period. The Installer shall make repairs and/or replacements promptly, the Owner may do so, and the Installer shall be liable to the Owner for the cost of such repairs and/or replacements. The Installer's warranty shall state that the materials were properly installed, properly welded, seamed and jointed and will not fail within 2 years of installation under similar conditions. The warranty shall provide for complete repair/replacement for the warranty period. Written warranties addressing the LLDPE and TPO geomembrane material shall be furnished by the contractor and shall be made to Sarasota County.

SECTION 5.0
GEOTEXTILE

The following section outlines the CQA required for the installation of geotextiles. Non-woven cushion, drainage, and woven separator geotextiles will be used to protect the geomembrane and segregate the soil from drainage stone.

5.1 PRE-CONSTRUCTION

5.1.1 Manufacturer's Quality Control

Before scheduled manufacturing of the product, the Geosynthetics Manufacturer will provide the following:

- Manufacturer's description (cut sheet) of the proposed geotextiles documenting it will meet or exceed specified requirements.
- Written instructions for storage, handling, installation, seaming, and repair of the proposed geotextiles.

Before shipment of the geotextile, the CQA organization shall review all pre-construction submittals.

The CQA Inspector will take conformance samples for testing in accordance with this CQA Plan and the specification Section 02778, Geotextiles.

Table 5-1
Manufacturer's Quality Control Testing for Geotextiles

MATERIAL	TYPE OF TEST	STANDARD TEST METHOD	FREQUENCY OF TESTING
Non-Woven Drainage Geotextile	Mass Per Unit Area (oz/yd^2)	ASTM D5261	One per 90,000 ft^2
	Grab Tensile Strength (lbs)	ASTM D4632	One per 90,000 ft^2
	Puncture Strength (lbs)	ASTM D4833	One per 90,000 ft^2
	AOS, US sieve (mm)	ASTM D4751	One per 540,000 ft^2
	Permittivity, (sec^{-1})	ASTM D4491	One per 540,000 ft^2
	Flow Rate (gpm/ft^2)	ASTM D4491	One per 540,000 ft^2
	UV Degradation, % retained @ 500 hrs	ASTM 4355	1 per formulation
Woven Separator Geotextile	Flow Rate (gpm/ft^2)	ASTM D4491	One per 540,000 ft^2
	UV Degradation, % retained @ 500 HRS	ASTM D4355	1 per formulation
	Permittivity, (sec^{-1})	ASTM D4491	One per 540,000 ft^2
	Trapezoidal Tear, (lbs)	ASTM D4533	One per 90,000 ft^2
	Grab Tensile Strength, (lbs)	ASTM D4632	One per 90,000 ft^2
	Elongation, %	ASTM D4632	One per 90,000 ft^2
	AOS, U.S. Sieve (mm)	ASTM D4751	One per 540,000 ft^2
	Puncture Strength, (lbs)	ASTM D4833	One per 90,000 ft^2

5.1.2 CQA Conformance Testing

The CQA Organization will obtain geotextile conformance test samples of each type of material manufactured for the project. Samples will be obtained across the entire roll width and will be 3 feet long. Samplers will mark the manufacturer's roll identification number, as well as the machine direction, on the sample. Samplers will assign a conformance test number to the sample and mark the sample with that number. Each sample will be sent to the CQA Laboratory for conformance testing. The CQA Inspector will review test results and report any nonconformance to the CQA Engineer.

The following conformance tests will be performed on the geotextile at the frequencies indicated in the specifications:

Table 5- 2
CQA Conformance Testing for Geotextiles

MATERIAL	TYPE OF TEST	STANDARD TEST METHOD	FREQUENCY OF TESTING
Geotextile	Puncture Strength (1bs)	ASTM D4833	One per 90,000 ft^2
	Flow Rate (gpm/ft^2)	ASTM D4491	One per 540,000 ft^2
	AOS, US sieve (mm)	ASTM D4751	One per 540,000 ft^2
	Grab Tensile Strength (lbs)	ASTM D4632	One per 90,000 ft^2
	Mass per Unit Area (oz/yd^2)*	ASTM D5261	One per 90,000 ft^2

* Non-woven geotextile only

5.2 CONSTRUCTION

5.2.1 Delivery, Storage and Handling

During delivery of geotextiles the CQA Inspector will monitor for the following:

- Equipment used to unload the rolls will not damage the geotextile.
- Rolls are wrapped in impermeable and opaque protective covers.
- Care is used to unload the rolls.
- Documentation required by specification Section 02778, Geotextiles has been received.
- Each roll is marked or tagged with manufacturer's name, project identification, lot number, roll number, roll dimensions, and that this information is documented on a geosynthetic receipt form.
- Materials are stored in a location that is protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

Damaged rolls may be rejected. If rejected, verify that rejected material is removed from the site or stored at a location separate from accepted rolls. Geotextile rolls that do not have proper manufacturer's documentation must also be stored at a separate location until all documentation has been received and approved.

5.2.2 Geotextile Subsurface Preparation

Before geotextile installation, the CQA Inspector will document that the surface where the geotextile will be installed is acceptable and CQC and CQA documentation verifies that its installation meets specified requirements.

5.2.3 Geotextile Placement and Seaming

During geotextile placement and seaming operations, the CQA Inspector will monitor for the following:

- All defects and defect corrective actions are performed in accordance with specification Section 02778, Geotextiles.
- Equipment used to install the geotextile does not damage it during deployment.
- Crews working on the geotextile do not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.
- The geotextile is securely anchored to prevent movement by the wind.
- Adjacent panels are overlapped and seamed in accordance with specification Section 02778, Geotextiles.
- The geotextile is not exposed to direct sunlight for more than the 14 days in accordance with technical specification Section 02778, Geotextiles.
- Final geotextile surface is free of harmful foreign objects.

The CQA Inspector will inform both the CQA Engineer and Contractor if they observe any conditions that do not conform to the requirements of the CQA Plan conditions.

5.2.4 Geotextile Repairs

Where repairs are necessary, the CQA Inspector will monitor for the following:

- Place a patch of the same type of geotextile which extends a minimum of 24 inches beyond the edge of the damage or defect.
- Fasten patches continuously using a sewn seam or other approved method.
- Align machine direction of the patch with the machine direction of the geotextile being repaired.
- Replace geotextile which cannot be repaired.

SECTION 6.0
GEOCOMPOSITE

The following section outlines the CQA required for the installation of the single and double-sided geocomposite. The single sided geocomposite will be used as the drainage layer of the final cover system (top slope). The double sided geocomposite will be used as the drainage layer of the final cover system (north and east slopes).

6.1 PRECONSTRUCTION

All HDPE drainage composite shall be manufactured in accordance with specification Section 02777, Drainage Composite. The drainage composite manufacturer will provide the Contractor and the CQA Inspector with a written certification, signed by a responsible party, that the drainage composites actually delivered have properties which meet or exceed the guaranteed properties. The CQA Inspector will examine all manufacturer's certifications to ensure that the property values listed on the certifications meet or exceed the project specifications. Any deviations will be reported to the CQA Engineer.

6.1.1 Manufacturer's Quality Control

Before scheduled manufacturing of the product, the Geosynthetics Manufacturer will provide the CQA organization with the following items for review and testing:

- Manufacturer's description (cut sheet) of the proposed geocomposites documenting that it will meet or exceed specified requirements.
- Available historical data documenting that the proposed geocomposites will meet specified interface residual strength.
- Written instructions for storage, handling, installation, seaming, and repair of the proposed geocomposites.

Before shipment of the geocomposite, the CQA organization will review pre-construction submittals.

Table 6- 1
Manufacturer's Quality Control Testing for Geonet / Geocomposite

MATERIAL	TYPE OF TEST	STANDARD TEST METHOD	FREQUENCY OF TESTING
Geonet	Specific Gravity/Density (g/cm3) (min)	ASTM D 1505	One per 50,000 ft^2 and every resin lot
	Thickness (mil)	ASTM D 5199	One per 50,000 ft^2 and every resin lot
	Carbon Black Content (% Minimum)	ASTM D 1603	One per 50,000 ft^2 and every resin lot
	Tensile Strength (MD), (lb/in)	ASTM D 5035	One per 50,000 ft^2 and every resin lot
	Compression Strength (lb/ft^2)	ASTM D1621	One per 540,000 ft^2 and every resin lot

MATERIAL	TYPE OF TEST	STANDARD TEST METHOD	FREQUENCY OF TESTING
Geocomposite	Transmissivity (m^2/sec)	ASTM D4716	One per 540,000 ft^2
	Ply adhesion (lb/ft^2)	ASTM D7005	One per 50,000 ft^2

1. This is an index transmissivity value measured at stress = 500 psf; a gradient =0.1; time =15 minutes; and boundary conditions = plate/geocomposite/plate

6.1.2 CQA Conformance Testing

The CQA Organization will obtain geocomposite conformance test samples of each type of material manufactured for the project. Samples will be obtained across the entire roll width and will be 3 feet long. Samplers will mark the manufacturer's roll identification number, as well as the machine direction, on the sample. Samplers will assign a conformance test number to the sample and mark the sample with that number. Each sample will be sent to the CQA Laboratory for conformance testing in accordance with the project Specification Section 02777, Part 2.2.C. The CQA Inspector will review all test results and report any non-conformance to the CQA Engineer.

The following conformance tests will be performed on the geocomposite:

Table 6-2
CQA Conformance Testing for Geocomposite

MATERIAL	TYPE OF TEST	STANDARD TEST METHOD	FREQUENCY OF TESTING
Geocomposite	Transmissivity (m^2/s)*	ASTM D4715	One per 540,000 ft^2
	Ply Adhesion	ASTM D 7005	One per 50,000 ft^2
	Thickness (Geonet Core Only)	ASTM D5199	One per 50,000 ft^2
	Interface Friction	ASTM D5321	One per Project

NOTE: Geotextiles shall be tested in accordance with Specification Section 02778.
* See specifications for transmissivity testing criteria.

Laboratory interface friction tests shall be conducted in general accordance with ASTM D5321, on the following interfaces (double-sided geocomposite only):

- Textured LLDPE and geocomposite.
- Geocomposite and protective cover soil.

The CQA Laboratory will perform three (3) direct shear tests at the project specific effective normal stresses. These tests will be performed using the Contractor's proposed LLDPE and a sample of geocomposite obtained from the Geosynthetics Manufacturer following award of the construction contract to the selected Contractor. A sample of protective cover soil proposed for the project will also be obtained for testing. A minimum interface friction angle based on the landfill design will be required to maintain stability.

The Owner will pay for "Passing" tests. Costs of corrective action, costs of "Failing" tests and all associated costs of testing due to failing tests are the sole responsibility of the Contractor. Materials not meeting the required shear strength will not be approved for use on this project.

6.2 CONSTRUCTION

The following subsection describes the CQA inspection activities that are necessary during the geocomposite installation. Refer to the specification Section 02777, Drainage Composite, for project specific construction and test requirements.

The CQA Inspector shall observe the geocomposite placement to confirm that specifications Section 02777 is followed, including coverage of all specified areas and adequate material overlap or seaming

6.2.1 Delivery, Storage and Handling

During delivery of geocomposite the CQA Inspector will observe rolls for the following, and any deviation will be reported to the CQA Engineer:

- Equipment used to unload the rolls does not damage the material.
- Rolls are wrapped in impermeable and opaque protective covers.
- Care is used to unload the rolls.
- Documentation required by specification Section 02777, Drainage Composite has been received.
- The drainage composite manufacturer has identified all rolls of drainage composite in accordance with specification Section 02777, Drainage Composite.

Drainage composite cleanliness is essential to its performance; therefore, the shipping and storage or drainage composite must be in strict accordance with specification Section 02777, Drainage Composite. The CQA Inspector will verify the following and report any deviations to the CQA Engineer.

- Materials are stored in a location that will protect the rolls from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.
- Drainage composites are free of dirt and dust just before installation. If the drainage composites are judged dirty or dusty, they will be washed by the drainage composite installer prior to installation. Washing operations will be observed by the CQA Inspector and improper washing operations will be reported to the CQA Engineer.
- When several layers of drainage composite are stacked, care is taken to ensure that stacked drainage composites are placed in the same direction. A stacked drainage composite will never be laid in a perpendicular direction to the underlying drainage composite (unless otherwise specified by the CQA Engineer.)

Damaged rolls may be rejected. If rejected, it must be verified that rejected material is removed from the site or stored at a location separate from accepted rolls. Geocomposite rolls that do not have proper manufacturer's documentation must also be stored at a separate location until all documentation has been received and approved.

6.2.2 Geocomposite Subsurface Preparation

Before geocomposite installation, the CQA Inspector will observe for the following:

- Lines and grades for the composite liner subgrade have been verified by the Contractor.
- Geomembrane installation is complete.

6.2.3 Geocomposite Placement and Seaming

During deployment and seaming operations, the CQA Inspector will observe for the following:

- All defects and defect corrective actions (panel rejected, patch installed, etc.) are recorded, and corrective actions are performed in accordance with the specifications.
- Equipment used to install geocomposite does not damage it during deployment.
- Crews working on the geocomposite do not smoke, wear shoes that could damage the geocomposite, or engage in activities that could damage the geocomposite.
- The geocomposite is securely anchored to prevent movement by the wind.
- Adjacent panels are overlapped and connected in accordance with Specification Section 02777, Drainage Composite.
- The geotextile component is not exposed to direct sunlight for more than the number of days recommended by the manufacturer.

The CQA Inspector will inform both the CQA Engineer and Contractor if they observe any conditions that do not conform to the requirements of the CQA Plan.

6.2.4 Geocomposite Repairs

Repair any holes or tears in the drainage composite by placing a patch of drainage composite extending a minimum of 2 FT beyond the edges of the holes or tear. Use approved fasteners, spaced every 6 IN around the patch to fasten the patch to the original roll.

6.2.5 Placement of Soil Materials

All soil material placed over the drainage composite will be placed in accordance with specification Section 02777, Drainage Composite, so as to ensure the following:

- The drainage composite and underlying geomembrane are not damaged.
- Minimal slippage of the drainage composite on the underlying geomembrane occurs.
- No excess tensile stresses occur in the drainage composite.

The CQA Inspector will inform both the CQA Engineer and Contractor if they observe any conditions that do not conform to the requirements of the CQA Plan.

SECTION 7.0
CORRUGATED POLYETHYLENE PIPE AND FITTINGS
CONSTRUCTION QUALITY ASSURANCE

7.1 PRECONSTRUCTION

All Advanced Drainage Systems (ADS) corrugated pipe and fittings for stormwater drainage shall be produced in accordance with specification Section 15079, Pipe – Corrugated Polyethylene.

7.1.1 Manufacturer's Quality Control

7.1.1.1 Prior to Shipment

Prior to shipment, the Contractor will provide the CQA Engineer and the CQA Inspector with a quality control certification for each lot/batch of ADS material provided. The quality control certificate will be signed by a responsible party employed by the Manufacturer, such as the production manager. The quality control certificate will include:

- lot/batch number and identification; and
- sampling procedures and results of quality control tests.

The CQA Inspector will verify that the quality control certificates have been provided at the specified frequency for all lots/batches of pipe and that each certificate identifies the pipe lot/batch related to it; and review the quality control certificates and verify that the certified properties meet the requirements of specification Section 15079.

7.1.1.2 Prior to Installation

Prior to the installation of ADS corrugated pipes, the Manufacturer will provide to the Contractor and the CQA Inspector the following:

- a properties sheet including, at a minimum, all specified properties, measured using test methods indicated in specification Section 15079;
- a list of quantities and descriptions of materials other than the base resin which comprise the pipe;
- the sampling procedure and results of testing; and
- a certification by the manufacturer that values given in the properties sheet are minimum values and are guaranteed by the Manufacturer.

The CQA Inspector will review these documents and verify that:

- the property values certified by the Manufacturer meet all requirements of specification Section 15079; and
- the measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
- report any discrepancies with the above requirements to the CQA Engineer.

SECTION 8.0
SURVEYING

Surveying of lines and grades is conducted on an ongoing basis during construction of the final and temporary final cover system. Close construction quality control (CQC) of the surveying is absolutely essential to ensure that slopes are properly constructed. The surveying conducted at the site shall be performed by the Contractor.

8.1 SURVEY CONTROL

Permanent benchmarks and baseline control points are to be established for the site at locations convenient for daily tie-in. The vertical and horizontal controls for this benchmark will be established within normal land surveying standards.

8.2 SURVEYING PERSONNEL

The Contractor's survey crew will consist of a Senior Surveyor, and as many Surveying CQC Monitors as are required to satisfactorily undertake the requirements for the work. All Surveying CQC personnel will be experienced in the provision of these services, including detailed, accurate documentation.

All surveying will be performed under the direct supervision of a Registered Professional Engineer (PE) or Licensed Land Surveyor (PLS) licensed in the state in which the project is located. The Licensed Land Surveyor may be the Senior Surveyor.

8.3 PRECISION AND ACCURACY

A wide variety of survey equipment is available to meet the requirements of this project. The survey instruments used for this work should be sufficiently precise and accurate to meet the needs of the project. All survey instruments should be capable of reading to a precision of 0.01 foot and with a setting accuracy of 20 seconds. (5.6×10^{-3} degrees).

8.4 LINES AND GRADES

The following surfaces shall be surveyed to verify the lines and grades achieved during construction. The survey should at least include (as deemed appropriate by the CQA Engineer and CQA Inspector):

- One or more construction baselines.
- The edges of all surface breaks (ex. toes, crests, ridges and valleys).
- Surface of the intermediate cover.
- Surface of the final cover.
- All structures including gas wells.
- Inverts of drainage pipe inlets and outlets.
- Top/toe of all berms, roads, and channels.
- Location of edge of liner, anchor trenches tie-in seam to adjacent existing liner system (as applicable).

- Major patches of LLDPE liner.

Laser planes are highly recommended for achieving the correct lines and grades during construction of each surface.

8.5 FREQUENCY AND SPACING

All surveying will be carried out immediately upon completion of a given installation to facilitate progress and avoid delaying commencement of the next installation. In addition, spot checks during construction, as determined by the Senior Surveyor, CQA Inspector, or CQA Engineer, may be necessary to assist the Contractor in complying with the required grades.

The following spacings and locations will be provided by the CQC surveyor, as a minimum, for survey points:

- Surfaces with slopes less than 10 percent will be surveyed on a square grid not wider than 100 feet.
- On slopes greater than 10 percent, a square grid not wider than 100 feet will be used, but, in any case, a line of survey points at the crest, midpoint, and toe of the slope will be taken.
- A line of survey points no farther than 100 feet apart will be taken along any slope break (this will include the inside edge and outside edge of any bench on a slope).
- A line of survey points not farther than 50 feet apart will be taken for all piping used for downdrains, in particular, at the end points.
- At a minimum, every 100 feet along the perimeter of the final cover liner system.

8.6 THICKNESS MEASUREMENTS

The CQC surveyor as a representative of the Contractor shall obtain thickness measurements of the intermediate cover and final cover at a maximum 100-foot grid points and at all grade break lines prior to placement of the geomembrane liner. The procedure for obtaining thickness measurements of the intermediate cover and final cover shall be agreed to by the CQA Inspector and CQA Engineer prior to construction. The CQC Surveyor shall review the survey information with the Contractor to ensure that the survey demonstrates compliance with the Project Plans and Specifications. The Contractor is responsible for identifying and reporting to the CQA Inspector any areas of non-compliance evidenced by the survey, and for repairing such areas. The CQA Inspector and Contractor shall review the elevation measurements of the intermediate cover prior to placement of the geomembrane liner.

8.7 TOLERANCES

The following are maximum tolerances for survey points:

- On surfaces, the maximum tolerances shall be 0.1 foot. This tolerance must be set to the record elevation of the surface below it and not the design elevation.
- On piping for downdrain lines, the maximum tolerance shall be 0.1 foot. This tolerance must be set to the record elevation of the surface below it and not the design elevation.
- For thickness verifications, no minor tolerances are acceptable.

8.8 DOCUMENTATION

All field survey notes will be retained by the Senior Surveyor. The results from the field surveys will be documented on a set of survey record (as-built) drawings by the Contractor for submittal to the CQA Inspector. The Contractor shall certify to the CQA Inspector and CQA Engineer that the results of the survey demonstrates compliance with the Contract Documents. Sealed surveys depicting the information gathered in Paragraph 8.5 shall be supplied to the CQA Engineer and CQA Inspector in sufficient quantities. The surveys shall depict the information in a topographic format and illustrate actual data points. For thickness verification a table shall be compiled by the CQC surveyor or contractor containing the following information for each point.

- Top of intermediate cover elevation.
- Intermediate cover thickness.
- Top of protective cover elevation.
- Protective cover thickness.

Any deviations in elevation or thickness outside the tolerances allowed by specification shall be corrected.

SECTION 9.0
REPORTING REQUIREMENTS AND DOCUMENTATION

9.1 PROJECT MEETINGS

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

- Pre-construction CQA meeting
- Problems or Work deficiency meetings

9.1.1 Preconstruction CQA Meeting

This meeting shall be attended by the Owner, Design Engineer, CQA Engineer, CQA Inspector, and Contractor. The topics should include but are not limited to:

- Providing each organization with all relevant CQA documents and supporting information.
- Familiarizing each organization with the site-specific CQA Plan and its role relative to the design criteria.
- Determining any changes to the CQA Plan that are needed to ensure that the facility will be constructed to meet or exceed the specified design.
- Reviewing the responsibilities of each organization.
- Reviewing lines of authority and communication for each organization.
- Discussing the established procedures or protocol for observations and tests including sampling strategies.
- Discussing the established procedures or protocol for handling construction deficiencies, repairs, and retesting.
- Reviewing methods for documenting and reporting inspection data.
- Reviewing methods for distributing and storing documents and reports.
- Reviewing work area security and safety protocol.
- Discussing procedures for the location and protection of construction materials and for the prevention of damage of the materials from inclement weather or other adverse events.
- Conducting a site walk-around to review construction material and inspection equipment storage locations.

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

9.1.2 Weekly Progress Meetings

A progress meeting shall be held weekly at the work area at a time determined at the pre-construction meeting. The frequency of progress meetings may be reduced as the project proceeds if agreed to by the Owner, Contractor, and CQA Engineer. At a minimum, the meeting should be attended by the CQA Engineer, CQA Inspector, Contractor and the Owner.

The purpose of the meeting is to:

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

This meeting shall be documented by the CQA Engineer.

9.1.3 Problem or Work Deficiency Meetings

A special meeting shall be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting shall be attended by the Design Engineer, Owner, Contractor, CQA Engineer, and CQA Inspector. The purpose of the meeting is to define and resolve a problem or recurring work deficiency in the following manner:

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

The meeting shall be documented by the CQA Engineer and transmitted to the Owner, Contractor, CQA Inspector and Design Engineer, if applicable.

9.2 DOCUMENTATION

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

9.2.1 Daily Summary Report

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

- Unique identifying sheet number for cross-referencing and document control.
- Date, project name, location, and other identification.
- Data on weather conditions.
- Reports on any meetings held and their results.
- Unit processes, and locations, of construction under way during the timeframe of the daily summary report.
- Equipment and personnel being worked in each unit process, including subcontractors.
- Descriptions of areas or units of work being inspected and documented.
- Description of off-site materials received, including any quality verification (vendor certification) documentation.

- Calibrations, or recalibrations, of test equipment, including actions taken as a result of recalibration.
- Decisions made regarding approval of units of material or of work (blocks), and/or corrective actions to be taken in instances of substandard quality.
- Unique identifying sheet numbers of inspection data sheets and/or problem reporting and corrective measures reports used to substantiate the decisions described in the preceding item.
- Supporting inspection data sheets.
- Signature of the CQA Inspector.

9.2.2 Inspection Data Sheets and Photographs

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

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

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

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

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

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

These photographs will serve as a pictorial record of work progress, problems, and corrective measures. They should be kept in a permanent protective file in the order in which they were taken.

9.2.3 Problem Identification and Corrective Measures Reports

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

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

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

9.2.4 Acceptance of Completed Components

All daily inspection summary reports, inspection data sheets, and problem identification and corrective measures reports, shall be reviewed by the CQA Engineer.

9.2.5 Final Documentation

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

APPENDIX D
TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

SECTION 01560

ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Addresses:
   1. Minimizing the pollution of air, water, or land; control of noise, the disposal of solid waste materials, and protection of deposits of historical or archaeological interest.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Employ and utilize environmental protection methods, obtain all necessary permits, and fully observe all local, state, and federal regulations

B. Land Protection:
   1. Except for any work or storage area and access routes specifically assigned for the use of the Contractor, the land areas outside the limits of construction shall be preserved in their present condition. Contractor shall confine his construction activities to areas defined for work within the Contract Documents.
   2. Manage and control all borrow areas, work or storage areas, access routes and embankments to prevent sediment from entering nearby water or land adjacent to the work site.
   3. Restore all disturbed areas including borrow and haul areas and establish permanent type of locally adaptable vegetative cover.
   4. Unless earthwork is immediately paved or surfaced, protect all side slopes and backslopes immediately upon completion of final grading.
   5. Plan and execute earthwork in a manner to minimize duration of exposure of unprotected soils.
   6. Except for areas designated by the Contract Documents to be cleared and grubbed, the Contractor shall not deface, injure or destroy trees and vegetation, nor remove, cut, or disturb them without approval of the Engineer. Any damage caused by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the Contractor's expense.

C. Surface Water Protection:
   1. Utilize, as necessary, erosion control methods to protect side and backslopes, and minimize the discharge of sediment to the surface water leaving the construction site as soon as rough grading is complete. These controls shall be maintained until the site is ready for final grading and landscaping or until they are no longer warranted and concurrence is received from the Engineer. Physically retard the rate and volume of run-on and runoff by:
      a. Implementing structural practices such as diversion swales, terraces, straw bales, silt fences, berms, storm drain inlet protection, rocked outlet protection, sediment traps and temporary basins.
      b. Implementing vegetative practices such as temporary seeding, permanent seeding, mulching, sod stabilization, vegetative buffers, hydroseeding, anchored erosion control blankets, sodding, vegetated swales or a combination of these methods.
      c. Providing Construction sites with graveled or rocked access entrance and exit drives and parking areas to reduce the tracking of sediment onto public or private roads.

2. Discharges from the construction site shall not contain pollutants at concentrations that produce objectionable films, colors, turbidity, deposits or noxious odors in the receiving stream or waterway.

D. Solid Waste Disposal:
1. Collect solid waste on a daily basis.
2. Provide disposal of degradable solid waste to an approved solid waste disposal site.
3. Provide disposal of nondegradable solid waste to an approved solid waste disposal site or in an alternate manner approved by Engineer and regulatory agencies.
4. No building material wastes or unused building materials shall be buried, dumped, or disposed of on the site.

E. Fuel and Chemical Handling:
1. Store and dispose of chemical wastes in a manner approved by regulatory agencies.
2. Take special measures to prevent chemicals, fuels, oils, greases, herbicides, and insecticides from entering drainage ways.
3. Do not allow water used in onsite material processing, concrete curing, cleanup, and other waste waters to enter a drainage way(s) or stream.
4. The Contractor shall provide containment around fueling and chemical storage areas to ensure that spills in these areas do not reach waters of the state.

F. Control of Dust:
1. The control of dust shall mean that no construction activity shall take place without applying all such reasonable measures as may be required to prevent particulate matter from becoming airborne so that it remains visible beyond the limits of construction. Reasonable measures may include paving, frequent road cleaning, planting vegetative groundcover, application of water or application of chemical dust suppressants. The use of chemical agents such as calcium chloride must be approved by the State of Florida DOT.
2. Utilize methods and practices of construction to eliminate dust in full observance of agency regulations.
3. The Engineer will determine the effectiveness of the dust control program and may request the Contractor to provide additional measures, at no additional cost to Owner.

G. Burning:
1. Do not burn material on the site. If the Contractor elects to dispose of waste materials by burning, make arrangements for an off-site burning area and conform to all agency regulations.

H. Control of Noise:
1. Control noise by fitting equipment with appropriate mufflers.

I. Completion of Work:
1. Upon completion of work, leave area in a clean, natural looking condition.
2. Ensure all signs of temporary construction and activities incidental to construction of required permanent work are removed.

J. Historical Protection:
1. If during the course of construction, evidence of deposits of historical or archaeological interests is found, cease work affecting find and notify Engineer. Do not disturb deposits until written notice from Engineer is given to proceed.
2. The Contractor will be compensated for lost time or changes in construction to avoid the find based upon normal change order procedures.

END OF SECTION

SECTION 02200
EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Earthwork, including intermediate cover and protective cover soil layers of the final cover system and anchor trench backfill material for exposed geomembrane closure area.

B. Related Sections include but are not necessarily limited to:
   1. Section 02260 – Topsoiling and Finished Grading

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D422, Method for particle size analysis of soil
      b. D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
      c. D2487, Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
      d. D2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
      e. D2937, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
      f. D3017, Standard Test Method for Water Content of Soil and Rock in Place by Neclear Methods (Shallow Depth)
      g. D6938, Standard Test Method for in-place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods.
   2. Florida Erosion and Sediment Control Planning and Design Manual, current edition.
   3. Florida Department of Transportation Standard Specification for Road and Bridge Construction, current edition.
   4. Construction Quality Assurance (CQA) Plan.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Certifications.
   3. Test reports:
      a. Soils inspection and testing results.

B. Samples:
   1. Submit samples and source of all soil materials proposed for use.
   2. Submit soil samples directly to CQA Laboratory with notification to the Engineer.

1.4 SOILS/GEOTECHNICAL

A. The Owner will provide for the on-site services of a CQA Inspector to selectively test materials and monitor compliance with the requirements of these Specifications.

B. The Contractor will afford these representatives access to the job site for the performance of their duties as described in the Contract Documents.

C. General Duties and Responsibilities of the Owner's CQA Inspector: Under the direction of a qualified registered engineer or geologist:

1. Perform stockpile and in-place testing of all soil material used in the work in conformance with these Specifications and the CQA Plan.
2. Inspect existing intermediate cover and excavations and evaluate/determine suitability of materials encountered. Determine extent of any overexcavation required to remove unsuitable materials under areas of construction.
3. Document placement of fill materials and perform testing to confirm compliance with these Specifications.
4. Evaluate the suitability of existing on-site materials for use in construction of embankments and fills.
5. Measure quantity of unsuitable materials under contract provisions for authorized overexcavation and backfill.
6. Review construction operations and monitor for compliance with Contract Documents.

D. Available Soil Information: Where provided, data on soil quantities or conditions is not intended as representations or warranties of the thickness of such conditions between borings or indicated sampling locations. It shall be expressly understood that neither the Owner nor the Engineer will be responsible for any interpretation or conclusion drawn therefrom by the Contractor. Data is made available for the convenience of the Contractor.

E. Additional or supplementary soil borings and/or test pits may be made by the Contractor at no additional cost to the Owner. The Contractor shall provide the Owner with a copy of any data obtained/developed during such work. Such additional work shall be performed in a timely manner in accordance with and not impacting or changing the project schedule set forth in the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All soils: Should be free of deleterious material (sticks, roots, waste, etc.) and rock fragments, boulders, or cobbles greater than 3 inches in size.

B. Intermediate cover and protective cover soils shall be classified as SP, SW, SM, SC, SP-SM, or SP-SC materials in accordance with ASTM D2487.

C. The Contractor shall conduct his own quantity and quality investigations and testing to determine availability and suitability of all borrow materials, as allowed by the Owner.

D. All earth materials proposed for use in the Work shall be adequately characterized prior to the Work by the CQA Inspector.

E. The Contractor shall submit source test data for all borrow soils to the CQA Inspector for approval a minimum of 48 hours prior to its intended use.

F. Structural fill will be used to construct berms and anchor trench backfill for the EGC. The soil will be classified as ML, SM, SW, SC, SP-SM, SP-SC or CL in accordance with USCS and will have no particles or soil clods larger than 3 in. (75 mm). The minimum dry density of the structural fill material in the anchor trench will be 102.5 lb/cf. Any deviation from the minimum dry density may be accommodated with a revised anchor trench design that provides equivalent design performance. These adjustments shall be communicated clearly in the final CQA report that is submitted to DEP.

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect existing surface and subsurface features on-site and adjacent to site as follows:
   1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
   2. Protect and maintain bench marks, monitoring wells, existing structures, monuments or other established reference points and property corners.
      a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
   3. Verify location of utilities.
      a. Omission or inclusion of utility items does not constitute non-existence or definite location.
      b. Secure and examine local utility records for location data.
      c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
      d. Repair damages to utility items at own expense.
      e. In case of damage, notify Engineer at once so required protective measures may be taken.
   4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
      a. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
      b. All repairs to be made and paid for by Contractor.
   5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
   6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
   7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.
   8. Conduct operation with minimum interference to daily landfill operations.

B. Construct erosion and sedimentation controls prior to beginning earthwork.

C. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed[11].

D. Dispose of waste materials, legally, off site.
   1. Burning, as a means of waste disposal, is not permitted.

E. Waste excavated for construction and installation of final cover, EGC anchor trenches and temporary final cover shall be disposed of by the Contractor at the active face of the landfill. The tipping fee for this relocated waste will be waived by the County. Contractor will be compensated for waste excavation and relocation in accordance with the Bid Form.

F. Contractor shall be responsible for complete repair of any damage to any and all components of existing gas collection system caused by his actions during performance of landfill closure at no expense to Owner. Modification, relocations (horizontally and vertically), or other work to gas collection system required, needed, or resulting from grade changes or other designed construction resulting from the landfill closure will be provided by others. Contractor shall notify Owner of any modifications to the gas collection system required for the performance of his work sufficiently ahead of time to allow the modifications to take place without impacting the construction schedule.

G. The protective cover material is placed directly over the geocomposite, thus extreme caution shall be exercised by the Contractor to prevent damage to the liner system.

H. Placement of the protective cover material shall be conducted only when the CQA Inspector or his representative is informed in advanced of the intent to perform this work and is present at the site to observe the placement.

I. During the placement of protective cover soil, no construction equipment shall be allowed directly on the geomembrane or drainage composite, except low ground pressure equipment necessary for the deployment and installation of geomembrane liner. Any damage to these components shall be repaired immediately in accordance with the respective specifications. A 4-foot thick traffic surface consisting of protective cover material shall be constructed to support haul trucks traveling over the liner.

J. Stockpiles of protective cover and topsoil shall be deposited in the closure area without vehicles traveling on the drainage composite. Soil shall then be pushed over the uncovered areas of the disposal unit with bulldozers. Advancement of soils over the liner system shall be achieved by pushing a minimum 12-inch thick loose lift ahead of the dozer blade.

K. Only low ground pressure dozers (10 psi or less track pressure) shall be used for spreading and grading of the protective cover and topsoil.

L. The protective cover and topsoil shall be placed on slopes starting at the toe of the slope and spreading toward the top of the slope.

M. Protective cover material shall only be spread when the liner is laying evenly over the intermediate cover of the landfill. Material shall not be spread over "standing waves" in the liner that form during periods of high temperature and direct sunlight. A standing wave is defined as a ripple in the liner in which the height of the ripple (as measured from the intermediate cover surface) exceeds the width of the ripple. If standing waves are occurring during peak temperature hours, the spreading operation shall be limited to mornings (before 10:00 am) and evenings (after 6:00 pm) or hours agreed upon by the Engineer and Contractor.

N. Any excavation in the protective cover trench will be performed with a backhoe bucket equipped with a protective sleeve over the bucket teeth or by another method approved by the Engineer. The Contractor shall exercise extreme care not to disturb or damage the drainage composite or liner. Any liner or drainage composite damaged shall be immediately repaired at no cost to the Owner and as directed by the Engineer.

3.2 SITE EXCAVATION AND GRADING

A. The work includes all operations in connection with excavation, borrow, construction of intermediate cover and protective cover, rough grading, and disposal of excess materials in connection with the preparation of the site(s) for construction of the proposed landfill closure.

B. Excavation and Grading: Perform as required by the Contract Drawings.
   1. Contract Drawings may indicate both existing grade and finished grade required for construction of Project.
      a. Stake all units, structures, piping, roads, parking areas and walks and establish their elevations.
      b. Perform other layout work required.
      c. Replace permanent survey markers to original location if disturbed or destroyed.
   2. Preparation of ground surface for additional intermediate cover:
      a. Before additional intermediate cover is placed, remove vegetation and unsuitable soils and scarify existing intermediate cover to a minimum depth of 6 IN in all proposed temporary final cover and final cover areas.
   3. Protection of finish grade:
      a. During construction, shape and drain intermediate cover, protective cover, berms and excavations.
      b. Maintain ditches and drains to provide drainage at all times.
      c. Protect graded areas against action of elements prior to acceptance of work.
      d. Reestablish grade where settlement or erosion occurs.

C. Borrow:
1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.
2. Include cost of excavation and transportation of all borrow material in original Bid.
3. Fill material to be approved by CQA Inspector prior to placement.
4. Obtain borrow soil only from the borrow area designated by the Owner. Do not excavate beyond permitted grades of borrow area. Contractor is responsible for maintaining drainage within the portions of the borrow area he is working in.

D. Construct intermediate cover, protective cover, access road, and berms as required by the Contract Drawings:
1. Construct access road and berms at locations and to lines of grade indicated.
   a. Completed fill shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.
2. Construct intermediate cover and protective cover to minimum thicknesses shown on the Drawings measured perpendicular to the slope. Grade to smooth true lines approved by Engineer with no soft spots or uncompacted areas. Top of final cover elevations shall not exceed the design elevations shown on the Drawings but may be lower than the design elevations as long as minimum thicknesses and minimum/maximum slopes are maintained.
3. Provide approved fill material:
   a. Ensure that stones larger than 3 IN are not placed in upper 6 IN of intermediate cover, protective cover, or berms.
   b. Do not place material in layers greater than 12 IN loose thickness.
   c. Place layers horizontally and compact each layer prior to placing additional fill.
   d. Lift thickness shall be at the discretion of the CQA Inspector.
4. Compact by sheepsfoot, pneumatic rollers, vibrators, or by other equipment as required toobtain specified density.
   a. Control moisture for each layer necessary to meet requirements of compaction.
5. The structural fill in the EGC anchor trenches and berms shall be placed and compacted in lifts to the lines and grades shown on the drawings. The compacted thickness of each lift shall be 6 IN. maximum (150 mm). Each lift shall be compacted to at least 95 percent of the standard proctor maximum dry density (ASTM D698) within ±4% of optimum moisture content. Each layer surface shall be scarified before placing subsequent lifts and compaction.

E. Upon reaching the required compacted thickness of intermediate cover, proofroll intermediate cover soils and obtain the CQA Inspector 's review/recommendation and approval. If unsuitable materials are encountered, repair as directed and approved by the CQA Inspector to remove unsuitable materials. Excavation of 1 CY or greater should be preapproved by the CQA Inspector.

F. Proofrolling shall be conducted with a 10 ton drum roller approved by the CQA Inspector. An alternate approved by the CQA Inspector may be used in constricted areas.

G. Where intermediate cover materials are determined to be unsuitable, such materials shall be removed to the lengths, widths, and depths directed by the CQA Inspector, and backfilled with suitable material unless further excavation or earthwork is required. Additional payment will be made for excavation and replacement of intermediate cover in accordance with the Contract Documents except for material previously placed by Contractor that did not meet project specifications. The final cover and temporary final cover areas to receive additional intermediate cover shall be free of all vegetation, sticks, roots, rocks, and debris greater than 3 inches in size.

H. Dewatering (as required): Provide and maintain dewatering of all surface water and/or groundwater as required for excavation. Where groundwater is or is expected to be encountered during borrow area excavation, install a dewatering system to prevent softening and disturbance of excavation, allow borrow material to be excavated in the dry, and maintain a stable excavation. Soils and hydrogeologic information may be reviewed before beginning excavation to determine where goundwater is likely to be encountered during excavation. Employ a dewatering specialist for selecting/designing, monitoring, and operating the dewatering system as needed. Keep dewatering system in operation until borrow activities are completed. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction as approved by the Owner. Install groundwater monitoring points as necessary. Shut off dewatering system at such a rate so as to prevent a quick upsurge of water that might weaken the subgrade. Installation, start-up, monitoring maintenance, and shut-off of the dewatering system shall be at no additional cost to the Owner.

I. Do not place fill when the underlying material is frozen, wet, loose, or soft.

J. Moisture control:
  1. Moisture content of materials prior to, and during compaction, shall be uniform throughout each layer of material.
  2. Granular materials shall be thoroughly wetted during or immediately prior to compaction.
  3. Supplementary water shall be added as required to materials by sprinkling and mixing uniformly throughout layer.
  4. Materials too wet for placing shall be temporarily spread or aerated until moisture content is acceptable. If these materials cannot be processed in time to use, the Contractor shall find alternatives acceptable to the CQA Inspector.

3.3 ROCK EXCAVATION – NOT APPLICABLE

3.4 USE OF EXPLOSIVES

A. Blasting with any type of explosive is prohibited.

3.5 FIELD QUALITY CONTROL

A. Moisture density relations, to be established by the CQA Inspector are required for all materials to be compacted.

B. Extent of compaction testing will be as necessary to assure compliance with Specifications.

C. Give minimum of 24 HR advance notice to CQA Inspector when ready for compaction or subgrade testing and inspection.

D. Should any compaction density test, subgrade inspection, or other QA/QC problem be identified, the affected area shall be delineated and reworked by Contractor as necessary to achieve passing criteria.

E. Contractor shall pay for all costs associated with corrective work and retesting resulting from failed tests.

F. Proofroll intermediate coversoils after reaching specified thicknesses and/or grades prior to geomembrane deployment by making 2 passes parallel to the slope or as directed by CQA Inspector. The proof-rolling shall be performed under the observation of the CQA Inspector. Intermediate and protective cover shall be compacted in accordance with Section 3.6.

3.6 COMPACTION DENSITY REQUIREMENTS

A. Obtain approval from CQA Inspector with regard to suitability of soils and acceptable subgrade prior to subsequent operations.

B. Provide dewatering system necessary to successfully complete compaction and construction requirements.

C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by CQA Inspector.

D. Stabilize subgrade with approved materials as directed by CQA Inspector.

E. Intermediate and protective cover soils shall be compacted to a target density as determined from a test pad performed by the Contractor on the landfill slope using equipment Contractor intends to use for final cover construction. The soils shall be wetted or dried as necessary so that the moisture content during compaction is near the optimum moisture content to consistently achieve target compaction, or as otherwise determined by Engineer.

F. Perform testing at a minimum frequency as shown below:

TEST DESCRPTION	TEST FREQUENCY
1. Additional Intermediate Cover, Protective Cover, and Berm Fill	
Density, Nuclear Method	1 per 1,500 yd3, ASTM D2922
Moisture Content, Nuclear Method	1 per 1,500 yd^3, ASTM D3017
Sand Cone or Drive Cylinder Method	1 per 20 nuclear tests, ASTM D2937
Oven Moisture Content Verification	1 per 20 nuclear tests, ASTM D2216
Moisture Density Relations	1 per 20,000 yd^3, ASTM D698*
Sieve Analysis	1 per 20,000 yd^3, ASTM D422*
2. Structural Fill for EGC Anchor Trenches	
In-Situ Density, Nuclear Method	1 per 250 ft/lift, ASTM D2922
In-Situ Moisture Content, Nuclear Method	1 per 250 ft/lift, ASTM D3017
Oven Moisture Content Verification	1 per 2,000 yd^3, ASTM D2216
Standard Proctor of borrow soil	1 per 5,000 yd^3, ASTM D698*
Sieve Analysis of borrow soil	1 per 2,000 yd^3, ASTM D422*
Atterberg Limits of borrow soil	1 per 5,000 yd^3, ASTM D4318*
Classification of borrow soil	1 per 5,000 yd^3, ASTM D2487*

*Increase frequency as needed to ensure each soil type is tested.

3.7 FINISH GRADING

A. Grade all areas disturbed by construction operations.

B. Grade to smooth, uniformly sloping surfaces to existing elevations or to finish grades shown on drawings or as approved by Engineer.

C. Grading shall maintain minimum required protective cover and topsoil thicknesses but not exceed the maximum top of final cover elevations shown on the Drawings.

D. Evenly slope finished grade to drainage swales, terraces, and downdrain inlets as shown on drawings to provide drainage.

E. Ensure a surface free of debris, roots, or angular stones larger than 1/2 IN.

F. Ensure rutting or raveling is not caused by installation equipment or weather.

3.8 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES– NOT APPLICABLE

3.9 SPECIAL REQUIREMENTS

A. Erosion Control:

1. Conduct work to minimize erosion of site.
2. Construct temporary ditch blocks in perimeter drainage channel of landfill and install turbidity curtain in Pond No. 1 to settle and detain eroded material.
3. Remove eroded material washed off site.
4. Clean streets daily of any spillage of dirt, rocks or debris from equipment entering or leaving site.

B. Provide as built survey of top of intermediate cover prior to geomembrane installation to verify the required thickness of intermediate cover is installed. Depth thickness determinations shall be obtained on a maximum 100 ft x 100 ft grid pattern. Depth verifications may be made by survey, test pits, temporary depth markers, or probes. Additional intermediate cover shall be placed in areas where insufficient depth is determined prior to geomembrane deployment in that area. Temporary depth markers, if used, shall be removed prior to installing geomembrane. Survey shall be sealed by a professional land surveyor.
   1. Provide as built survey of top of final cover (i.e. top of topsoil layer) prior to sodding to verify the required thickness of protective cover and topsoil combined is installed. Depth thickness determinations shall be obtained on a maximum 100 ft x 100 ft grid pattern. Depth verifications may be made by survey, test pits, or temporary depth markers with careful attention to avoid damage to the underlying geosynthetics. Additional protective cover and/or topsoil, as appropriate, shall be placed in areas where insufficient depth is determined prior to laying sod in that area. Temporary depth markers, if used, shall be removed prior to installing sod. Survey shall be sealed by a professional land surveyor.

3.10 REPAIRS AND RETESTING

At locations where the field testing indicates densities below the requirements of the project specifications, the failing area shall be reworked. For the structural fill soil where the field testing indicates the dry density is below the requirements, the area shall be scarified, moisture-conditioned, and recompacted.

The contractor shall correct the deficiency to the satisfaction of the CQA officer. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQA officer will develop and present to the Engineer and/or project manager suggested solutions for approval.

All retests recommended by the CQA officer must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the deficiency.

The CQA officer will also verify that installation requirements are met and that submittals are provided.

END OF SECTION

SECTION 02260

TOPSOILING AND FINISHED GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Topsoiling and finished grading.

B. Related Sections include but are not necessarily limited to:
   1. Section 02200 - Earthwork.
   2. Section 02270 - Soil Erosion and Sediment Control.
   3. Section 02485 - Sodding.
   4. Section 02486 – Hydroseeding.

C. Location of Work: All areas within limits of grading unless otherwise shown on Drawings and all vegetated areas outside limits of grading which are disturbed in the course of the work and require the reestablishment of vegetation..

1.2 PROJECTCONDITIONS

A. Verify amount of topsoil available in designated stockpiles and borrow area and determine amount of additional topsoil, if necessary, to complete work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil:
   1. Original surface soil typical of the area.
   2. Capable of supporting native plant growth.

2.2 TOLERANCES

A. Provide minimum of 6 inches (compacted) of topsoil. Final topsoil elevations shall not exceed final buildout elevations on Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Correct, adjust and/or repair rough graded areas.
   1. Cut off mounds and ridges.
   2. Fill gullies and depressions.
   3. Perform other necessary repairs.
   4. Ensure underlying intermediate cover and protective cover minimum thicknesses are achieved and that all underlying materials have been tested and meet Specifications.

B. Loosen surface to depth of 2 IN, minimum.

C. Remove all stones and debris over 2 IN in any dimension.

3.2 PLACING TOPSOIL

A. Do not place when subgrade is wet or frozen enough to cause clodding.

B. Spread to compacted depth of 6 IN for all areas where required

C. Do not over compact topsoil. Compaction of topsoil shall only be performed with dozer tracks. Rollers and compactors will not be allowed.

D. If topsoil stockpiled is less than amount required for work, furnish additional topsoil in accordance with Bid Form.

E. Provide finished surface free of stones, sticks, or other material 1 IN or more in any dimension and suitable for the installation of sod.

F. Provide finished surface smooth and true to required grades.

G. Restore stockpile area to condition of rest of finished work.

3.3 ACCEPTANCE

A. Upon completion of topsoiling, perform depth survey as required in Section 02200.

B. Make test holes where directed to verify proper placement and thickness of topsoil.

END OF SECTION

SECTION 02270
SOIL EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Soil erosion and sediment control.

B. Related Sections include but are not necessarily limited to:
   1. Section 02200 - Earthwork.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Florida Erosion and Sediment Control Planning Handbook, or current edition.
   2. Florida Department of Transportation Standard Specifications for Roads and Structures Construction, Latest edition.

1.3 SITE CONDITIONS

A. The Owner has installed sediment control features for their current operations.

B. The Contractor may use these existing features with the Owner's prior approval, provided the Contractor maintains said features.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Stone: Manufacturer's certification that materials supplied meet project requirements.
   2. Silt Fence: Product information demonstrating materials supplied meet project requirements including installation instructions.
   3. Turbidity Curtain: Product information demonstrating materials supplied meet project requirements including installation instructions and layout diagrams.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stone for temporary ditch blocks and construction entrances constructed as per the Plans/Drawings.

B. Temporary Grass Seed.

C. Silt Fence: Premanufactured or constructed on site as per Plans/Drawings.

D. Turbidity Curtains: pre-manufactured and installed as per the Plans/Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to Disturbance:
   1. Install silt fence, ditches, channels, ditch blocks, temporary construction entrances, and turbidity curtains.
   2. Refer to the construction sequence on the plans for further detail.

3.2 DURING CONSTRUCTION PERIOD

A. Maintain silt fence, ditches, channels, ditch blocks, temporary construction entrances, and turbidity curtains:
   1. Inspect regularly especially after rainstorms.
   2. Repair or replace damaged or missing items.

B. After rough grading, sow temporary grass cover and mulch over all exposed earth areas not draining into sediment basin or trap.

C. Provide necessary swales, dikes and temporary culverts to control erosion. Contractor shall provide all erosion protection measures at no additional cost to the Owner to prevent off-site sediment/erosion. Although there are stormwater ponds on-site, the Contractor shall take all reasonable precautions to reduce sediment transport to the ponds.

D. Do not disturb existing vegetation (grass and trees) to the extent possible.

E. Excavate sediment out of basins and traps when capacity has been reduced by 40 percent.
   1. Remove sediment from silt fence to prevent overtopping.

F. Topsoil and Fine Grade Slopes and Swales, Etc.:
   1. Seed and mulch or sod as soon as areas become ready.

G. The erosion control features shown on the plans are performance based. If the feature does not adequately control erosion and sediment control to the satisfaction of the project manager, the contractor will be required to install additional erosion and sediment control features. The project manager will work with the contractor to determine the extent of the additional measures.

H. After fine grading, sod all areas receiving final cover.

I. Remove accumulated mud and soil from roadways on a daily basis.

3.3 NEAR COMPLETION OF CONSTRUCTION

A. Removed accumulated sediment from erosion and sediment control devises.

B. Eliminate temporary basins, dikes, traps, turbidity curtain, etc.

C. Grade to finished or existing grades.

D. Fine grade all remaining earth areas, then seed and mulch or sod in accordance with the Plans/Drawings.

END OF SECTION

SECTION 02485
SODDING

PART 1 - GENERAL

1.1 WORK INCLUDED

This section covers the work necessary to provide for sodding.

1.2 RELATED WORK

The General and Supplementary Conditions of these specifications are a part of this section as if incorporated herein. Section 02486 presents requirements for seeding.

1.3 REFERENCES

A. The latest edition of the Florida Department of Transportation (DOT) Standard Specifications for Road Bridge Construction (Standard Specifications) shall be referred to for both specific and general standards for materials, construction, workmanship, and quality control as specified herein with exceptions, as noted herein.

B. The latest edition of DOT Roadway and Traffic Design Standards.

1.4 SUBMITTALS

A. Soil Analysis: The Contractor shall furnish a soil analysis for each borrow source or distinct on-site soil type used as topsoil for the final cover. The analysis shall be made by a qualified independent soil-testing agency, to be approved by the Engineer. The analysis shall state percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content of the soils. The analysis shall state recommended quantities of nitrogen, phosphorus, and potash nutrients and any soil amendments to be added to produce satisfactory topsoil. The Contractor shall perform soil test 30 days prior to mobilizing for landscape construction.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Fertilizer for grassing shall conform to Section 982 of the Standard Specifications.

B. Fertilizer shall be granulated so that 80 percent is held on a 16-mesh screen, uniform in composition, dry, and free flowing. The Contractor shall test screen one bag of fertilizer per source and per shipment.

2.2 SODDING

The following sections of the Standard Specifications shall apply:

A. Section 575-1, Description

B. Section 981-2 and 981-4, Materials

2.3 WATER

Water for sodding shall conform to Section 983 of the Standard Specifications.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. All areas within the limits of work and all areas disturbed by the Contractor's operations shall be sodded unless otherwise indicated on the Drawings.

B. The period of sod establishment shall begin immediately after the completion of sodding in an area and shall continue for a period of 1 year after the completion of sodding on the entire project unless the desired sod cover is established in a shorter period of time and shortening of the sod-establishment period is authorized by the Engineer.

C. Areas to be sodded shall be graded to remove construction debris, litter, depressions, undulations, and irregularities in the surface before sodding and in accordance with the Drawings. Grading activities shall be conducted such that the minimum required thickness of topsoil is maintained.

3.2 SODDING

A. Sodding shall be placed within the entire final closure area unless shown otherwise on the Drawings and in all graded and disturbed areas that have a 4 (horizontal) to 1 (vertical) slope or steeper and other areas as shown on the Drawings.

B. The following sections of the Standard Specifications shall apply:
Section 575-3, Construction Methods

C. Exceptions:
Section 575-3.3, replace phrase "a suitable length of roadway" with "an area."
Section 575-3.3, Placing Sod; do not plant dormant sod or if ground is frozen. Rolled sod shall be placed parallel to contours. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. The offsets of individual staggered strips shall not exceed 6 inches. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass. On areas where sod may slide due to the slope gradient, may be displaced by flowing water or may otherwise move, the sod must be pegged using suitable wooden pegs and netting or other approved means. The pegs should be driven through the sod strips into firm earth, at suitable intervals. Water sod thoroughly with a fine spray immediately after planting. Roll sod within 24 hours of placement to ensure contact between sod and subgrade.
Section 575-3.4, watering shall conform to requirements previously specified herein. Replace the word "Department" with the Word "County" in the last sentence. The cost of resodding shall be borne exclusively by the Contractor.
Section 575-3.5, Maintenance shall be performed as specified herein.

D. Sod installed within drainage swales, terraces, and near drainage inlets shall be adequately anchored using pegs, netting, or other means to ensure that the sod is not displaced by the flow of water.

3.3 CLEANUP

All excess sod materials, stones, and other waste shall be removed from the site weekly and shall not be allowed to accumulate.

3.4 MAINTENANCE

Maintenance shall begin immediately following the last operation of sodding and continue until conclusion of the sod-establishment period specified herein. Maintenance shall include watering, mowing, resodding, repair of erosion, and all other work necessary to produce a uniform stand of grass. Sod will be considered for final acceptance when the sod roots are firmly anchored to underlying soil and the permanent grass is healthy and growing on 97 percent of the area with no bare areas wider than 12 inches, as determined by the Engineer. If the planted areas must be resodded, reshaped, or otherwise repaired, regardless of cause, the Contractor shall perform such work at the Contractor's expense. The period of sod establishment for areas that are resodded shall extend to 1 year after the completion of resodding unless otherwise authorized by Engineer.

END OF SECTION

SECTION 02486
HYDROSEEDING

PART 1 - GENERAL

1.1 WORK INCLUDED

This section covers the work necessary to provide for hydroseeding.

1.2 RELATED WORK

The General and Supplementary Conditions of these specifications are a part of this section as if incorporated herein. Section 02485 presents requirements for sodding.

1.3 REFERENCES

A. The latest edition of the Florida Department of Transportation (DOT) Standard Specifications for Road Bridge Construction (Standard Specifications) shall be referred to for both specific and general standards for materials, construction, workmanship, and quality control as specified herein with exceptions, as noted herein.

B. The latest edition of DOT Roadway and Traffic Design Standards.

1.4 SUBMITTALS

A. Soil Analysis: The Contractor shall furnish a soil analysis for each borrow source or distinct on-site soil type used as topsoil for the final cover. The analysis shall be made by a qualified independent soil-testing agency, to be approved by the Engineer. The analysis shall state percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content of the soils. The analysis shall state recommended quantities of nitrogen, phosphorus, and potash nutrients and any soil amendments to be added to produce satisfactory topsoil. The Contractor shall perform soil test 30 days prior to mobilizing for landscape construction.

B. Method Statement: Method Statement of Hydroseeding shall be provided to the Engineer at least ten (10) working days in advance for approval prior to execution. The Method Statement shall contain, but not be limited to, the following items:

1. Binder
2. Binder type.
3. Mix proportions.
4. Mixing Procedure
5. Spraying Equipment
6. Equipment for short-range application.
7. Equipment for long-range application.
8. Agitator.
9. Pressure pump.
10. Biodegradable Mat
11. Installation procedure.
12. Mat anchor type.
13. Size, length, and spacing of mat anchor.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Fertilizer for grassing shall conform to Section 982 of the Standard Specifications.

B. Fertilizer shall be granulated so that 80 percent is held on a 16-mesh screen, uniform in composition, dry, and free flowing. The Contractor shall test screen one bag of fertilizer per source and per shipment.

2.2 SEED BLEND AND QUALITY CERTIFICATION

A. The application rate (lbs per acre) shall be:

Bahiagrass, Pensacola	80
Bermudagrass, Unhulled	10
Bermudagrass, Hulled	10
Millet, Brown Top	20
Ryegrass, Annual or Gulf Annual	20

B. Seasonal grasses.
1. October 1 to March 31 using Annual or Gulf Annual Ryegrass.
2. April 1 to September 30 using Brown Top Millet. (Delete Millet if birds are a concern.) Timing is subject to the weather.

C. The seed shall not contain noxious or prohibited weed seeds. A laboratory that is certified by the State of Florida shall test the seed. The test date on the seed analysis card shall not be more than six (6) months old. Seed shall be packaged in containers that are fully labeled and comply with the state laws (Florida) and regulations. Seed analysis cards shall accompany the seed used as a part of the hydroseeding installation.

2.3 MULCH MATERIAL

A. Wood cellulose fiber mulch for use with hydraulic application of grass seed and fertilizer shall consist of specially prepared wood cellulose fiber or a combination of wood cellulose and recycled newsprint, processed to contain no growth or germination inhibiting factors and dyed an appropriate color to facilitate visual metering of the application of materials.

B. The mulch material shall be supplied in packages having a gross weight of not in excess of 100 pounds each. On air-dry weight basis, the wood cellulose fiber shall contain a maximum of 10 to 15 percent (10-15%) moisture, plus or minus 3 percent (3%), at the time of manufacture.

C. The wood cellulose fiber shall be manufactured so that, after addition and agitation in slurry tanks with fertilizers, grass seed, water, and other approved additives, the fibers in the material will become uniformly suspended to form homogeneous slurry. When hydraulically sprayed on the ground, the material will form a blotter-like cover impregnated uniformly with grass seed.

D. The cover will allow the absorption of moisture and allow rainfall or applied water to percolate to the underlying soil. Shrinkage after wetting shall not exceed 20 percent of the surface area.

E. The Wood Cellulose Fiber shall be applied at the following rates:

per 1,000 square feet	30 pounds
per acre	1300 pounds (or at manufacturer's recommendations)

2.4 TACK MATERIAL

A. (binder/glue) shall be applied at the manufacturer's recommended rate. The tack/binder shall be a biodegradable (environmentally friendly) material. A printed specification sheet shall be supplied upon request to the owner or owner's representative.

2.5 WATER

Water for grassing shall conform to Section 983 of the Standard Specifications.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Hydroseeding shall be carried out as soon as practicable on graded and disturbed areas not designated for sod.

B. Seeding shall be carried out by means of a proper hydroseeder where approved slurry of seeds, mulch, fertilizers, binders, and organic manner are sprayed onto the prepared soil surface.

C. The period of grass establishment shall begin immediately after the completion of hydroseeding in an area and shall continue for a period of 1 year after the completion of seeding on the entire project unless the desired grass cover is established in a shorter period of time and shortening of the grass-establishment period is authorized by the Engineer.

D. Areas to be grassed shall be graded to remove construction debris, litter, depressions, undulations, and irregularities in the surface before grassing and in accordance with the Drawings.

E. The Engineer or his designated Monitor shall be present during hydroseeding and material applications and observe and documenting that the seed, mulch, fertilizer, tackifier, and other materials were applied according to the specifications. The Monitor shall personally observe that all material was delivered to the site unopened and shall collect all bags and containers used to hold these products which will be submitted to the Engineer for inspection.

3.2 HYDROSEEDING

A. Preparation of the Soil Surface Prior to Hydroseeding
1. The areas to be hydroseeded shall be uniform and shall conform with the finished grade shown on the plans or as otherwise designated. Minor shaping of uneven and rough areas outside the graded section shall be performed as directed by the Engineer in order to provide for more effective erosion control and for ease of subsequent mowing operations.
2. Vertical striations or grooves shall be absent from the final trimmed slope; instead a rough-textured surface shall be prepared. Any surface rills in excess of 1" shall be rectified by re-trimming.
3. Gullies or local washouts shall be backfilled with suitable material placed in layers of up to 8" thick, each layer being compacted as required by the earthwork specifications.
4. Large clods of earth and stones greater than 2" shall be removed.
5. Slopes that have been exposed for a long time must be trimmed and scaled to remove any oxidized layer prior to hydroseeding.

B. The following sections of the Standard Specifications shall apply:
Section 570-3, Construction Methods

C. Exceptions:
Section 570-3.1, replace phrase "a suitable length of roadway" with "an area."
Section 570-3.5, section does not apply
Section 575-3.4, watering shall conform to requirements previously specified herein. Replace the word "Department" with the Word "County" in the last sentence. The cost of reseeding shall be borne exclusively by the Contractor.

3.3 CLEANUP

All excess materials, stones, and other waste shall be removed from the site weekly and shall not be allowed to accumulate.

3.4 MAINTENANCE

The Contractor is to ensure the full establishment of ground cover by taking the necessary maintenance procedures, such as regular watering, fertilizing, and reseeding of failed areas. The Contractor shall guarantee the success of the seeding work. Any dead grass or bare spots larger than 3 square feet shall be immediately replaced or re-sprayed at Contractor's own expense. If the planted areas must be replanted, reshaped, or otherwise repaired, regardless of cause, the Contractor shall perform such work at the Contractor's expense. The period of grass establishment for areas that are replanted shall extend to 1 year after the completion of replanting unless otherwise authorized by Engineer.

END OF SECTION

SECTION 02771
TPO GEOMEMBRANE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the scrim reinforced Thermoplastic Polyolefin (TPO) geomembrane components used in the exposed geomembrane temporary cover. The scrim reinforced TPO is 60 mil UltraPly^{TM} TPO as manufactured by Firestone Building Products or equivalent.

B. Related Sections:
   1. Section 02200 -Earthwork.
   2. Section 02778 - Geotextile.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. ASTM D 1204 – Test Method for Liner Dimensional Changes of Flexible Thermoplastic Sheeting or Film at Elevated Temperature
      b. ASTM D2136 - Standard Test Method for Coated Fabrics-Low-Temperature Bend Test
      c. ASTM 4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
      d. ASTM D4437 – Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembrane
      e. ASTM D 4833 – Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
      f. ASTM D5199 – Measuring Nominal Thickness of Geotextiles and Geomembranes.
      g. ASTM D5261 – Test Method for Measuring Mass per Unit Area of Geotextiles
      h. ASTM D5721 – Practice for Air-Oven Aging of Polyolefin Geomembranes
      i. ASTM D5884 – Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes
      j. ASTM D5885 - Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimeter
      k. ASTM D6636 – Test Method for Determination of Ply Adhesion Strength of Reinforced Geomembranes
      l. ASTM D7004 - Standard Test Method for Grab Tensile Properties of Reinforced Geomembranes
      m. ASTM G 151 – Practice for Exposing Non-Metallic Materials in Accelerated Test Devices that Use Laboratory Light Sources
      n. ASTM G 155 – Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
      o. ASTM D4885 – Standard Test Method for Determining Performance of Geomembranes by the Wide Strip Tensile Method
      p. ASTM D4437 – Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Geomembranes

   2. The Geosynthetic Research Institute (GRI).
      a. GRI/G 16 – Observation of Surface Cracking of Geomembranes

B. Qualifications:

1. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience with a minimum of 10,000,000 SF of TPO geomembranes.
2. Installer:
   a. Demonstrate 5 years continuous experience with a minimum 10,000,000 SF of TPO geomembranes.
   b. Trained and certified by at least one of the named manufacturers in this Specification (not necessarily the manufacturer supplying materials for this Project).
   c. Geomembrane Installer Personnel Qualifications:
      1) Installation Superintendent shall have worked in a similar capacity on at least five geomembrane liner jobs similar in size and complexity to the project described in the Contract Documents.
      2) The Master Welder shall have completed a minimum of 5,000,000 sf of TPO geomembrane seaming work using the type of seaming apparatus proposed for use on this Project.
      3) Other welders shall have seamed a minimum of 1,000,000 sf of TPO geomembrane.
3. CQA Testing Laboratory shall demonstrate 3 years of continuous experience in similar geosynthetic materials testing.

C. Quality Assurance:

1. The Owner or Engineer's representative will conduct independent testing to support construction quality assurance program and to provide documentation of such to appropriate regulatory agencies.
2. Unless specifically superseded by these contract documents or approved plans submitted by the Contractor, the geosynthetic materials shall be manufactured, stored, placed, seamed, tested and protected as described in EPA/600/R-93/182 and EPA/530/SW-91/051.
   a. This specifically includes:
      1) Material Composition.
      2) Manufacturing.
      3) Handling and Packaging.
      4) Shipment.
      5) Storage (Manufacturer and Site).
      6) Placement:
         a) Seaming and Joining.
         b) Destructive and Non Destructive Testing.
         c) Protection, Backfilling and Covering.
      7) Conformance Testing.
      8) Anchoring and Anchor Trenches.
      9) Access Roads/Ramps.

D. CQA Plan Implementation: Construction Quality Assurance will be performed in accordance with the CQA Plan prepared for this project. The Contractor and Geomembrane Installer should familiarize themselves with the CQA Plan.

E. Installer's construction quality control programs to include, but not be limited to, product acceptance testing, installation testing, including both nondestructive and destructive quality control field testing of the sheets and seams during installation of the geomembrane, proposed methods of testing geosynthetic joints and connections at appurtenances for continuity, documentation and changes, alterations, repairs, retests, and acceptance.

F. Geomembrane Installer's installation manual to include:

1) Ambient temperature at which the seams are made
2) Control of panel lift up by wind
3) Acceptable condition of the subsurface beneath the geomembrane
4) Quality and consistency of the welding material
5) Proper preparation of the liner surfaces to be joined

6) Cleanliness of the seam interface (e.g., the amount of airborne dust and debris present)
7) Proposed details for connecting the TPO liner to appurtenances, i.e. penetrations of the containment facilities.
8) A complete description of seaming by hot-air welding and hot-wedge welding.
9) Requirements of the Manufacturer's Installation Manual unless exceptions are noted and approved by the Engineer.

1.3 DEFINITIONS AND RESPONSIBILITIES

A. Geomembrane Manufacturer: Manufacturer of geomembranes producing geomembrane sheets from resin and additives. The manufacturer is responsible for producing geomembrane sheet which complies with these Specifications. These responsibilities include but are not limited to:
1. Acceptance of the resin and additives from chemical formulators. Testing of the raw resin and additives to ensure compliance with the manufacturer's specifications and with this Specification.
2. Formulation of the resin and additives into geomembrane sheeting using mixing and extrusion equipment.
3. Testing of the geomembrane sheet to ensure compliance with manufacturer's specification and this Specification.
4. Shipping of the geomembrane sheet to installer designated facilities.
5. Certification of the raw materials and finished geomembrane sheet to comply with this Specification.
6. Certification of installer's training, experience, and methods for welding and inspection of geomembrane installations in compliance with manufacturer's standards.

B. Geomembrane Installer. Installer of geomembranes are responsible for handling, fitting, welding, and testing of geomembrane sheets or blankets in the field. These responsibilities include but are not limited to:
1. Acceptance (in writing) of the geomembrane from the manufacturer.
2. Acceptance (in writing) of the surface which will serve as a base for the geomembrane. This acceptance shall precede installation of the geomembrane, and shall state that the installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of geomembrane liners. The written acceptance shall explicitly state any and all exceptions to acceptance.
3. Handling, welding, testing, and repair geomembrane liners in compliance with this Specification and the Geomembrane Installer's Installation Procedures Manual.
4. Performance of QC testing and record keeping as required by the approved Geomembrane Installer's Field Installation Procedures Manual.
5. Repair or replacement of defects in the geomembrane as required by the Installer's CQC Consultant or the CQA Inspector.

C. CQA Inspector:
1. Inspectors of TPO geomembrane are the individuals responsible for observing field installation of the geosynthetic materials and providing the Manufacturer, Installer, CQA Engineer, and Owner with verbal and written documentation of the compliance of the installation with this specification and with written procedures manuals prepared by the Manufacturer or Installer.

D. CQA Testing Laboratory shall:
1. Perform destructive testing of the TPO geomembrane.
2. Perform conformance testing of TPO geomembrane.

E. Installer's CQC Consultant: Responsible for observing field installation of the geomembrane and performance of material conformance and CQC testing to provide the Contractor with verbal and written documentation of the compliance of the installation with these Specifications.

F. CQA Engineer: Responsible for implementing CQA Plan including overview of material conformance testing, field installation of the geomembrane, and CQC activities, and to perform limited CQA conformance testing to provide Owner with verbal and written documentation of the compliance of the installation with these Specifications. The CQA Engineer will use the written results of the CQC program and the CQA program in the preparation of the facility Certification Document. The CQA Engineer reports to the Owner and is not part of this contract.

G. Refer to the accompanying CQA Plan for additional definitions.

1.4 SUBMITTALS

A. Shop Drawings:
1. Submit for Engineer's approval Shop Drawings, including:
   a. Manufacturer's certification that raw materials and sheet materials comply with required materials, mil thickness, and material properties.
      1) Original certificates are required.
   b. Manufacturer/Fabricator/Installer quality control requirements.
   c. Qualifications and experience of key personnel per 1.2 B of this section.
   d. Manufacturer's written acceptance of Geomembrane Installer's qualifications for installation of the TPO geomembrane.
   e. TPO Geomembrane layout plan with proposed size, number, position and sequencing of liner panels and showing the location and direction of all field or factory joints.
      1) Proposed details for connecting the geosynthetic materials to appurtenances.
      2) Proposed methods of welding, seaming or jointing geosynthetic materials.
      3) Proposed method of testing TPO geomembrane and other geosynthetic materials, joints and connections at appurtenances for continuity.
      4) Location and configuration of haul roads and access points.
      5) Proposed details for anchor trench if different than included in Contract Documents.

B. Miscellaneous:
1. Test results:
   a. Resin test, tests of sheet material and factory seam tests at frequency specified in respective quality control manuals.
      1) Results shall include or bracket the rolls delivered for use in the Work.
   b. Daily test seam results.
   c. Daily results of production seam testing.
2. Warranties as described below.
3. Submit written certifications that:
   a. Utilize certification forms from this Section unless alternately approved. Make appropriate number of copies, as required.
   b. The TPO geomembrane material delivered to site meets the requirements of this Specification.
   c. The TPO geomembrane was received and accepted in undamaged condition from shipper.
   d. The TPO geomembrane liner was installed in accordance with this Specification and with approved Shop Drawings.
   e. The TPO geomembrane joints were inspected, tested for strength and continuity, and passed all inspections and tests.
      1) All test and inspection data shall be incorporated into this certification.
4. Manufacturer/Installer's Field Installation Procedures Manual shall clearly identify any exceptions taken to the specified execution of the Work.

5. Record Drawings: Submit reproducible drawings of record showing changes from the approved installation drawings. The record drawings shall include the identity and location of each repair, cap strip, penetration, boot, and sample taken from the installed geosynthetic for testing. The record drawings shall show locations of each type of material, anchor trenches and the construction baseline.

C. Provide all submittals in a single coordinated transmittal. Partial submittals will not be accepted. All submittals must be submitted prior to the Geomembrane Preconstruction Meeting and a minimum of four weeks prior to installation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. The TPO geomembrane should be protected from punctures, abrasions, vandalism, excessive heat or cold or other damaging conditions

B. The TPO geomembrane shall be delivered to the project site intact and free from any tears, abrasion, or damage. Store TPO geomembrane and accessories in original containers in a dry area protected from the elements.

C. Each roll shall be labeled with the manufacturers name, type, lot number, roll number, and roll dimensions (length, width, gross weight).
   1. TPO geomembrane or plastic wrapping damaged as a result of storage or handling shall be repaired or replaced, as directed.
   2. TPO geomembrane shall not be exposed to temperatures in excess of 60 Deg C (140 Deg F) or less if recommended by the Manufacturer.

D. No hooks, tongs or other sharp instruments shall be used for handling the TPO geomembrane.
   1. Rolls shall not be lifted by use of cables or chains in contact with the TPO geomembrane.
   2. TPO geomembrane shall not be dragged along the ground.

1.6 PROJECT CONDITIONS

A. When the weather is of such a nature as to endanger the integrity and quality of the installation, whether this is due to rain, high winds, cold temperatures, or other weather elements, the installation of the geomembrane shall be halted at the direction of, or with the concurrence of, the Owner until the weather conditions are satisfactory.

B. The contractor shall ensure that adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt on geosynthetic surfaces which hamper the efficient field seaming of geosynthetic panels or performance.

C. Maintain natural surface water drainage diversions around the work area and provide for the disposal of water which may collect in the work area directly from precipitation falling within the area or from inadequate diversion structures or practices.

D. All materials shall be placed and spread with low ground pressure equipment (10 psi ground pressure or less) as approved by the CQA Engineer to reduce potential damage to the geosynthetics. The geosynthetics surface shall be off limits to construction traffic. Hard turning of tracked equipment on the protective cover and stone must be avoided.
   1. At least 12 inches of separation between the geosynthetics and all low ground pressure equipment shall be maintained.
   2. Stockpiling of materials within the limits of the cell shall be subject to advanced approval by the CQA Inspector. Any hauling equipment (dump trucks, etc.) operating within the cell limits (and including access ramps), shall have a minimum of 4 feet of separation between the vehicle wheels and the geosynthetics.
   3. No vehicle shall access the completed Work unless it can be demonstrated that its weight, movement or activities will not damage the Work.
   4. When damage is suspected, uncover area, repair damage if required, and recover area at no cost to Owner.
   5. Suspect areas may be identified by Owner or Engineer.

1.7 WARRANTIES

A. Written warranties addressing TPO geomembrane material and installation workmanship shall be furnished by the Contractor and shall be made to the Owner.

B. Submit material samples and warranties prior to shipment.

C. Suitability of geosynthetic liner system shall be subject to Owner's approval of warranty.
   1. The Manufacturer's warranty shall be against manufacturing defects and workmanship and against deterioration due to ozone, ultra- violet exposure from direct sunlight, and other exposure to the elements, for a period of 20 years on a pro rata basis. The warranty shall be limited to replacement of material, and shall not cover installation of replacement geomembrane.
   2. The Installer's warranty shall state that the materials were properly installed, properly (field and factory) welded, seamed and jointed and will not fail within two years of the date of final acceptance of the Work by the Owner.
      a. Warranty shall not be prorated.

D. Warranties shall provide for complete repair/replacement excluding installation costs at no additional cost to the Owner for the warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND/OR GEOMEMBRANE INSTALLERS

A. Subject to compliance with the Contract Documents, the following manufacturers and installers are acceptable:
   1. TPO Geomembrane liners manufacturers:
      a. Firestone Building Products
      b. Carlisle SynTec
   2. TPO Geomembrane Liner Installers:
      a. Authorized installers of approved manufacturers.
      b. Other installers may qualify by providing references for a minimum of 10,000,000 SF of TPO liner installations.

2.2 MATERIALS

A. The membrane will be Firestone UltraPly TPO 60 mil geomembrane or equivalent.
B. Accessories will be as supplied or approved by geomembrane manufacturer.
C. Geomembrane meets or exceeds the property values listed in Table 1.
D. Interfaces of liner and intermediate cover will be submitted as specified in Table 2.

Table 1: Physical Properties

Property	Test Method	Typical
UNAGED PROPERTIES:		
Thickness, min. in (mm)	60 mil	.060" (1.52 mm) ± 10%
Thickness Over Scrim	ASTM D 4637 (Optical Method)	
	0.060" Membrane	0.024" (0.609 mm) ± 10%
Breaking Strength (TD)	ASTM D 4885	150 ppi (26.3 kN/m)
Elongation at Reinforcement break (TD)	ASTM D 4885	30%
Tearing Strength	ASTM D 751 (8"x8" specimen)	86 lbf (382 N)
Brittleness Point	ASTM D 2137	-50°F (-46°C)
Linear Dimension Change	ASTM D 120 (6 hrs @70° C)	4 ±0.15%
Ozone Resistance	ASTM D 1149	PASS (no cracks)
Factory Seam Strength	ASTM D 4885	150 ppi (26.3 kN/m)
Puncture Resistance	FTM 101C Method 2031	265 lbf (1174 N)
HEAT AGED PROPERTIES:		
Breaking Strength (TD) 3	ASTM D 4885	150 ppi (26.3 kN/m)*
Elongation at Reinforcement Break (TD)	ASTM D 4885	30%*
Tearing Strength	ASTM D 751 (8"x8" specimen)	86 lbf (382N)*
Weight Change (Membrane)	ASTM D 471	1% (change in mass)
AGED PROPERTIES:		
Ozone Resistance	ASTM D 1149	PASS (No cracks)
Weather resistance (Retained Values)	ASTM G 151/ G 154	
Visual Inspection		PASS
Breaking Strength, % min.		90% retained
Elongation at Reinforcement Break 90% retained	ASTM D 4885	90% retained
Resistance to Xenon-Arc Weathering	ASTM G 151/ G155	Pass

*ASTM D 6878 requires retained values of 90% or original breaking strength and elongation and 60% for tearing strength

Table 2: Interface Friction Angles

PROPERTIES	QUALIFIERS	UNITS	VALUES	TEST METHOD
Engineering Properties Interface friction between geomembrane liner and geotextile material in the anchor trench	minimum	degrees	22[(1)]	ASTM D 5321[(2)]

(1) Perform testing using normal stress range of 144 lb/sf, 288 lb/sf and 432 lb/sf.

(2) Wet the geotextile/TPO geomembrane interface prior to testing: perform test using: (i) normal stress indicator above; and (ii) a strain rate calculated in accordance with ASTM D 3080, Sections 9.12 and 9.13, not to exceed 1 mm/min. (0.04 in./min.).

2.3 MANUFACTURING QUALITY CONTROL

A. Rolls:

1. The Manufacturer will continuously monitor the TPO geomembrane sheets during the manufacturing process for inclusions, bubbles, or other defects.
2. No TPO geomembrane will be accepted that exhibits any defects.
3. The Manufacturer will continuously monitor the TPO geomembrane thickness during the manufacturing process.
4. No TPO geomembrane will be accepted that fails to meet the specified minimum thickness.
5. The Manufacturer will sample and test the geomembrane, at a minimum, at the test frequencies specified in Table 3.
   a. Samples taken from stored rolls will be taken across the entire width of the roll and will not include the first wrapping or outer layer of the roll (about 3.3 feet).
   b. Samples taken at the time of manufacturing can be obtained from the start/end of the roll.
   c. Unless otherwise specified, samples will be 2 feet long by the roll width. The Manufacturer will mark the machine direction on the samples with an arrow.
   d. Manufacturer quality control data shall accompany the geomembrane shipment.

Table 3: Manufacturer Quality Control Requirements

Material Property	Method	Test Frequency
Thickness	ASTM D751	Per roll
Mass per Unit Area	ASTM D5261	Once per day or 200,000 lb
Tensile Properties	ASTM D4885	Once per day or 20,000 lb
Tear Resistance	ASTM D751	Once per day or 45,000 lb
Scrim Orientation	Visual	Every Lot or Every Scrim Roll

6. Any TPO geomembrane sample that does not comply with the Specifications will result in rejection of the roll from which the sample was obtained. Contractor will replace any rejected rolls at no additional cost to Owner.
7. If a TPO geomembrane sample fails to meet the quality control requirements of this Section, the Manufacturer will sample and test each roll manufactured, in the same resin batch, or at the same time, as the failing roll. Sampling and testing of rolls will continue until a pattern of acceptable test results is established.
8. Additional testing may be performed at the Manufacturer's discretion and expense, to more closely identify the non-complying rolls and/or to qualify individual rolls.

2.4 CONFORMANCE TESTING

At the Geomembrane Manufacturer's plant or upon delivery of the rolls of geomembrane at the site, the CQA Officer will verify that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify conformance to both the design specifications and the list of guaranteed properties. The minimum number of tests to be performed and test procedures will be as indicated in Table 4.

Samples will be taken across the entire width of the roll and will not include the first linear 3 ft. Unless otherwise specified, samples will be 3-ft long by the roll width. The CQA Officer will mark the machine direction on the samples with an arrow. The required minimum sampling frequencies are provided in Table 4.

The CQA Officer will examine the results from laboratory conformance testing and will report non-conformance to the Project Manager.

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

- the Installer will replace the roll of geomembrane that is in nonconformance with the specifications with a roll that meets specifications;
- the Installer will 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 both conform to specifications. If either of these samples fail, then every roll of geomembrane on site and every roll delivered subsequently must be tested by the Geosynthetics CQA Laboratory for conformance to the specifications. This additional conformance testing will be at the expense of the Installer.

The CQA Officer will document actions taken in conjunction with conformance test failures.

Table 4: Geomembrane Conformance Testing Requirements

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Mass per Unit Area	ASTM D 5261	1 test per 100,000 ft^2
Thickness	ASTM D 4637	1 test per 100,000 ft^2
Tensile Strength at Break	ASTM D 4885	1 test per 100,000 ft^2
Elongation at Break	ASTM D 4885	1 test per 100,000 ft^2
Tear Strength	ASTM D 5884	1 test per 100,000 ft^2
Puncture Resistance	ASTM D 4833	1 test per 100,000 ft^2
Resistance to Xenon-Arc Weathering	ASTM G 155	1 test per 100,000 ft^2
Ozone Resistance	ASTM D 1149	1 test per 100,000 ft^2

2.5 EQUIPMENT AND ACCESSORIES

A. Welding and Seaming Equipment:
   1. Equipped with gages showing temperatures at the nozzle or at the wedge (wedge welder).
   2. Maintained in adequate numbers to avoid delaying work.
   3. Supplied by a power source capable of providing constant voltage under a combined-line load.
   4. Electric generator shall not be placed on the TPO geomembrane.

B. Field Tensiometer:
   1. Provide a tensiometer for on-site shear and peel testing of TPO geomembrane seams.
      a. Tensiometer shall be in good working order.

b. Built to ASTM specifications.
c. Accompanied by evidence of calibration of equipment and gages within the past six months.

2. Tension meter:
   a. Motor driven.
   b. Jaws capable of traveling a measure rate of 2 IN per minute.
   c. Equipped with a gauge that measures the force in unit pounds exerted between the jaws.
   d. Digital readout.

C. Punch Press:
1. Provide a punch press for the onsite preparation of specimens for testing.
2. Capable of cutting specimens in accordance with ASTM D4437.

D. Air Lance Test:
1. Provide equipment for air lance test per ASTM D4337.

E. Equipment necessary to perform "Pressurized Air Channel Evaluation of Dual Seamed Geomembranes" in accordance with ASTM D5820.

F. Gages:
1. Calibrated within past six months.
2. Specified test values reading near mid-range of the gage scale.

G. Equipment necessary to perform "Non-Destructive Testing of Geomembrane Seams Using The Spark Test" in accordance with ASTM D6365.

PART 3 - EXECUTION

3.1 GEOSYNTHETIC LINER SYSTEM

A. Geomembrane Subgrade:
1. Protect subgrade at all times from damage until such time as the placement of TPO geomembrane liner and other components of the geosynthetic liner system are complete.
2. The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of TPO Geomembrane.
   a. The subgrade shall be properly compacted so as not to settle and cause excessive strains in the TPO Geomembrane or other synthetic liner materials.
   b. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.
   c. In addition, ensure that the subgrade has been rolled to provide a uniform surface.
   d. During installation, ensure that rutting or ravelling is not caused by installation equipment or weathering.

B. Anchor Trenches:
1. Geosynthetic materials placed on side slopes shall be anchored into trenches as detailed on the Contract Drawings.
2. Excavation, backfill and compaction shall be in accordance with Section 02200.

C. TPO Geomembrane:
1. General:
   a. Installer of TPO geomembranes is responsible for handling, fitting, welding, seaming, jointing and testing of geosynthetic materials sheets or blankets in the field in accordance with the Construction Quality Assurance (CQA) Plan.
   b. These responsibilities include but are not limited to:
      1) Acceptance (in writing) of the geosynthetic materials sheets or blankets from the transporter.
      2) Acceptance (in writing) of the surface which will serve as a base for the TPO geomembrane.

a) This acceptance shall precede installation of the TPO geomembrane.

b) Shall state that the Installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of TPO geomembrane liners.

c) Shall explicitly state any and all exceptions to acceptance.

3) Handling, welding, seaming, jointing, testing and repair of TPO geomembrane liners and other geosynthetic materials in compliance with this Specification and with written procedures manuals prepared by the Manufacturer or Fabricator.

a) Manual shall be submitted to the Engineer together with Shop Drawings showing the layout of TPO geomembrane within the facility.

(1) Do not deviate from the procedures included in the manual.

b) TPO Geomembrane shall not be placed upon frozen foundation, standing water or other conditions which will result in deterioration of the foundation.

c) TPO Geomembrane liner materials shall be laid out according to plans previously approved by the Engineer.

d) Adjacent rolls of TPO geomembrane shall overlap a minimum of 4 IN.

4) Repair or replacement of defects in the geosynthetic materials as required by the Inspector or the Owner.

5) Installer and Manufacturer may be the same firm.

2. Panel deployment:

a. Subgrade Preparation:

1) Prepare subgrade in a manner consistent with proper subgrade preparation techniques for the installation of TPO geomembrane liner.

2) Properly compact the subgrade so as not to settle and cause excessive strains in the TPO geomembrane liner.

3) Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 IN.

4) Subgrade soils proof-rolled with a ten (10) ton drum roller, two (2) passes parallel to slope or as directed by CQA Inspector. The subbase shall be compacted and proof-rolled under observation of the CQA Inspector to assure the maximum practical compaction under the existing field conditions has been achieved. See specification Section 02220 for project specific compaction requirement.

5) Ensure rutting or raveling is not caused by installation equipment or weather.

6) Ensure that lines and grades have been verified by the Contractor and a subgrade acceptance form has been submitted.

b. Construct and backfill anchor trenches

c. Deploy TPO geomembrane liner in a manner to ensure it is not damaged

d. On slopes, anchor the TPO geomembrane liner securely and deploy it down the slope in a controlled manner.

e. Weight the TPO geomembrane liner with sandbags or equivalent in the presence of wind.

f. Minimize cutting the TPO geomembrane liner. Whenever possible, overlap instead of cutting material. If cutting is required, cut TPO geomembrane liner with a cutter or other approved device. Seal all cut edges, as recommended by Manufacturer.

g. Only those panel/sheets that can be seamed in 1 day shall be deployed.

h. Place panels with minimal handling.

1) No horizontal seams on side slopes.

2) Protect panels from tear, puncture or abrasion.

i. Equipment used to deploy the geomembrane shall not damage the TPO geomembrane.

j. Minimize foot traffic.

1) Do not allow personnel access to wet or slippery liners without adequate safety precautions.

2) Do not allow footwear that may damage the geomembrane.

k. Ballast with sandbags to prevent wind uplift as recommended by Manufacturer based on local climatic conditions.
   1) Remove and replace all wind damaged panels at no additional cost to Owner.
   2) If wind causes panels to be displaced, displaced panel may not be reused.
l. Install TPO geomembrane in stress free, tension free and relaxed condition.
   1) Account for temperature and weather-related impacts when deploying and covering.
   2) Stretching to fit and folding are not permitted.
m. Do not allow TPO geomembrane to bubble, fold, or create ripples as a result of deployment of drainage layer or protective soil cover placement.
   1) Except as noted on Contract Drawings no folds in TPO geomembrane will be allowed.
n. Any panel exhibiting stretching caused by placement, covering techniques, or wind shall be removed and may not be incorporated in the final construction.
o. Field seaming:
   1) Field seaming shall be done in accordance with seaming recommendations furnished by the geomembrane Manufacturer and referenced EPA documents.
   2) Each piece of seaming equipment and each operator shall perform trial seams at the start of a shift, whenever equipment has broken down or seaming is interrupted for more than 30 minutes, and at other times at the discretion of the Installer and Inspector.
   3) Trial seams shall use the same seaming materials and methods to be used in the actual construction.
   4) Surfaces to be seamed shall be clean and dry at the time of seaming.
      a) Precipitation and ponding of water on the TPO geomembrane shall cause termination of seaming operations.
      b) TPO geomembrane shall not be seamed when ambient temperatures are below 41 DegF or above 104 DegF, without written consent of TPO geomembrane Manufacturer and Engineer.
   5) TPO geomembrane sheets shall be seamed continuously without fishmouths or breaks in the seam.
      a) Where fishmouths are unavoidable, the sheet shall be slit to a point such that the sheet lies flat and with no remaining wrinkle.
      b) The two edges of the slit shall be seamed together provided that the overlap for this seam shall be a minimum of 6 IN.
      c) Areas of the slit which do not achieve an overlap of 6 IN, including the terminus of the slit, shall be provided with a patch as discussed below.
   6) All TPO geomembranes shall be seamed by thermal fusion methods as recommended by the TPO geomembrane Manufacturer.
      a) TPO geomembrane seaming shall be either hot-air or double wedge welded as approved by the Engineer.
   7) Manufacturer's seaming instructions shall specifically address seaming materials, temporary and permanent jointing, seaming temperatures including temperatures for seaming materials, seam finishing and curing.
   8) A copy of Manufacturer's seaming instructions shall be available on site at all times and shall not be deviated from without written approval of the Manufacturer and Engineer.
   9) All panels/sheets should be overlapped a minimum of 3 IN.
      a) No horizontal seams will be permitted on the side slopes.
   10) Seaming shall not be conducted in the presence of standing water.
      a) The seamed area shall be cleaned of dust, dirt and foreign material prior to and during the seaming operation.
   11) Seaming shall extend to the outside edge of panels/sheets to be placed in anchor and/or drainage trenches.
   12) Tack welds shall conform to manufacturer's seaming techniques and shall not damage underlying membrane.

p. Patching:
   1) Defects in and damage to TPO geomembrane sheets shall be repaired by seaming a patch over the defect.
      a) The patch material shall consist of an undamaged piece of TPO geomembrane cut to provide a minimum of 6 IN of overlap in all directions from the defect.
      b) Round corners shall be utilized on all patches. No bead or spot patching will be accepted.
      c) Torn or permanently twisted TPO geomembrane shall be replaced at no expense to the Owner.
   2) Test all patch seams using one of the following nondestructive tests: air lance tests or spark tests.
      a) Test patch seams destructively at a frequency of ten percent or a minimum of one test per seaming personnel per day.
      b) This destructive testing may be accomplished using demonstration seams performed adjacent to the liner installation.

q. Smoking is not permitted while on the geomembrane.

r. Field Panel Identification: The Installer's CQC Consultant will document that the Geomembrane Installer labels each field panel with an "identification code" consistent with the approved panel layout plan. The location of the label and the color of marker used must be as agreed to in the QA/QC Preconstruction Meeting.

s. Exposed reinforcement from cut TPO edges must be sealed with and hot-air weld.

3.2 FIELD QUALITY CONTROL

A. Inspector shall not be a part of the installation program and shall not serve as a substitute for performing the duties or certification required of the Manufacturer and Installer.

1. Inspector responsibilities include, but are not limited to:
   a. Inspection of the material and the handling and field installation of the geomembranes. Inspection of all welds, repairs and quality control test results.
   b. All exceptions to material or installation shall be documented and furnished to the CQA firm in writing within 48 HRS of discovery.
   c. Inspection and Certification of TPO geomembrane integrity until completion of placement of protective soil cover.

B. Non-Destructive Testing:

1. The Geosynthetics Installer will nondestructively test all field seams over their full length using a air lance test, air pressure test (for double fusion seams only), or other approved method. Continuity testing will be carried out as the seaming work progresses, not at the completion of all field seaming. The Installer will complete any required repairs in accordance with specifications. The following procedures will apply to locations where seams cannot be nondestructively tested:

   a. If the seam is accessible to testing equipment prior to final installation, the seam will be nondestructively tested prior to final installation.

   b. If the seam cannot be tested prior to final installation, the seaming operations must be observed in their entirety by the CQA Officer for uniformity and completeness.

2. Air Pressure Testing (For Double Fusion Seams Only):

   a. The following procedures are applicable to those processes that produce a double seam with an enclosed space.

   b. The equipment will comprise the following.

i. An air pump (manual or motor driven), equipped with a pressure gauge, capable of generating and sustaining a pressure between 25 and 30 psi, mounted on a cushion to protect the geomembrane.
ii. A rubber hose with fittings and connections.
iii. A sharp hollow needle, or other approved pressure feed device.

c. The following procedures will be followed.

i. Seal both ends of the seam to be tested.
ii. Insert needle, or other approved pressure feed device, into the channel created by the fusion weld.
iii. Insert a protective cushion between the air pump and the geomembrane.
iv. Energize the air pump to a pressure between 25 and 30 psi, close valve, allow two minutes for pressure to stabilize, and sustain the pressure for not less than 5 minutes.
v. If loss of pressure exceeds 4 psi, or if the pressure does not stabilize, locate faulty area and repair in accordance with Section 3.3.
vi. Cut opposite end to verify continuity of seam, remove needle, or other approved pressure feed device, and repair in accordance with Section 3.3.

3. Air Lance Testing

Mechanical point stressing method (see ASTM D4437, article 4.5) or the air lance test method will be used to verify seam integrity for hot air seams and wedge seams without air channel. Since the mechanical point stressing method cannot evaluate the bond over its entire width, and since there is a potential for damaging the membrane with the sharp point of the probe, the air lance test method is recommended to verify seam integrity.

C. Trial Seams

1. Trial seams shall be made prior to production seaming by all seamers and by all equipment to be used during production seaming. The trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, seaming operation has been suspended for more than 1/2 hour, breakdown of the seaming equipment occurs or at least once each five hours, for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams. The trial seam sample shall be at least 5 ft long by 1 ft wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as specified.

2. Two adjoining specimens, each 1-inch wide for peel and 2-inch wide for shear, shall be cut from the trial seam sample by the Geosynthetics Installer. Fully support the test specimen within the grips across the width of the specimen. The specimens shall be tested in shear and peel, using a field tensiometer, and the specimen shall fail by film tear bond rather than in the seam. The minimum requirements for the seams strengths shall be as specified in Table 5. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.

3. After completion of the above-described tests, the remaining portion of the trial seam sample can be discarded. If a trial seam sample fails a test, then a destructive test seam sample shall be taken from the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the CQA Consultant and, if they fail the tests, the procedure indicated in Paragraph 3.3 of this section shall apply. The conditions of this paragraph shall be considered as met for a given seam if a destructive seam test sample has already been taken from the considered seam

D. Destructive Testing:

1. Destructive test seams are to be made by each seaming crew, at the beginning of the seaming process and every four hours thereafter, or every time equipment is changed. Test seams will be made under the same conditions as the production welds (i.e., in contact with the geomembrane subsurface and similar ambient temperature). These seams are to be made of like materials provided for the purpose of testing and not cut from the seamed panels. Each seaming crew and the materials they are using must be traceable and identifiable to their test seams. The samples will be numbered, dated and identified as to the personnel making the seam, and the location made by appropriate notes on a print of the panel layout for the project. The completed field seam sample will measure at least fourteen inches wide and twenty four inch long.

2. The field test samples are to be tested for seam strength and peel adhesion using equipment suitable for this purpose. Shear and peel strength will be tested in accordance with ASTM D4437. The geomembrane Installer will provide a punch press or other suitable means for the on-site preparation of the specimens for testing. The geomembrane Installer will provide a tensiometer for the on-site shear and peel testing of the samples. The tensiometer will be in good working order, built to ASTM specifications and accompanied by evidence of recent calibration.

3. To be acceptable, 4 out of 5 samples will pass shear and peel testing with strength values equal to those indicated in Table 5. If a test sample fails to meet the field seam design specification, then the seaming crew will make additional test samples, using the same tools, equipment, environmental conditions and materials and retest.

Table 5: Seam Strength and Related Properties of Thermally Bonded TPO Geomembrane per ASTM D 4437/GM 19

Geomembrane Nominal Thickness	60 mils
Hot Wedge Seams(1)	
Shear strength(2), lb/in	150
Peel strength(2), lb/in	20
Hot-air Seams	
Shear strength(2), lb/in	150
Peel strength(2), lb/in	20

Notes:
1. Also for hot air seaming methods
2. Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values.

E. Procedures for Destructive Test Failure

The following procedures will apply whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetics CQA Laboratory, the Installer's laboratory, or by field tensiometer.

The Installer has two options.

- The Installer can reconstruct (e.g., remove the old seam and reseam) the seam between any two passed destructive seam test locations.
- The Installer can trace the seaming path to an intermediate location (at 10 ft (3 m) minimum from the point of the failed test in each direction) and take a small sample for an additional field test at each location. 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, then the process is repeated to establish the zone in which the seam should be reconstructed.

If a wedge type seam fails destructive testing and the Installer chooses to cap the seam, then the only acceptable capping method is to reconstruct seam between any two passed destructive seam test locations. Applying topping is not an approved method of capping long lengths of seam.

All acceptable seams must be bounded by two locations from which destructive samples passing laboratory tests have been taken. In cases exceeding 150 ft (50 m) of reconstructed seam, a sample will 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 Officer will document all actions taken in conjunction with destructive test failures.

3.3 DEFECTS AND REPAIRS

A. All seams and non-seam areas of the geomembrane will be examined by the CQA Officer for evidence of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be swept or washed by the Geosynthetics Installer if surface contamination inhibits examination. The Geosynthetics Installer shall ensure that this examination of the geomembrane precedes any seaming of that section.

B. Each suspect location, both in seam and non-seam areas, shall be nondestructively tested using the methods described, as appropriate. Each location that fails nondestructive testing shall be marked by the CQA Consultant and repaired by the Geosynthetics Installer. Work shall not proceed with any materials that will cover repaired locations until laboratory test results with passing values are available.

C. When seaming of a geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the CQA Consultant shall identify excessive geomembrane wrinkles. The Geosynthetics Installer shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested like any other seams.

D. Repair Procedures:

1. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Geosynthetics Installer. Several repair procedures are specified below. The final decision as to the appropriate repair procedure shall be agreed upon between the CQA Consultant and the Geosynthetics Installer. The procedures available include:

   i. patching - used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;
   ii. abrading and reseaming - used to repair small sections of extruded seams;
   iii. spot seaming - used to repair small tears, pinholes, or other minor, localized flaws;

iv. capping - used to repair long lengths of failed seams; and
v. removing bad seam and replacing with a strip of new material seamed into place (used with long lengths of fusion seams).

2. In addition, the following shall be satisfied:

i. surfaces of the geomembrane that are to be repaired shall be abraded no more than one hour prior to the repair;

ii. all surfaces must be clean and dry at the time of repair;
iii. all seaming equipment used in repair procedures must be approved by Engineer;
iv. the repair procedures, materials, and techniques shall be approved in advance, for the specific repair, by the CQA Consultant and Geosynthetics Installer;
v. patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.; and
vi. the geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

E. Each repair shall be numbered and logged and shall be nondestructively tested using the methods described in this section, as appropriate. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests will require the repair to be redone and retested until a passing test result is achieved. At the discretion of the CQA Consultant, destructive testing may be required on large caps at no additional cost to OWNER.

3.4 GEOSYNTHETIC LINER SYSTEM ACCEPTANCE

A. Contractor shall retain all ownership and responsibility for the geosynthetic liner system until final acceptance by the Owner.

1. Owner will accept the geosynthetic liner system installation when the installation is finished and all required warranties, test results, and documentation from the Contractor, Manufacturer, Inspector and Installer has been received and approved, and verification of the adequacy of all field seams and repairs, including associated testing, is complete.

END OF SECTION

SECTION 02775
LLDPE GEOMEMBRANE LINER SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
  1. Furnishing, installation, quality control, and testing of a LLDPE geomembrane liner.

B. Related Sections include but are not necessarily limited to:
  1. Section 02200 - Earthwork.
  2. Construction Quality Assurance Plan.

1.2 QUALITY STANDARDS

A. Referenced Standards:
  1. ASTM International (ASTM).
    a. ASTM D1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
    b. ASTM D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
    c. ASTM D1505 Standard Test Method for the Density of Plastics by the Density-Gradient Technique.ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics.
    d. ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics.
    e. ASTM D3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
    f. ASTM D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
    g. ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
    h. ASTM D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
    i. ASTM D5321, Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
    j. ASTM D5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
    k. ASTM 5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
    l. ASTM D5820, Standard Practice for Pressured Air Channel Evaluation of Dual Seamed Geomembrane.
    m. ASTM D5994 Test Method for Measuring the Core Thickness of Textured Geomembranes.
    n. ASTM D6365 Non-Destructive Testing of Geomembrane Seams Using the Spark Test
    o. ASTM D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
    p. ASTM D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexibly Polypropylene Geomembranes.

  2. The Geosynthetic Research Institute (GRI).
    a. GRI GM12, Asperity Measurement of Textured Geomembranes Using a Depth Gage.
    b. GRI GM17 Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

c. GRI GM19, Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

B. Qualifications:
1. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience with a minimum of 10,000,000 SF of LLDPE geomembranes.
2. Installer:
a. Demonstrate 5 years continuous experience with a minimum 10,000,000 SF of LLDPE geomembranes.
b. Trained and certified by at least one of the named manufacturers in this Specification (not necessarily the manufacturer supplying materials for this Project).
c. Geomembrane Installer Personnel Qualifications:
1) Installation Superintendent shall have worked in a similar capacity on at least five geomembrane liner jobs similar in size and complexity to the project described in the Contract Documents.
2) The Master Welder shall have completed a minimum of 5,000,000 sf of LLDPE geomembrane seaming work using the type of seaming apparatus proposed for use on this Project.
3) Other welders shall have seamed a minimum of 1,000,000 sf of LLDPE geomembrane.
3. CQA Testing Laboratory shall demonstrate 3 years of continuous experience in similar geosynthetic materials testing.

C. Quality Assurance:
1. The Owner or Engineer's representative will conduct independent testing to support construction quality assurance program and to provide documentation of such to appropriate regulatory agencies.
2. Unless specifically superseded by these contract documents or approved plans submitted by the Contractor, the geosynthetic materials shall be manufactured, stored, placed, seamed, tested and protected as described in EPA/600/R-93/182 and EPA/530/SW-91/051.
a. This specifically includes:
1) Material Composition.
2) Manufacturing.
3) Handling and Packaging.
4) Shipment.
5) Storage (Manufacturer and Site).
6) Placement:
a) Seaming and Joining.
b) Destructive and Non Destructive Testing.
c) Protection, Backfilling and Covering.
7) Conformance Testing.
8) Anchoring and Anchor Trenches.
9) Access Roads/Ramps.

D. CQA Plan Implementation: Construction Quality Assurance will be performed in accordance with the CQA Plan prepared for this project. The Contractor and Geomembrane Installer should familiarize themselves with the CQA Plan.

E. Certifications:
1. Certifications are required for various aspects of the project related to the LLDPE geomembrane liner system construction.
a. Unless alternately approved, the certificates provided at the end of this Section shall be used and no alterations, additions, deletions, or exception shall be made to the specified language.

F. Installer's construction quality control programs to include, but not be limited to, product acceptance testing, installation testing, including both nondestructive and destructive quality control field testing of the sheets and seams during installation of the geomembrane, proposed methods of testing geosynthetic joints and connections at appurtenances for continuity, documentation and changes, alterations, repairs, retests, and acceptance.

G. Geomembrane Installer's installation manual to include:

1) Ambient temperature at which the seams are made
2) Control of panel lift up by wind
3) Acceptable condition of the subsurface beneath the geomembrane
4) Quality and consistency of the welding material
5) Proper preparation of the liner surfaces to be joined
6) Cleanliness of the seam interface (e.g., the amount of airborne dust and debris present)
7) Proposed details for connecting the LLDPE liner to appurtenances, i.e. penetrations of the containment facilities.
8) A complete description of seaming by extrusion welding and hot-wedge welding.
9) Requirements of the Manufacturer's Installation Manual unless exceptions are noted and approved by the Engineer.

1.3 DEFINITIONS AND RESPONSIBILITIES

A. Geomembrane Manufacturer: Manufacturer of geomembranes producing geomembrane sheets from resin and additives. The manufacturer is responsible for producing geomembrane sheet which complies with these Specifications. These responsibilities include but are not limited to:

1. Acceptance of the resin and additives from chemical formulators. Testing of the raw resin and additives to ensure compliance with the manufacturer's specifications and with this Specification.
2. Formulation of the resin and additives into geomembrane sheeting using mixing and extrusion equipment.
3. Testing of the geomembrane sheet to ensure compliance with manufacturer's specification and this Specification.
4. Shipping of the geomembrane sheet to installer designated facilities.
5. Certification of the raw materials and finished geomembrane sheet to comply with this Specification.
6. Certification of installer's training, experience, and methods for welding and inspection of geomembrane installations in compliance with manufacturer's standards.

B. Geomembrane Installer. Installer of geomembranes are responsible for handling, fitting, welding, and testing of geomembrane sheets or blankets in the field. These responsibilities include but are not limited to:

1. Acceptance (in writing) of the geomembrane from the manufacturer.
2. Acceptance (in writing) of the surface which will serve as a base for the geomembrane. This acceptance shall precede installation of the geomembrane, and shall state that the installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of geomembrane liners. The written acceptance shall explicitly state any and all exceptions to acceptance.
3. Handling, welding, testing, and repair geomembrane liners in compliance with this Specification and the Geomembrane Installer's Installation Procedures Manual.
4. Performance of QC testing and record keeping as required by the approved Geomembrane Installer's Field Installation Procedures Manual.
5. Repair or replacement of defects in the geomembrane as required by the Installer's CQC Consultant or the CQA Inspector.

C. CQA Inspector:
   1. Inspectors of LLDPE geomembrane are the individuals responsible for observing field installation of the geosynthetic materials and providing the Manufacturer, Installer, CQA Engineer, and Owner with verbal and written documentation of the compliance of the installation with this specification and with written procedures manuals prepared by the Manufacturer or Installer.

D. CQA Testing Laboratory shall:
   1. Perform destructive testing of the LLDPE geomembrane.
   2. Perform conformance testing of LLDPE geomembrane.

E. Installer's CQC Consultant: Responsible for observing field installation of the geomembrane and performance of material conformance and CQC testing to provide the Contractor with verbal and written documentation of the compliance of the installation with these Specifications.

F. CQA Engineer: Responsible for implementing CQA Plan including overviewing material conformance testing, field installation of the geomembrane, and CQC activities, and to perform limited CQA conformance testing to provide Owner with verbal and written documentation of the compliance of the installation with these Specifications. The CQA Engineer will use the written results of the CQC program and the CQA program in the preparation of the facility Certification Document. The CQA Engineer reports to the Owner and is not part of this contract.

G. Refer to the accompanying CQA Plan for additional definitions.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Submit for Engineer's approval Shop Drawings, including:
      a. Manufacturer's certification that raw materials and sheet materials comply with required materials, mil thickness, and material properties.
         1) Original certificates are required.
      b. Manufacturer/Fabricator/Installer quality control requirements.
      c. Qualifications and experience of key personnel per 1.2 B of this section.
      d. Manufacturer's written acceptance of Geomembrane Installer's qualifications for installation of the LLDPE geomembrane.
      e. LLDPE Geomembrane layout plan with proposed size, number, position and sequencing of liner panels and showing the location and direction of all field or factory joints.
         1) Proposed details for connecting the geosynthetic materials to appurtenances.
         2) Proposed methods of welding, seaming or jointing geosynthetic materials.
         3) Proposed method and sequencing for placement of drainage layer on top of the LLDPE geomembrane liner.
         4) Proposed method of testing LLDPE geomembrane and other geosynthetic materials, joints and connections at appurtenances for continuity.
         5) Location and configuration of haul roads and access points.
         6) Proposed details for anchor trench if different than included in Contract Documents.

B. Miscellaneous:
   1. Test results:
      a. Resin test, tests of sheet material and factory seam tests at frequency specified in respective quality control manuals.
         1) Results shall include or bracket the rolls delivered for use in the Work.
      b. Daily test seam results.
      c. Daily results of production seam testing.
   2. Warranties as described below.
   3. Submit written certifications that:
      a. Utilize certification forms from this Section unless alternately approved. Make appropriate number of copies, as required.

b. The LLDPE geomembrane material delivered to site meets the requirements of this Specification.

c. The LLDPE geomembrane was received and accepted in undamaged condition from shipper.

d. The LLDPE geomembrane liner was installed in accordance with this Specification and with approved Shop Drawings.

e. The LLDPE geomembrane joints were inspected, tested for strength and continuity, and passed all inspections and tests.

1) All test and inspection data shall be incorporated into this certification.

f. The drainage composite and protective cover soil on top of the LLDPE geomembrane liner was placed properly and carefully.

4. Manufacturer/Installer's Field Installation Procedures Manual shall clearly identify any exceptions taken to the specified execution of the Work.

5. Record Drawings: Submit reproducible drawings of record showing changes from the approved installation drawings. The record drawings shall include the identity and location of each repair, cap strip, penetration, boot, and sample taken from the installed geosynthetic for testing. The record drawings shall show locations of each type of material, anchor trenches and the construction baseline.

C. Provide all submittals in a single coordinated transmittal. Partial submittals will not be accepted. All submittals must be submitted prior to the Geomembrane Preconstruction Meeting and a minimum of four weeks prior to installation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Unused or stockpiled LLDPE geomembrane shall be stored in accordance with the manufacturer's recommendations.

B. Each roll shall be labeled with the manufacturers name, type, lot number, roll number, and roll dimensions (length, width, gross weight).

1. LLDPE geomembrane or plastic wrapping damaged as a result of storage or handling shall be repaired or replaced, as directed.
2. LLDPE geomembrane shall not be exposed to temperatures in excess of 60 DegC (140 DegF) or less if recommended by the Manufacturer.

C. No hooks, tongs or other sharp instruments shall be used for handling the LLDPE geomembrane.

1. Rolls shall not be lifted by use of cables or chains in contact with the LLDPE geomembrane.
2. LLDPE geomembrane shall not be dragged along the ground.

1.6 PROJECT CONDITIONS

A. When the weather is of such a nature as to endanger the integrity and quality of the installation, whether this is due to rain, high winds, cold temperatures, or other weather elements, the installation of the geomembrane shall be halted at the direction of, or with the concurrence of, the Owner until the weather conditions are satisfactory.

B. The contractor shall ensure that adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt on geosynthetic surfaces which hamper the efficient field seaming of geosynthetic panels or performance.

C. Maintain natural surface water drainage diversions around the work area and provide for the disposal of water which may collect in the work area directly from precipitation falling within the area or from inadequate diversion structures or practices.

D. All materials shall be placed and spread with low ground pressure equipment (10 psi ground pressure or less) as approved by the CQA Engineer to reduce potential damage to the geosynthetics. The geosynthetics surface shall be off limits to construction traffic. Hard turning of tracked equipment on the protective cover and stone must be avoided.

1. At least 12 IN of separation between the geosynthetics and all low ground pressure equipment shall be maintained.
2. Stockpiling of materials within the limits of the cell shall be subject to advanced approval by the CQA Inspector. Any hauling equipment (dump trucks, etc.) operating within the cell limits (and including access ramps), shall have a minimum of 4 feet of separation between the vehicle wheels and the geosynthetics.
3. No vehicle shall access the completed Work unless it can be demonstrated that its weight, movement or activities will not damage the Work.
4. When damage is suspected, uncover area, repair damage if required, and recover area at no cost to Owner.
5. Suspect areas may be identified by Owner or Engineer.

1.7 WARRANTIES

A. Written warranties addressing LLDPE geomembrane material and installation workmanship shall be furnished by the Contractor and shall be made to the Owner.

B. Submit material samples and warranties prior to shipment.

C. Suitability of geosynthetic liner system shall be subject to Owner's approval of warranty.
   1. The Manufacturer's warranty shall be against manufacturing defects and workmanship and against deterioration due to ozone, ultra- violet, and other exposure to the elements, for a period of 5 years on a pro rata basis. The warranty shall be limited to replacement of material, and shall not cover installation of replacement geomembrane.
   2. The Installer's warranty shall state that the materials were properly installed, properly (field and factory) welded, seamed and jointed and will not fail within two years of the date of final acceptance of the Work by the Owner.
      a. Warranty shall not be prorated.

D. Warranties shall provide for complete repair/replacement excluding installation costs at no additional cost to the Owner for the warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND/OR GEOMEMBRANE INSTALLERS

A. Subject to compliance with the Contract Documents, the following manufacturers and installers are acceptable:
   1. LLDPE Geomembrane liners manufacturers:
      a. Agru/America, Inc.
      b. GSE, Inc.
      c. Poly-Flex Inc.
   2. LLDPE Geomembrane Liner Installers:
      a. Authorized installers of approved manufacturers.
      b. Other installers may qualify by providing references for a minimum of 10,000,000 SF of liner installations.

2.2 MATERIALS

A. LLDPE Geomembrane Liner:
   1. Consist of unreinforced polyethylene.
      a. Thickness: 40 mils.
      b. Manufactured from virgin, first quality resin designed and formulated specifically for liquid containment in hydraulic structures.
      c. Reclaimed polymer shall not be added to the resin; except use of polymer recycled during the manufacturing process shall be allowed provided that recycled polymer shall be clean and shall not exceed 10 percent by weight.

d. No additives or fillers may be added to the resin prior to or during manufacture of the LLDPE geomembrane.

2. Manufactured to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
   a. Any such defects shall be cause for rejection of the material.
   b. Minor defects may be repaired in accordance with Manufacturer's recommendations if approved by the Engineer.
3. Manufactured as seamless rolls.
   a. Minimum width: 22 FT as delivered to the site.
4. Prior to shipment, the geomembrane manufacturer will provide the CQA Engineer and the Installer's CQC Consultant with a quality control certificate for each roll of geomembrane provided. The quality control certificate will be signed by a responsible party employed by the geomembrane manufacturer and will include:
   a. Roll numbers and identification; and
   b. The results of quality control tests performed under the MQC program.
5. The Installer's CQC Consultant and the CQA Inspector will verify that a control certificate has been received for each roll and that the certified roll properties meet the requirements of these Specifications.
6. LLDPE sheet with **texture** on both sides shall be used for all sideslopes including drainage terrace.
7. **Smooth** LLDPE sheet shall be used on the top slope of the landfill.
8. The geomembrane liner material shall consist of 40 **MIL NOMINAL LLDPE** and meet or exceed GRI GM17 and the following requirements:

PROPERTY	TEST METHOD	TEST VALUE TEXTURED LLDPE	TEST VALUE SMOOTH LLDPE
a. Sheet Thickness, Mils	ASTM D5199 (smooth) or		
•Minimum Average	ASTM D5994 (textured)	nominal ± 5%	nominal ± 5%
•Lowest Individual 8 of 10		nominal ± 10%	nominal ± 5%
•Lowest Individual 10 of 10		nominal ± 15%	nominal ± 10%
b. Sheet Density (min. ave.)	ASTM D1505	≥ 0.92 g/cc	≥ 0.92 g/cc
c. Melt Flow Index (g/10 min.)	ASTM D1238 Condition 190/2.16	≤ 1.00	≤ 1.00
d. Minimum Tensile Properties (each direction)	ASTM D6693 Type IV Dumb-bell		
• Break Stress	2 ipm	60 ppi	152 ppi
• Elongation at Break	G.L. = 2.0 in (51 mm)	250%	800%
e. Min. Tear Resistance Initiation	ASTM D1004	22 lbs	22 lbs
f. Carbon Black Content	ASTM D1603 or ASTM D4218	2.0-3.0%	2.0-3.0%
g. Carbon Black Dispersion	ASTM D5596	Category	Category
• Minimum 9 of 10		1 or 2	1 or 2
• All 10 of 10		1, 2, or 3	1, 2, or 3
h. Puncture Resistance, Minimum Average	ASTM D4833	44 lbs	56 lbs
i. Oxidative Induction Time, Minimum Average	ASTM D3895 200°, O_2, 1 atm	>100 min.	>100 min
j. Asperity Height, Minimum	GRI GM12		N/A

PROPERTY	TEST METHOD	TEST VALUE TEXTURED LLDPE	TEST VALUE SMOOTH LLDPE
Average			
• Minimum Average		10 mil	
• Lowest Individual 8 of 10		7 mil	
• Lowest Individual 10 of 10		5 mil	

9. Rolls may be rejected if they appear damaged upon delivery or if they have been rejected or returned from another project.

B. Geomembrane Manufacturing Quality Assurance (QA): The geomembrane liner shall be manufactured in accordance with a written quality assurance/quality control program (QC). This QA/QC program shall be submitted to the Engineer or Inspector, together with shop drawings showing the layout of geomembrane liner in the containment facility. After this QA/QC program has been approved by the Engineer or Inspector, the Manufacturer shall not deviate from the program without written approval of the Engineer or Inspector. All testing shall be performed by the manufacturer and results shall be submitted to CQA Inspector for review. The QA/QC program shall include:

1. Routine testing of incoming resin prior to manufacture of geomembranes. This testing shall include tests for density, melt index, and oxidative induction time, at a frequency of not less than one per 200,000 LB.
2. Routine testing of the manufactured sheet for physical parameters. This testing shall include tests for carbon black, tensile strength, and elongation properties, at a frequency of not less than one per 20,000 LB of manufactured geomembrane; tear and puncture resistance and carbon black dispersion at a frequency of not less than one per 45,000 LB of manufactured geomembrane. Thickness shall be monitored continuously through the manufacturing process, or measured physically at a frequency of not less than one per roll of manufactured geomembrane. For textured sheet only, asperity height shall be measured every other roll.
3. Extrusion rod shall be manufactured from identical resin to that used in geomembrane manufacture. Manufactured extrusion rod shall be tested for carbon black, specific gravity and melt index at a frequency of not less than one test per batch.
4. The Manufacturer shall reject resin shipments which do not conform with the density and melt index requirements of the approved QA/QC program. The Manufacturer shall reject manufactured geomembrane which does not conform to the sheet physical requirements of the approved QA/QC program
5. The textured geomembrane shall conform to the requirements prescribed in GRI Test Method GM17.

C. Manufacturing QC data shall accompany the geomembrane shipment.

D. Independent testing of geomembrane shall be conducted in accordance with the CQA Plan.

2.3 INTERFACE FRICTION TESTS

A. Laboratory friction tests shall be conducted, on behalf of the OWNER by the CQA Laboratory, with representative samples of the materials selected by the Contractor for use in the Work. The CQA Inspector is responsible for shipping materials to the testing laboratory. The initial set of testing and subsequent conformance tests (if any) shall be paid for by the Owner. If any interface doesn't meet the requirements, or if the Contractor changes geosynthetic materials, then the additional cost to qualify those materials shall be borne by the Contractor.
Testing will include the interfaces between the following adjacent materials.

Material	Specification Section
Intermediate Cover	02200
40 mil Textured LLDPE Geomembrane	02775

Drainage Composite	02777
Protective Cover	02200

B. The testing shall be performed in accordance with ASTM D5321.
1. The materials shall be tested at normal stressed of 250, 500, and 1,000 psf. Displacement rates shall be in accordance with ASTM D5321 Procedure A for geosynthetic to geosynthetic interfaces and Procedure B for soil to geosynthetic interfaces. Soil components shall be compacted to the same moisture-density requirements specified for full-scale field placement and saturated prior to shear. All geosynthetic interfaces shall be tested in a wet condition. Geosynthetics shall be oriented such that the shear force is parallel to the downslope orientation of these components in the field. The testing laboratory shall confirm these criteria with the CQA Inspector prior to performing the tests.

C. A minimum friction angle of 26 degrees is required for each interface in the system defined in Paragraph A.

D. Interface shear strength of the actual components which will be used in the liner system shall be tested with method ASTM D5321 or an equivalent test method. The interface shall be tested in a water-saturated state.

E. This material is part of a system. The system shall meet the requirements before the component material can be deemed acceptable.

F. Interface friction tests will be conducted by the Owner.

2.4 EQUIPMENT AND ACCESSORIES

A. Welding and Seaming Equipment:
1. Equipped with gages showing temperatures at the nozzle (extrusion welder) or at the wedge (wedge welder).
2. Maintained in adequate numbers to avoid delaying work.
3. Supplied by a power source capable of providing constant voltage under a combined-line load.
4. Electric generator shall not be placed on the LLDPE geomembrane.

B. Field Tensiometer:
1. Provide a tensiometer for on-site shear and peel testing of LLDPE geomembrane seams.
    a. Tensiometer shall be in good working order.
    b. Built to ASTM specifications.
    c. Accompanied by evidence of calibration of equipment and gages within the past six months.
2. Tension meter:
    a. Motor driven.
    b. Jaws capable of traveling a measure rate of 2 IN per minute.
    c. Equipped with a gauge that measures the force in unit pounds exerted between the jaws.
    d. Digital readout.

C. Punch Press:
1. Provide a punch press for the onsite preparation of specimens for testing.
2. Capable of cutting specimens in accordance with ASTM D4437.

D. Vacuum Box:
1. Provide a vacuum box for onsite testing of LLDPE geomembrane seams in accordance with ASTM D5641.

E. Equipment necessary to perform "Pressurized Air Channel Evaluation of Dual Seamed Geomembranes" in accordance with ASTM D5820.

F. Gages:
1. Calibrated within past six months.
2. Specified test values reading near mid-range of the gage scale.

G. Equipment necessary to perform "Non-Destructive Testing of Geomembrane Seams Using The Spark Test" in accordance with ASTM D6365.

2.5 FABRICATION

A. The Manufacturer is responsible for producing geomembrane sheet that complies with this Specification. These responsibilities include but are not limited to:
1. Resin and additive quality control:
    a. Acceptance of the resin and additives from chemical formulators.
    b. Testing of the raw resin and additives to ensure compliance with the Manufacturer's specifications and with this Specification.
2. Formulation of the resin and additives into sheeting using mixing and extrusion equipment.
3. Testing of the sheet material to ensure compliance with Manufacturer's specifications and this Specification.
4. Shipping of the sheet material to Installer.
5. Certification of the raw materials and finished sheet to comply with this Specification.
6. Certification of Installer's training (unless Installer is certified by other acceptable manufacturer list herein), experience and methods for welding, seaming, joining and inspecting geosynthetic materials installations in compliance with Manufacturer's standards and with Quality Assurance requirements of this Specification Part 1.2.

PART 3 - EXECUTION

3.1 GEOSYNTHETIC LINER SYSTEM

A. Geomembrane Subgrade:
1. Protect subgrade at all times from damage until such time as the placement of LLDPE geomembrane liner and other components of the geosynthetic liner system are complete.
2. The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of LLDPE Geomembrane.
    a. The subgrade shall be properly compacted so as not to settle and cause excessive strains in the LLDPE Geomembrane or other synthetic liner materials.
    b. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.
    c. In addition, ensure that the subgrade has been rolled to provide a uniform surface.
    d. During installation, ensure that rutting or ravelling is not caused by installation equipment or weathering.

B. Anchor Trenches:
1. Geosynthetic materials placed on side slopes shall be anchored into trenches as detailed on the Contract Drawings.
2. Excavation, backfill and compaction shall be in accordance with Section 02200.

C. LLDPE Geomembrane:
1. General:
    a. Installer of LLDPE geomembranes is responsible for handling, fitting, welding, seaming, jointing and testing of geosynthetic materials sheets or blankets in the field in accordance with the Construction Quality Assurance (CQA) Plan.
    b. These responsibilities include but are not limited to:
        1) Acceptance (in writing) of the geosynthetic materials sheets or blankets from the transporter.
        2) Acceptance (in writing) of the surface which will serve as a base for the LLDPE geomembrane.
            a) This acceptance shall precede installation of the LLDPE geomembrane.

b) Shall state that the Installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of LLDPE geomembrane liners.

c) Shall explicitly state any and all exceptions to acceptance.

3) Handling, welding, seaming, jointing, testing and repair of LLDPE geomembrane liners and other geosynthetic materials in compliance with this Specification and with written procedures manuals prepared by the Manufacturer or Fabricator.

a) Manual shall be submitted to the Engineer together with Shop Drawings showing the layout of LLDPE geomembrane within the facility.

(1) Do not deviate from the procedures included in the manual.

b) LLDPE Geomembrane shall not be placed upon frozen foundation, standing water or other conditions which will result in deterioration of the foundation.

c) LLDPE Geomembrane liner materials shall be laid out according to plans previously approved by the Engineer.

d) Adjacent rolls of LLDPE geomembrane shall overlap a minimum of 3 IN.

4) Repair or replacement of defects in the geosynthetic materials as required by the Inspector or the Owner.

5) Installer and Manufacturer may be the same firm.

2. Panel deployment:

a. Subgrade Preparation:

1) Prepare subgrade in a manner consistent with proper subgrade preparation techniques for the installation of LLDPE geomembrane liner.

2) Properly compact the subgrade so as not to settle and cause excessive strains in the LLDPE geomembrane liner.

3) Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 IN.

4) Subgrade soils proof-rolled with a ten (10) ton drum roller, two (2) passes parallel to slope or as directed by CQA Inspector. The subbase shall be compacted and proof-rolled under observation of the CQA Inspector to assure the maximum practical compaction under the existing field conditions has been achieved. See specification Section 02220 for project specific compaction requirement.

5) Ensure rutting or raveling is not caused by installation equipment or weather.

6) Ensure that lines and grades have been verified by the Contractor and a subgrade acceptance form has been submitted.

b. Construct and backfill anchor trenches

c. Deploy LLDPE geomembrane liner in a manner to ensure it is not damaged

d. On slopes, anchor the LLDPE geomembrane liner securely and deploy it down the slope in a controlled manner.

e. Weight the LLDPE geomembrane liner with sandbags or equivalent in the presence of wind.

f. Minimize cutting the LLDPE geomembrane liner. Whenever possible, overlap instead of cutting material. If cutting is required, cut LLDPE geomembrane liner with a cutter or other approved device. Seal all cut edges, as recommended by Manufacturer.

g. Only those panel/sheets that can be seamed in 1 day shall be deployed.

h. Place panels with minimal handling.

1) No horizontal seams on side slopes.

2) Protect panels from tear, puncture or abrasion.

i. Equipment used to deploy the geomembrane shall not damage the LLDPE geomembrane.

j. Minimize foot traffic.

1) Do not allow personnel access to wet or slippery liners without adequate safety precautions.

2) Do not allow footwear that may damage the geomembrane.

k. Ballast with sandbags to prevent wind uplift as recommended by Manufacturer based on local climatic conditions.
   1) Remove and replace all wind damaged panels at no additional cost to Owner.
   2) If wind causes panels to be displaced, displaced panel may not be reused.

l. Install LLDPE geomembrane in stress free, tension free and relaxed condition.
   1) Account for temperature and weather-related impacts when deploying and covering.
   2) Stretching to fit and folding are not permitted.

m. Do not allow LLDPE geomembrane to bubble, fold, or create ripples as a result of deployment of drainage layer or protective soil cover placement.
   1) Except as noted on Contract Drawings no folds in LLDPE geomembrane will be allowed.

n. Any panel exhibiting stretching caused by placement, covering techniques, or wind shall be removed and may not be incorporated in the final construction.

o. Field seaming:
   1) Field seaming shall be done in accordance with seaming recommendations furnished by the geomembrane Manufacturer and referenced EPA documents.
   2) Each piece of seaming equipment and each operator shall perform trial seams at the start of a shift, whenever equipment has broken down or seaming is interrupted for more than 30 minutes, and at other times at the discretion of the Installer and Inspector.
   3) Trial seams shall use the same seaming materials and methods to be used in the actual construction.
   4) Surfaces to be seamed shall be clean and dry at the time of seaming.
      a) Precipitation and ponding of water on the LLDPE geomembrane shall cause termination of seaming operations.
      b) LLDPE geomembrane shall not be seamed when ambient temperatures are below 41 DegF or above 104 DegF, without written consent of LLDPE geomembrane Manufacturer and Engineer.
   5) LLDPE geomembrane sheets shall be seamed continuously without fishmouths or breaks in the seam.
      a) Where fishmouths are unavoidable, the sheet shall be slit to a point such that the sheet lies flat and with no remaining wrinkle.
      b) The two edges of the slit shall be seamed together provided that the overlap for this seam shall be a minimum of 6 IN.
      c) Areas of the slit which do not achieve an overlap of 6 IN, including the terminus of the slit, shall be provided with a patch as discussed below.
   6) All LLDPE geomembranes shall be seamed by thermal fusion methods as recommended by the LLDPE geomembrane Manufacturer.
      a) LLDPE geomembrane seaming shall be either extrusion or double wedge welded as approved by the Engineer.
   7) Manufacturer's seaming instructions shall specifically address seaming materials, temporary and permanent jointing, seaming temperatures including temperatures for seaming materials, seam finishing and curing.
   8) A copy of Manufacturer's seaming instructions shall be available on site at all times and shall not be deviated from without written approval of the Manufacturer and Engineer.
   9) All panels/sheets should be overlapped a minimum of 3 IN.
      a) No horizontal seams will be permitted on the side slopes.
   10) Seaming shall not be conducted in the presence of standing water.
      a) The seamed area shall be cleaned of dust, dirt and foreign material prior to and during the seaming operation.
   11) Seaming shall extend to the outside edge of panels/sheets to be placed in anchor and/or drainage trenches.
   12) Tack welds shall conform with manufacturers seaming techniques and shall not damage underlying membrane.

p. Patching:

1) Defects in and damage to LLDPE geomembrane sheets shall be repaired by seaming a patch over the defect.

a) The patch material shall consist of an undamaged piece of LLDPE geomembrane cut to provide a minimum of 6 IN of overlap in all directions from the defect.

b) Round corners shall be utilized on all patches. No bead or spot patching will be accepted.

c) Torn or permanently twisted LLDPE geomembrane shall be replaced at no expense to the Owner.

2) Test all patch seams using one of the following nondestructive tests: vacuum tests or spark tests.

a) Test patch seams destructively at a frequency of ten percent or a minimum of one test per seaming personnel per day.

b) This destructive testing may be accomplished using demonstration seams performed adjacent to the liner installation.

q. Smoking is not permitted while on the geomembrane.

r. Field Panel Identification: The Installer's CQC Consultant will document that the Geomembrane Installer labels each field panel with an "identification code" consistent with the approved panel layout plan. The location of the label and the color of marker used must be as agreed to in the QA/QC Preconstruction Meeting.

3.2 FIELD QUALITY CONTROL

A. Inspector shall not be a part of the installation program and shall not serve as a substitute for performing the duties or certification required of the Manufacturer and Installer.

1. Inspectors responsibilities include, but are not limited to:

a. Inspection of the material and the handling and field installation of the geomembranes. Inspection of all welds, repairs and quality control test results.

b. All exceptions to material or installation shall be documented and furnished to the CQA firm in writing within 48 HRS of discovery.

c. Inspection and Certification of LLDPE geomembrane integrity until completion of placement of protective soil cover.

B. Trial Seam Testing:

1. Trial seams shall be at the start of a shift, whenever equipment has broken down or seaming is interrupted for more than 30 minutes, and at other times at the discretion of the Installer and Inspector.

a. The location of trial seam shall be in an area proposed for the day's production seaming.

b. Equipment, methods and personnel shall be the same as proposed for the day's seaming.

2. Test four replicates (1 IN wide specimens) cut from trial seam.

a. To be acceptable, four of four replicate test specimens must meet specified seam strength requirements and failures shall be Film Tear Bond.

b. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 IN per minute.

c. If the field trial seam tests fail to meet these requirements, the entire operation shall be repeated.

d. If the additional test seams fail, the seaming apparatus or seamer shall not be accepted or used for seaming until the deficiencies are corrected and two consecutive successful test seams are achieved.

C. Non-Destructive Seam Testing:

1. All field seams shall be non-destructively tested over their full length.

a. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming.

b. All testing shall be documented. Any seams which fail shall be repaired and documented.

2. Non-destructively test all field seams continuously using one of the following nondestructive seam tests:
   a. Vacuum box (ASTM D5641). Test at 5psi for 10 seconds. Any loss in vacuum, as indicated by bubbling of soap solution, is a failing test.
   b. Spark tests (ASTM D6365). Test at uniform rate between 6 and 9 meters per minute. A spark indicates a failing test.
   c. Pressurized air channel test (ASTM D5820). For 40 mil geomembrane, test at between 24 and 30 psi for at least 5 minutes. A pressure drop of more than 4psi is a failing test.
3. All tests should be conducted in accordance with their corresponding ASTM method.

D. Destructive Seam Testing:

1. A minimum of one destructive test per 500 LF of seam, and as many other samples as CQA firm determines appropriate, shall be obtained at locations specified by the CQA firm.
   a. Sample locations shall not be identified prior to seaming.
   b. The samples shall be a minimum of 12 IN wide by 48 IN long with the seam centered lengthwise.
   c. Each sample shall be cut into three equal pieces with one piece retained by the Installer, one piece given to an CQA Testing Laboratory, and the remaining piece given to the CQA Engineer for quality assurance testing and/or permanent record.
   d. Each sample shall be numbered and recorded on the final panel layout record drawing, and cross-referenced to a field log which identifies:
      1) Panel/sheet number.
      2) Seam number.
      3) Top sheet.
      4) Date and time cut.
      5) Ambient temperature.
      6) Seaming unit designation.
      7) Name of seamer.
      8) Seaming apparatus temperature and pressures (where applicable).
2. A minimum of four 1 IN wide replicate specimens shall be cut from the Installer's sample.
   a. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 IN per minute.
   b. To be acceptable, all field test specimens must meet the specified seam strength requirements and fail as Film Tear Bond.
   c. If all field tests pass, 5 specimens shall be tested at the CQA Testing Laboratory for shear strength and 5 for peel adhesion in accordance with ASTM D6392.
   d. To be acceptable, 4 out of 5 replicate test specimens must meet the specified seam strength requirements and fifth sample must meet 80% required strength.
   e. Shear elongation and Peel separation shall not exceed values given in GRI GM19
3. The minimum required seam strengths for <u>40 mil LLDPE</u> are:

Description	Test Method	Seam Type	Required Value (lbs/in width)
LLDPE Peel	ASTM D6392	Extrusion	48
LLDPE Peel	ASTM D6392	Fusion	50
LLDPE Shear	ASTM D6392	All	60

4. For destructive samples which have failed the passing criterion, the Contractor will reconstruct all the field seams between any two previous passed seam locations which include the failed seam or will go on both sides of the failed seam location (10 feet minimum), take another sample each side and test both. If both pass, the Contractor may patch or cap strip the seam between the passed samples. If either fails, the Contractor will remove and replace the entire seam. In all cases, acceptable field seams must be bounded by two passed test locations. The decision of the CQA Engineer will be final.

   a. In addition, all destructive seam sample holes shall be repaired the same day as cut.
   b. Certified test results on all field seams shall be submitted to and approved by the CQA Engineer prior to acceptance of the seam.
5. All repaired areas shall be destructively tested at a minimum of every 500 LF of extrusion weld.
   a. All repaired areas shall be non-destructively tested.
6. Destructive testing shall be performed by an CQA Testing Laboratory not employed by the Installer.
7. A map showing the locations, number and type of all patches shall be prepared and provided to the Owner.
8. Documentation: The following documentation must be maintained at the project site for review by the CQA Engineer or Inspector.
   a. Geomembrane Installer's Documentation:
      1) Daily Log: daily record that summarizes panels deployed, seams completed, seam testing, seam repair, personnel on site, weather conditions, and equipment on site.
      2) Material Conformance: maintain original conformance certificate(s) from geomembrane manufacturer.
      3) Subgrade Acceptance Log: maintained originals of subgrade acceptance forms for each panel and signed by the Geomembrane Installer.
      4) Panel Log: provides geomembrane roll number used and subgrade acceptance for each panel deployed.
      5) Seam Testing Log: provides a complete record of all nondestructive and destructive seam tests performed as part of the Geomembrane Installer's QC program.
      6) Seam/Panel Repair Log: provides a complete record of all repairs and vacuum box testing of repairs made to defective seams or panels.
      7) As-Built Drawing: maintain an as-built drawing updated on a weekly basis.

3.3 GEOSYNTHETIC LINER SYSTEM ACCEPTANCE

A. Contractor shall retain all ownership and responsibility for the geosynthetic liner system until final acceptance by the Owner.
   1. Owner will accept the geosynthetic liner system installation when the installation is finished and all required warranties, test results, and documentation from the Contractor, Manufacturer, Inspector and Installer has been received and approved, and verification of the adequacy of all field seams and repairs, including associated testing, is complete.

END OF SECTION

SECTION 02777
DRAINAGE COMPOSITE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bonded geotextile-geonet drainage composite.

B. Related sections include but are not necessarily limited to:
   1. Section 02778 - Geotextiles.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D1238, Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
      b. D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
      c. D1603, Standard Test Method for Carbon Black in Olefin Plastics.
      d. D1987 Test Method for Biological Clogging of Geotextile or Soil/Geotextile Filters.
      e. D4716, Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
      f. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
      g. D5199, Standard Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
      h. D5321, Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
      i. D7005, Determining the Bond Strength (Ply Adhesion) of Geocomposites.
      j. D5035, Standard Test Method for Breaking Force and Elongation of Textile Fabrics (strip method).

   2. Geosynthetic Research Institute (GRI).
      a. GRI GC8 – Determination of the Allowable Flow Rate of a Drainage Geocomposite.

B. Qualifications:
   1. Each manufacturing and fabricating firm shall demonstrate five (5) years continuous experience, including a minimum of 5,000,000 SF of drainage composite production in the past three (3) years.
   2. Installer shall attend pre-installation conference.

1.3 DEFINITIONS

A. Manufacturer: Manufacturer producing drainage composites from geonet cores and geotextiles.

B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer's documentation that raw materials and roll materials comply with required drainage composite physical properties.
   2. Manufacturer and Installer quality control manuals.

3. Original test results for resins and roll material at frequency specified in respective quality control manuals.
    a. Include or bracket the rolls delivered for use in the Work.
4. Proposed details of anchor trench if different than included in Contract Documents.

B. Miscellaneous Submittals:
1. Qualification documentation specified in Article 1.2.
2. Transmissivity test.
3. Interface friction test.

1.5 DELIVERY, STORAGE AND HANDLING

A. Label, handle, and store drainage composites in accordance with ASTM D4873 and as specified herein.

B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
1. Do not remove the plastic wrapping until deployment.

C. Label each roll with the manufacturer's name, drainage composite type, lot number, roll number, and roll dimensions (length, width, gross weight).

D. Repair or replace, as directed by the Engineer, drainage composite or plastic wrapping damaged as a result of storage or handling.

E. Do not expose drainage composite to temperatures in excess of 71 DegC (160 DegF) or below 0 DegC (32 DegF) unless recommended by the Manufacturer.

F. Do not use hooks, tongs or other sharp instruments for handling the drainage composite.

G. Do not lift rolls by use of cables or chains in contact with the drainage composite.

H. Do not drag drainage composite along the ground or across textured geomembranes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. CETCO
2. GSE Lining Technology.
3. Polyflex Inc.
4. Skaps Industries.
5. Tenax Corp.

2.2 MATERIALS AND MANUFACTURE

A. Geonet Core:
1. Use nonthermally degraded polyethylene polymer which is clean and free of any foreign contaminants.
2. Manufactured geonet to conform to the property requirements listed in Table 1 and be free of defects including tears, nodules or other manufacturing defects which may affect its serviceability.

TABLE 1 - GEONET PROPERTIES

PROPERTY	TEST METHOD	REQUIRED VALUE	MIN. MQC TEST FREQUENCY
Specific Gravity/ Density (g/cm^3) (min)	ASTM D1505	>0.94 g/cc	1 per 50,000 ft^2 and every resin lot
Thickness (mil)	ASTM D5199	300 mil (min)	1 per 50,000 ft^2 and every resin lot
Carbon Black Content	ASTM D1603	2 percent	1 per 50,000 ft^2 and every resin lot
Tensile Strength	ASTM D5035	75 lbs/in MD	1 per 50,000 ft^2 and every resin lot

B. Geotextile:
1. Cover geonet core on both sides or single side, as shown on Drawings, with a geotextile complying with requirements specified in Section 02778: Geotextiles, Drainage.

C. Drainage Composite:
1. Create a composite by heat bonding geotextiles to the geonet.
2. Transmissivity = 1.3x10^{-3} m^2/sec @ 100 hrs and 1,000 psf by ASTM D4716 (see Paragraph 2.3 A).
3. Ply adhesion ASTM D7005 MARV of 1 lb/in.

D. Independent conformance testing shall be performed in accordance with CQA Plan.

2.3 SOURCE QUALITY CONTROL

A. Transmissivity Testing:
1. Measure transmissivity using water at 68 DegF with a normal compressive load of 1,000 psf. and a hydraulic gradient of 0.33
2. Attach geotextiles to the geonet in the same configuration as will be used in the field.
3. Boundary conditions are soil interface on the upper geotextile and textured LLDPE geomembrane against the lower geotextile.
4. Maximum design normal load testing shall be conducted for a minimum period of 100 hours unless data equivalent to the 100-hour period is provided in which case the test shall be conducted for a minimum period of one hour.
5. Testing frequency: 1 test for every 540,000 SF of installed product

B. Interface Friction Tests.
1. Laboratory friction tests shall be conducted, on behalf of the OWNER by the CQA Laboratory, with representative samples of the materials selected by the Contractor for use in the Work. The Contractor is responsible for shipping materials to the testing laboratory. The initial set of testing and subsequent conformance tests (if any) shall be paid for by the Owner. If any interface doesn't meet the requirements, or if the Contractor changes geosynthetic materials, then the additional cost to qualify those materials shall be borne by the Contractor. Testing will include the interfaces between the following adjacent materials.

Material	Specification Section
Protective Cover	02200
Drainage Composite	02777
40 Mil Textured HDPE	02775
Intermediate Cover	02200

2. The testing shall be performed in accordance with ASTM D5321.
3. The materials shall be tested at normal stressed of 250, 500, and 1,000 psf. Displacement rates shall be in accordance with ASTM D5321 Procedure A for geosynthetic to geosynthetic interfaces and Procedure B for soil to geosynthetic interfaces. Soil components shall be compacted to the same moisture-density requirements specified for full-scale field placement and saturated prior to shear. All geosynthetic interfaces shall be tested in a wet condition. Geosynthetics shall be oriented such that the shear force is parallel to the downslope orientation of these components in the field. The testing laboratory shall confirm these criteria with the CQA Inspector prior to performing the tests.
4. A minimum friction angle of 26 degrees is required for each interface in the system defined in Paragraph A.
5. Interface shear strength of the actual components which will be used in the liner system shall be tested with method ASTM D5321 or an equivalent test method.
6. This material is part of a system. The system shall meet the requirements before the component material can be deemed acceptable.
7. Interface friction tests will be conducted by the CQA Testing Laboratory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prior to placement of the drainage composite, clean the substrate of all soil, rock, and other materials which could damage the composite.

B. The geocomponent drainage media shall be placed only on geomembrane that has been approved by the Geomembrane Installer and accepted by the CQA Inspector.

3.2 INSTALLATION

A. Install geocomposite drain in accordance with manufacturer's written recommendations.

B. Deploy the drainage composite ensuring that the drainage composite and underlying materials are not damaged.
   1. Replace or repair faulty or damaged drainage composite as directed by Engineer.

C. Unroll drainage composite downslope keeping in slight tension to minimize wrinkles and folds.

D. Maintain free of dirt, mud, or any other foreign materials at all times during construction.
   1. Clean or replace rolls which are contaminated.

E. Place adequate ballast to prevent uplift by wind.

F. Overlap adjacent rolls a minimum of 6 IN.
   1. Overlap new drainage composite over existing as shown on the Drawings.
   2. Shingle all edges of geocomposite downslope

G. Use manufacturer's fasteners to join adjacent rolls.
   1. Metallic fasteners will not be allowed.
   2. Space fasteners a maximum of 5 FT along downslope roll overlaps and a maximum of 1 FT along cross slope roll overlaps.
   3. Use fasteners of contrasting color from the drainage composite to facilitate visual inspection.
   4. Do not weld drainage composite to geomembranes.
   5. Install geotextile cap strip wherever ends of geocomposite are exposed to soil intrusion.

H. See Section 02778, Geotextiles, for information on seaming the upper geotextile to the upper geotextile of the adjacent rolls.

I. Repairs holes or tears in the drainage composite by placing a patch of drainage composite extending a minimum of 2 FT beyond the edges of the hole or tear.

1. Use approved fasteners, spaced every 6 IN around the patch, to fasten the patch to the original roll.

3.3 FIELD QUALITY CONTROL

A. Prior to installation of the drainage composite, the Installer's CQC Consultant shall provide the Engineer quality control certificates signed by the manufacturer's quality assurance manager for every 540,000 SF of geocomposite drainage media to be installed illustrating satisfactory transmissivity tests among other attributes.

END OF SECTION

SECTION 02778
GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Non-woven geotextile material for use in geocomposite drainage layer and other applications shown on the Drawings..
   2. Woven geotextile material for wrapping drainage stone.

B. Related Sections:
   1. Section 02200 -Earthwork.
   2. Section 02777 - Drainage Geocomposite.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway Transportation Officials (AASHTO):
      a. M288, Standard Specification for Geotextile Specification for Highway Application.
   2. ASTM International (ASTM):
      a. D1987, Biological Clogging of Geotextile or Soil/Geotextile Filters.
      b. D3786, Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method.
      c. D4354, Sampling of Geosynthetics for Testing.
      d. D4355, Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
      e. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
      f. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
      g. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
      h. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
      i. D4759, Standard Practice for Determining the Specification Conformance of Geosynthetics.
      j. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
      k. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
      l. D4884, Strength of Sewn or Thermally Bonded Seams of Geotextiles
      m. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
      n. D6193, Standard Practice for Stitches and Seams.

B. Qualifications:
   1. Each manufacturing, fabricating firm shall demonstrate 5 years continuous experience, including a minimum of 10,000,000 SF of geotextile installation in the past three (3) years.
   2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation of a minimum of 1,000,000 SF of geotextile.
   3. Installer shall attend pre-installation conference.

1.3 DEFINITIONS

A. Manufacturer: Manufacturer producing geotextile sheets from resin and additives.

B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

C. MARV: Minimum Average Roll Value

1.4 SUBMITTALS

A. Shop Drawings:
   1. Manufacturer's documentation that raw materials and roll materials comply with required geotextile physical properties.
   2. Manufacturer and Installer quality control manuals.
   3. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals.
      a. Results shall include or bracket the rolls delivered for use in the Work.
   4. Proposed details of anchoring and overlapping if different than included in Contract Documents.

B. Miscellaneous Submittals:
   1. For needle punched geotextiles, the Manufacturer shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
   2. Qualification documentation specified in Article 1.2.B

1.5 DELIVERY, STORAGE AND HANDLING

A. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.

B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
   1. Do not remove the plastic wrapping until deployment.

C. Label each roll with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).

D. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.

E. Do not expose geotextile to temperatures in excess of 71 DegC (160 DegF) or less than 0 DegC (32 DegF) unless recommended by the manufacturer.

F. Do not use hooks, tongs or other sharp instruments for handling geotextile.
   1. Do not lift rolls lifted by use of cables or chains in contact with the geotextile.
   2. Do not drag geotextile along the ground.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. GSE Lining Technology.
   2. Mirafi (Ten CAte Geosybthetics)
   3. Propex.
   4. SKAPS Industries.
   5. Tenax Corp.
   6. Or approved equal

2.2 MATERIALS AND MANUFACTURE

A. Geotextile:
   1. Non-woven and woven pervious sheet of polymeric material.
   2. Geotextile fibers:
      a. Long-chain synthetic polymer composed of at least 85 percent by weight polyolefins, polyesters, or polyamides.
      b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
      c. Do not add reclaimed or recycled fibers or polymer to the formulation.

3. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.
4. The geotextile physical properties shall equal or exceed the minimum average roll values listed below.
   a. Values shown are for the weaker principal direction unless both values are shown.
   b. Acceptance of geotextile shall be in accordance with ASTM D4759.

Non-woven Drainage Geotextile: Used in the geocomposite for drainage and other applications shown on Drawings.

PROPERTY	TEST METHOD	MARV	MIN. MQC TEST FREQUENCY
Mass per Unit Area, oz/yd^2	ASTM D5261	6	1 per 90,000 ft^2
Grab Tensile Strength (lbs)	ASTM D4632	170	1 per 90,000 ft^2
Puncture Strength (lbs)	ASTM D4833	90	1 per 90,000 ft^2
AOS, US sieve (mm)	ASTM D4751	70	1 per 540,000 ft^2
Permittivity, (sec^{-1})	ASTM D4491	1.5	1 per 540,000 ft^2
Flow Rate, gpm/ft^2	ASTM D4491	110	1 per 540,000 ft^2
Ultraviolet Degradation, % retained @ 500 HRS	ASTM D4355	70	1per formulation

Non-woven Drainage Geotextile: Used in the EGC anchor trenches.

PROPERTY	TEST METHOD	MARV	MIN. MQC TEST FREQUENCY
Mass per Unit Area (oz/sy)	ASTM D5261	16	1 per 90,000 ft^2
Grab Tensile Strength (lb)	ASTM D4632	370	1 per 90,000 ft^2
Grab Tensile Elongation (%)	ASTM D4632	50	1 per 90,000 ft^2
Puncture Resistance (lb)	ASTM D4833	170	1 per 90,000 ft^2
Trapezoidal Tear Strength (lb)	ASTM D4533	145	1 per 90,000 ft^2

Woven Geotextile: Used to wrap drainage stone.

PROPERTY	TEST METHOD	MARV	MIN. MQC TEST FREQUENCY
Grab Tensile Strength (lbs)	ASTM D4632	370x250	1 per 90,000 ft^2
Trapezoidal Tear (lbs)	ASTM D4533	100x60	1 per 90,000 ft^2
Elongation, %	ASTM D4632	16x15	1 per 90,000 ft^2
Puncture Strength (lbs)	ASTM D4833	130	1 per 90,000 ft^2
AOS, US sieve (mm)	ASTM D4751	70	1 per 540,000 ft^2
Permittivity, (sec^{-1})	ASTM D4491	0.28	1 per 540,000 ft^2
Flow Rate, gpm/ft^2	ASTM D4491	18	1 per 540,000 ft^2
Ultraviolet Degradation, % retained @ 500 HRS	ASTM D4355	90	1per formulation

B. Thread:
   1. High-strength polyester, nylon, or other approved thread type.
   2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
   3. Contrasting color with the geotextile.

PART 3 - EXECUTION

3.1 PREPARATION

A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

3.2 INSTALLATION

A. Install geotextiles in accordance with manufacturer's written recommendations except as follows.

B. Handling shall be in accordance with ASTM D4873.
   1. No equipment will be permitted to traffic in direct contact with the geotextile.

C. Lay geotextile smooth so as to be free of tensile stresses, folds, and wrinkles.

D. Seam Construction:
   1. Sew all geotextile seams except for geotextile used to wrap drainage stone or used for erosion control purposes For these exceptions. Adjacent panels may be overlapped without sewing as long as the seams do not come apart when material is placed over them.
   2. Broom clean existing geotextile and cut off to provide a clean area for seaming with the new geotextile.
   3. Sew seams continuously using an SSA flat seam with one (1) row of a two-thread 401 chain stitch unless otherwise recommended by the manufacturer.
   4. Minimum distance from the geotextile edge to the stitch line nearest to that edge: 2 IN unless otherwise recommended by the manufacturer.
   5. Tie off thread at the end of each seam to prevent unraveling.
   6. Construct seams on the top side of the geotextile to allow inspection.
   7. Sew skipped stitches or discontinuities with an extra line of stitching with 18 IN of overlap.
   8. Overlap adjacent panels a minimum of 6 IN.

E. Protect geotextiles from clogging, tears, and other damage during installation.

F. Geotextile Repair:
   1. Place a patch of the same type of geotextile which extends a minimum of 24 IN beyond the edge of the damage or defect.
   2. Fasten patches continuously using a sewn seam or other approved method.
   3. Align machine direction of the patch with the machine direction of the geotextile being repaired.
   4. Replace geotextile which cannot be repaired.

G. Use adequate ballast (e.g., sand bags) to prevent uplift by wind.

H. Do not use staples or pins to hold the geotextile in place.

I. Geotextile left uncovered for more than 14 days shall be removed and replaced at the contractors expense.

J. Damaged rolls may be rejected. If rejected, verify that rejected material is removed from the site or stored at a location separate from accepted rolls. Geotextile rolls that do not have proper manufacturer's documentation must also be stored at a separate location until all documentation has been received and approved.

K. The CQA Inspector shall observe that the equipment used to install the geotextile does not damage it during deployment.

L. Crews working on the geotextile shall not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.

3.3 FIELD QUALITY CONTROL

A. The CQA Consultant shall confirm that the identification, storage, and handling of geotextiles is in accordance with ASTM D4873. Any deviation from this requirement will be reported to the Engineer.

B. The CQA Consultant will examine all manufacturer's certifications to ensure that the property values listed on the certifications meet or exceed these specifications. Any deviations will be reported to the Engineer.

C. The CQA Consultant will observe placement of the geotextiles to confirm that the panel overlaps and seams are in accordance with these speacifications. Any deiations will be reported to the Engineer.

END OF SECTION

SECTION 15079
PIPE - CORRUGATED POLYETHYLENE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This item shall consist of furnishing, fabricating, and installing corrugated polyethylene pipe of the types, classes, sizes, gauges, and dimensions as shown on the plans, at such places as are designated on the plans and profiles, or by the Engineer, in accordance with these specifications and in conformity with the lines and grades given.

B. Piping locations include, but may not be limited to:
   1. Slope drains.
   2. Toe drains.

1.2 SUBMITTALS

A. Verify on Shop Drawing dimensions, schedule of pipe, fittings, and miscellaneous appurtenances. When special fittings are necessary, verify locations of items and include complete details.

B. Render copies of any manufacturer's written instructions regarding material handling, delivery, storage, and installation.

C. As Work progresses and again when Work is complete, submit "As Recorded" Drawings of piping systems in project including project items and pre-existing items. Identify complete location, elevation, and description of piping systems. Relate piping systems to identified structures and appurtenances.

PART 2 - MATERIALS

2.1 GENERAL

A. Corrugated Polyethylene Pipe and Connections: This pipe and connections shall conform to the requirements of AASHTO M294-94.

B. All pipes shall be dual-walled pipe (water tight connections) and shall have a full circular cross-section, within an outer corrugated pipe wall and a smooth inner liner, ADS N-12 or approved equal.

C. Basic Materials: Pipe and fittings shall conform to the requirements of ASTM D3350, except the carbon black content shall not exceed 5 percent.

D. Coupling Bands: Flexible pipe shall be firmly joined by coupling bands. These bands shall be not more than two nominal sheet thicknesses lighter than the thickness of the pipe to be connected.
   1. Soil/Watertight couplers shall be used to connect individual pipe sections.
   2. Reinforced couplers shall be used where the possibility of separation is great. These couplers shall be constructed of a heavy cross-laminated polyethylene backing, rubberized mastic sealer, plastic straps with sheathing, and woven polypropylene reinforcing.

PART 3 - EXECUTION

3.1 GENERAL

A. Equipment: All equipment necessary and required for the proper construction of piping shall be on the project, in first class working condition. The Contractor shall provide such mechanical tampers as required to obtain the compaction of the pipe bedding and backfill as specified.

B. Excavation: The Contractor shall perform all excavation to the depth and/or dimensions shown on the plans with special attention given to avoid damaging the underlying geosynthetic components of the final and temporary final cover system. Any damage to the final and temporary final cover system due to Contractor's action shall be repaired at Contractor's expense. The bedding for the pipe shall be so shaped that at least the lower quarter of the pipe shall be in continuous contact with the bottom of the trench. Bedding shall be as shown on the plans.

C. Placing Pipe: The pipe shall be laid with the separate sections joined firmly together with coupling bands with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. The pipe shall be laid carefully and true to lines and grades on a bed which is uniformly firm throughout its entire length. Any pipe which is not in true alignment, or which shows any undue settlement after laid or is damaged, shall be taken up and relaid or replaced without extra compensation. Pipe shall not be laid on frozen ground.

D. Connections: Contractor shall follow manufacturer's recommendations in installing pipe connections.

E. Backfill: The trench shall be backfilled with protective cover material and compacted to the same density as specified in Section 02200. Maintain minimum cover as shown in the Drawings.

END OF SECTION