PERMIT TO CONSTRUCT

Wayne County Municipal Solid Waste Landfill Facility Phase 3

Permit No.:	9606-MSWLF-1998
Site Location:	460B South Landfill Rd. Dudley, NC 28333
Applicant:	Wayne County
Applicant's Address:	224 E. Walnut St., 3rd Floor Goldsboro, NC 27530

MESCO Project Number
G06096

Permit No.	Date	Document ID No.
96-06	**June 13, 2011**	**14016**

APPROVED DOCUMENT
Division of Waste Management
Solid Waste Section
Received Dated: April 2010 revised through May 2011
Date: **June 13, 2011** By: **Ming-Tai Chao**

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE
5/13/2011

Revised May 2011
Revised March 2011
Revised February 2011
Revised December 2010
April 2010

Submitted by the Garner Office of:

LICENSE NUMBER: C-0281
Municipal Services Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529
(919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607
(828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557
(252) 726-9481

License No. C-0281

CIVIL/SANITARY/ENVIRONMENTAL ENGINEERS

SOLID WASTE MANAGEMENT

Municipal Services Engineering Company, P.A.

SITE PLANNING/SUBDIVISIONS

SUBSURFACE UTILITY ENGINEERING (SUE)

Permit No.	Date	Document ID No.
96-06	**May 24, 2011**	**14008**

RECEIVED
May 24, 2011 via a mail
Solid Waste Section
Raleigh Central Office

May 20, 2011

Ming-Tai Chao, P.E.
Environmental Engineer II
NCDENR – Solid Waste Section
401 Oberlin Rd.
Raleigh, NC 27605

Re: Permit to Construct Phase 3
Wayne County Municipal Solid Waste Landfill Facility
Permit No. 96-06

Dear Mr. Chao:

In response to your email dated May 19, 2011, we submit the following:

Response to DWM Comment Number 1: (Drawings)

We have revised Drawings F1, F2, F3 and E1.

Response to DWM Comment Number 2: (Post-Closure Costs)

We have revised Page 334 as requested..

Please find enclosed one (1) hard copy of the revised page 334, the four(4) revised drawings and the Electronic copy. If you have any questions or need additional information please don't hesitate to give us a call.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., PA

Lisa H. Crawford

Lisa H. Crawford
Designer

Enclosures

Permit No.	Date	Document ID No.
96-06	May 24, 2011	14007

DELIVERED
May 19, 2011 via an e-mail
Solid Waste Section
Raleigh Central Office

Chao, Ming-tai

From: Chao, Ming-tai
Sent: Thursday, May 19, 2011 2:44 PM
To: 'Wayne Sullivan'
Subject: FW: Phase 3 PTC, Wyane County MSWLF, # 96-06
Attachments: 13957.pdf

Hey Wayne:

I have two comments on the new submittal which was received on 05/18/2011.

1. The following figures have the old IDs of the methane gas wells which are inconsistent with those in the Landfill Gas Monitoring Plan dated April 12, 2011 (Doc ID 13611). They are: Figures F1, F2, & F3 in the Facility Plan. Figure E1 in the Engineering Plan. Please revise this figures accordingly.
2. In the post-closure cost estimate (page 334), please add the costs for "soil cover (cap) monitoring and repairing problem" in the amount of $100,000.00 for 30 years to the final costs.

Please provide me a electronic copy of the final document and hard copy of the revised portions of the permit application document – figures and post-closure estimates.

By the way, Christine has approved the Design Hydro today (Doc ID 13957) – see attachment.

I am currently working on the draft PTO for Phase 1 & 2 and PTC for Phase 3. Upon receiving your final document, I will submit the draft permit to Ed for review and approval. Please be sure that County submit the correct FA (including the 3 million dollars) to Donald Herndon (919-508-8502) ASAP. Without his FA approval, Ed may not sign the permit. Thanks for your and your associates' assistances and patients on this year-long permit-reviewing journey.

Best regards,

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section
Division of Waste Management
1646 Mail Service Center
Raleigh, NC 27699-1646
401 Oberlin Road, Suite 150, NC 27605
Tel: 919.508.8507, Fax 919.733.4810
ming.chao@ncdenr.gov
http://portal.ncdenr.org/web/wm/sw

From: Chao, Ming-tai
Sent: Wednesday, May 18, 2011 2:40 PM
To: 'Wayne Sullivan'
Subject: Phase 3 PTC, Wyane County MSWLF, # 96-06

Hey Wayne: I received the new submittal of the PTC application and two figures this noon for the above-referenced landfill. I will start the review this afternoon. By the way, could you send me the electronic copy of this new submittal? So that I can upload the document to the DWM web site. Thanks.

Ming Chao

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Beverly Eaves Perdue | Dexter R. Matthews | Dee Freeman
Governor | Director | Secretary

May 19, 2011

Mr. Tim Rogers, Solid Waste Director
406 B South Landfill Road
Dudley, North Carolina 28533

Re: Technical Review of Design Hydrogeologic Report,
Ground and Surface Water Sampling and Analysis Plan, and
Landfill Gas Monitoring Plan
Wayne County Subtitle D Landfill Phase 3 Expansion
Wayne County, Dudley, North Carolina
Permit No. 96-06, Document ID No. 13957

Dear Mr. Rogers:

The North Carolina Solid Waste Section has completed a technical review of the Design Hydrogeologic Study *DIN 10382*, Ground and Surface Water Sampling and Analysis Plan *DIN 13717* and Landfill Gas Monitoring Plan *DIN 13611* submitted as part of the Permit to Construct Application for the Wayne County Subtitle D Landfill Phase 3 Expansion.

The Groundwater and Surface Water Sampling and Analysis Plan is amended to include three new groundwater monitoring wells (MW-14, MW-15, and MW-16) associated with the Phase 3 expansion area plus thirteen existing groundwater monitoring wells (MW-1 through MW-13) to comprise a total groundwater monitoring network of sixteen wells. Piezometers installed during subsurface exploration of Phase 3 will need to be abandoned prior commencement of construction activities.

Surface water will be monitored at 4 locations: existing surface water sampling points SW-2, SW-3, SW-4 and SW-5. One leachate sample will be collected at leachate collection point LE-1.

The Design Hydrogeologic Study and the Ground and Surface Water Sampling and Analysis Plan meet the criteria of 15A NCAC 13B .1623(b) and .1624(b) (4), and therefore, this portion of the Permit to Construct Application is approved.

The Landfill Gas Monitoring Plan was submitted and reviewed on April 12, 2011. Seven existing landfill gas monitoring points (MP-17 through MP-21, MP-24 and MP-25) are located on the western and eastern perimeters of Phases 1 and 2 of the landfill. Five additional landfill gas monitoring points MP-26 through MP-30 will be installed on the northern perimeter of Phase 3 of the landfill. The Landfill Gas Monitoring Plan meets the regulatory requirements of 15A NCAC 13B .1626(4) (b).

Piezometers, groundwater monitoring wells, and borings located in the proposed phase for construction may be abandoned now or after a Permit to Construct is issued by the Solid Waste Section. Prior to construction of the new phase, all piezometers, groundwater monitoring wells, and borings located within the footprint must be properly abandoned by overdrilling first (exception of non-cased borings) and sealed with grout in accordance with 15A NCAC 2C.0113 (d) entitled "Abandonment of Wells".

Well abandonment records (GW-30 form) for each decommissioned piezometer, boring, and groundwater monitoring well must be certified by a Licensed Geologist in accordance with rule .1623(b)(2)(I) and submitted to the Solid Waste Section in accordance with 15A NCAC 02C.0114(b). After the piezometers and/or groundwater wells are abandoned and new landfill gas well(s) constructed, submit an updated monitoring well location drawing.

The new groundwater monitoring wells must be sampled for the Appendix I constituent list, including Mercury, Chloride, Manganese, Sulfate, Iron, specific conductance, pH, temperature, Alkalinity, Total Dissolved Solids prior to the Solid Waste Section issuing the Permit to Operate. In addition to a hard copy report, provide the Solid Waste Section with an electronic copy of the groundwater and surface water monitoring data collected at the landfill facility. Guidelines for sampling groundwater and surface water, and submitting data electronically can be located at the Solid Waste Section's web site: http://wastenotnc.org/swhome/technical_assistance.asp

Additional Geologic, Ground Water and Monitoring Requirements will be included in the Permit to Construct.

If you have any questions, you may contact me at (919)508-8506.

Sincerely,

Christine Ritter
Hydrogeologist
Solid Waste Section

Cc: Madelaine German, Municipal Engineering Services Company, P.A.
Ming-Tai Chao, DWM
Ed Mussler, DWM
Wes Hare, DWM

CIVIL/SANITARY/ENVIRONMENTAL ENGINEERS
SOLID WASTE MANAGEMENT
Municipal Services Engineering Company, P.A.
SITE PLANNING/SUBDIVISIONS
SUBSURFACE UTILITY ENGINEERING (SUE)

May 13, 2011

Ming-Tai Chao, P.E.
Environmental Engineer II
NCDENR – Solid Waste Section
401 Oberlin Rd.
Raleigh, NC 27605

Re: Permit to Construct Phase 3
Wayne County Municipal Solid Waste Landfill Facility
Permit No. 96-06

Dear Mr. Chao:

In response to your email dated April 13, 2011, we submit the following:

Facility Plan

Response to DWM Comment Number 1: (Section 1.1.2)

We have revised the text.

Response to DWM Comment Number 2: (Section 1.1.2)

The text has been revised.

Response to DWM Comment Number 3: (Section 1.1.1)

The text has been revised.

Operation Plan

Response to DWM Comment Number 4 (Leachate Breakouts):

We have added Section 5.5 - Appendix III.

Response to DWM Comment Number 5: (ADC)

We have added Section 5.6 – Appendix IV back into the text.

Additional Comments(PTO – Phase 1 & 2/PTC Phase 3

Response to DWM Comment Number 1: (Compliance History Review)

This will be provided directly to you from the county.

Response to DWM Comment Number 2: (Financial Assurance)

The text has bee revised as requested.

PO Box 97, Garner, North Carolina 27529 (919) 772-5393
PO Box 828, Morehead City, NC 28557 (252) 726-9481
PO Box 349, Boone, NC 28607 (828) 262-1767

Please find enclosed one (1) hard copy of the complete revised text, and two (2) drawings that were revised due to Hydrogeologic Comments. If you have any questions or need additional information please don't hesitate to give us a call.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., PA

Lisa H. Crawford

Lisa H. Crawford
Designer

Enclosures

Cc: w/o Enclosures: Tim Rogers, Solid Waste Director

Chao, Ming-tai

From:	Chao, Ming-tai
Sent:	Wednesday, April 13, 2011 4:06 PM
To:	'Tim.Rogers@waynegov.com'
Cc:	'Joan C. Snider'; 'Wayne Sullivan'; Hare, Wes; Mussler, Ed; Herndon, Donald
Subject:	Additionall Comments on PTC -Phase 3, Wayne County MSWLF, 96-06
Attachments:	ADC.Guidance.Draft.pdf; Compliance History Review-Wayne County.pdf

Dear Mr. Rogers:

I have completed the another round review of the engineering portions of the permit application for Phase 3. Below are the questions or comments that need your inputs:

Facility Plan

1. (Section 1.1.2) This Section describes that the facility is open 4 days per week, but according to the Wayne County website, the landfill opens for public four and half days per week, closed on Sunday & Wednesday. Please provide the correct info of operation hours and days in Section 1.1.2..

2. (Section 1.1.2) The waste disposal rate stated in this Section is 402 ton per day (tpd) which is less than the existing permit-approved 450 tpd. Does the County intend to reduce the waste disposal rate? Additionally, the annual disposal rate and tpd are normally calculated from the projected air space of the 5-year phase (cy) converting to tonnage according the historical compaction effort & density and operation day per year. So please provide me the final annual disposal tonnage and the tonnage per day for the next 5 years.

3. The Section 1.1.1 describes the facility has a permitted total capacity of 5,004,195 cy. However, the total capacity in Section 1.2 is 5,365,695 cy (including 3,825,935 cy from Phase 2 (unused) through Phase 8 plus the maximum inventory waste of 1,539,760 cy from Phases 1 &2). I believed the capacity of 5,004,195 cy, approved in 1997 is the air space of the landfill excluding volume consists of the final cover system because the 1600 Rule does not require report the total gross capacity (later 500 Rule requires the total gross capacity & so does the DWM's annual report). The way to straight out this matter, I suggest that "Soli needed for closure" of 398,066 cy in Section 1.2 is replaced with the value of 361,500 cy, the difference between 5,365,695 cy & 5,004,195 cy. Additionally, to be consistent through the Facility Plan, in Section 1.1.1, please rephrase the last sentence in the first paragraph that "The facility has a permitted air space of 5,004,195 cubic yards. The approved gross capacity that is the measured volume between the top of the protective cover and the top of final cover is 5,365,695 cubic yards". If you agree with my suggestion please revise these Sections accordingly.

Operations Plan

4. The Division Audit Report dated January 25, 2011 indicated that ponding water and leachate outbreaks occurred at the landfill. To properly manage and control the runoff and prevent from recurrence of the similar situation in the future, County must modify the Operations Plan to address the provisions for inspecting, preventing, and repairing leachate breakout on the side slopes and standing water at landfill.

5. The Division Audit Report dated January 25, 2011 indicated that tarps are being used as an alternative daily cover (ADC). I went through the DWM file system and couldn't locate any application that has been submitted by County to request for using tarp as an ADC. I can't find approval documents including existing permit to allow County use tarp as an ADC in lieu of 6-inch earthen material, either. Therefore, please provide me the document of approving use of the trap as an ADC issued by DWM; **otherwise, Wayne County must cease applying ADC immediately** and use earthen material as daily

cover according to Rule 15A NCAC 13B .1626(2) and the existing permit condition. If County wants to use an ADC, please submit an application according to the attached guidance document and modify the Operations Plan.

In addition to the responses to the above-mentioned comments, County must complete the following conditions (It is advised that the issuance of the permit [PTO- Phase 1 & 2 /PTC- Phase 3] for Wayne County MSWLF is contingent on the DWM approval of these conditions):

1. The approved Compliance History Review. The permit shall not be issued to County until the compliance review is completed and approved by DWM. **The questionnaire form has been sent over to your attention twice last year**. Up to now the Solid Waste Section has not received the completed form yet. Again, I am attaching the form in this e-mail for you to complete the processes. This process will cover both landfill facilities – C&DLF (96-01) & MSWLF (96-06). Please complete the form ASAP, if you have any question please contact Mr. Donald Herndon, the Compliance Officer at 919-508-8502 or ask Mr. Wayne Sullivan for assistance.

2. The approved financial assurance (FA). Pursuant to NCGS 130A-295.2(h), effective August 1, 2009, Wayne County must also provide financial assurance sufficient to cover a minimum required amount of three million dollars ($3,000,000.00) for potential assessment and corrective action at the MSWLF facility and costs of closure and post-closure care at Phases 1 & 2 areas. The Solid Waste Section agrees to allow environmental monitoring costs and maintenance costs being removed out of post-closure costs and rolling into costs for potential assessment and corrective action. The approaches for cost adjustments and final costs for closure, post-closure, and potential assessment and corrective action are shown below:

   The process for recalculating Post Closure Costs is pretty straight forward. The costs that can be transferred to the $3 million are ground water and surface water monitoring, landfill gas monitoring and the maintenance of these monitoring networks.

   In the case of Wayne County:
   2003 Post Closure Estimates =$1,291,600
   (subtract)
   2003 Groundwater and Surface water Monitoring Estimate=$705,600
   2003 Methane Gas Monitoring Estimate=$72,000
   2003 Monitoring Network Maintenance=$60,000
   (equals)
   2003 Reduced Post Closure Cost Estimates=$454,000

   Post Closure Costs adjusted for inflation (2% each year) for 2011 dollars=$532,000

   2003 Closure Costs=4,060,466

   Closure Costs adjusted for inflation (2% each year) for 2011 dollars=$4,757,000

   2011 Potential Assessment and Corrective Action=$3,000,000

   Total Financial Assurance in 2011 dollars=$8,289,000

If you have any questions of the above-mentioned matters, please feel free to contact me.

Best regards,

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section
Division of Waste Management
1646 Mail Service Center
Raleigh, NC 27699-1646
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License No. C-0281

CIVIL/SANITARY/ENVIRONMENTAL ENGINEERS

SOLID WASTE MANAGEMENT

Municipal Services Engineering Company, P.A.

SITE PLANNING/SUBDIVISIONS

SUBSURFACE UTILITY ENGINEERING (SUE)

March 31, 2011

Ming-Tai Chao, P.E.
Environmental Engineer II
NCDENR – Solid Waste Section
401 Oberlin Rd.
Raleigh, NC 27605

Re: Permit to Construct Phase 3
Wayne County Municipal Solid Waste Landfill Facility
Permit No. 96-06

Dear Mr. Chao:

In response to your letter March 11, 2011, we submit the following:

<u>Section 1.0 – Facility Plan</u>

Response to DWM Comment Number 1: (Section 1.2. Landfill Capacity)

We have revised the text.

<u>Section 2.0 –Engineering Plan</u>

Response to DWM Comment Number 2: (Section 2.1.3)

The plans and text have been revised to reflect these changes.

Response to DWM Comment Number 3: (Section 2.1.3)

The plans and text have been revised to reflect these changes.

Response to DWM Comment Number 4 (Engineering Plan Figures):

All drawings have been revised.

<u>Section 4.0 –Construction Quality Assurance (CQA) Plan</u>

Response to DWM Comment Number 5: (4.2.2)

The text has been revised.

Response to DWM Comment Number 6: (Section 4.2.6)

We have added the requested text in Section 4.2, because we were address all components of the liner system we decided it should be placed in a general section, not just in the protective cover section.

Response to DWM Comment Number 7: (Section 4.2.7)

The text has not been revised. Testing is not required for this material.

Response to DWM Comment Number 8: (Section 4.2.11)

The text has been revised.

<u>Section 5.0 – Operation Plan</u>

Response to DWM Comment Number 9:

As agreed, the LFGCC's, LFGTE As-Builts and Operation Plan will be submitted with the QA/QC documents.

<u>Section 6.0 – Closure Plan</u>

Response to DWM Comment Number 10: (Section 6.1)

The text has been revised.

Response to DWM Comment Number 11: (Section 6.3)

The text has been revised in Section 6.3 to match the revised text in Section 1.2.

Response to DWM Comment Number 12: (Section 6.8):

The text has been revised in Section 6.7 and the cost estimate in Section 6.8 remains the same.

<u>Section 7.0 – Post-Closure Plan</u>

Response to DWM Comment Number 13: (Section 7.2)

The text has been revised to show the correct total.

Please find enclosed one (1) hard copy of the revised drawings and text, and a CD with the revised Permit to Construct application. If you have any questions or need additional information please don't hesitate to give us a call.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., PA

Lisa H. Crawford

Lisa H. Crawford
Designer

Enclosures

Cc: w/o Enclosures: Tim Rogers, Solid Waste Director

North Carolina Department of Environment and Natural Resources
Division of Waste Management

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

Solid Waste Section

March 11, 2011

Mr. Tim Rogers
Solid Waste Director
460 B South Landfill Road
Dudley, NC 28333

Re: Additional Comments on Permit To Construct Application for Phase 3 (Permit Application), Wayne County Municipal Solid Waste Landfill (MSWLF)
Wayne County, North Carolina
Permit No. 96-06, Document ID No. (Doc ID) 13196

Dear Mr. Rogers:

The Division of Waste Management (DWM), Solid Waste Section has reviewed the February 02 2011 letter and attached revised Permit Application (Doc ID12973), submitted by Municipal Engineering Services Co., Inc. (MESCO), on behalf of Wayne County, to respond the DWM's comments (Doc ID 12580) dated January 04, 2011. Based on the review Solid Waste Section has additional comments on the new submittal, and your responses to the following comments will expedite the review of the Permit Application:

Section 1.0 – Facility Plan

1. (Section 1.2 Landfill Capacity) In the last sentence of the Section 1.2, the estimated schedule of closure will be approximately 33 years, the reported "43 years" is likely a typographic error. Please make necessary correction.

Section 2.0 – Engineering Plan

2. (Section 2.1.3, page 15) The Solid Waste Management Rule (Rule) 15A NCAC 13B .1624(b)(4) requires that a MSWLF shall be constructed so that the **post settlement** bottom elevation of the **base liner system** is a minimum of four feet above the season high groundwater table and bedrock datum plan counters established in the Design Hydrogeological Report prepared in accordance with Rule .1632(b) of this section." Pursuant to Rule .1624(b)(4) requirement, County must revise the description of the "vertical separation – **waste** and season high groundwater" in Section 2.1.3 accordingly.

3. (Section 2.1.3, page 15) Section 2.1.3 reported that "Phase 3 has a minimum vertical separation … of **9.11 ft**." However, according to the data presented in Table 5 and Drawing Nos. Plate 4A/Sheet No. 1 of 1 and Plate 4B/Sheet No. 1 of 1 of the *Design Hydrogeologic*

Study (Doc ID 10382) for Phase 3 development dated July 2008, the elevations of seasonal high groundwater and long term seasonal high underneath the Phase 3 ranging from 134 to 152 feet above mean seal level (amsl), from the west to east directions; and the elevations of designed subgrade range from 165 to 139.5 feet amsl - from center portion of the Phase 3 toward the west end (west sump area) and from 165 to 153 feet amsl - from center portion of the Phase 3 toward the east end (east sump area) as shown on Drawing No. E6/Sheet 8 of 17. Superposing or overlapping the above-referenced drawings, it is evident that the minimum vertical separation distances occur in the vicinity of each of the two sump areas, approximately 4.79 feet (east sump area) and 4 feet (west sump area), respectively.

However, according to the Engineering Plan the calculated total settlement on the subgrade underneath Phase 3 area resulting from the proposed 115-feet-high waste loading is approximately 18 inches or 1.5 feet. The Rule .1624(b)(4) requires that vertical separation distance is measured from the **post settlement** top elevation of the subgrade. Therefore, the actual minimum vertical separation distances occur in the vicinity of each sump area, after subtracting out 1.5 feet settlement, approximately **3.29 feet** (east sump area) and **2.5 feet** (west sump area), respectively. County must conduct the following actions:

i. Redesign the final subgrade elevations of each landfill cell to meet the requirements stated in Rule .1624(b)(4) & (7).

ii. Re-examine the designs and calculations of the proposed leachate collection and removal system (LCRS) in the Engineering Plan to ensure the expected leachate can be properly and safely removed by gravity drain according to the requirements stated in Rule .1624(b)(2).

iii. Revise the related information due to the change of subgrade elevations throughout the Permit Application resulting from the response to the Comment 3i, such as the total gross landfill capacity for Phase 3 and/or future phases in the Facility Plan (text, tables and drawings).

4. (Engineering Plan Figures) Please address the following concerns:

i. (Drawing No. E2/Sheet 4 of 17) The references of details of silt fence and inlet/outlet protections to Sheet 6 of 17 is incorrect. The correct reference is Sheet 7 of 17. Please correct the typo on the drawing.

ii. (Drawing No. E6/Sheet 8 of 17 through Drawing No. E8/Sheet 10 of 17 and E13/ Sheet 15 of 17) The designed final grade lines for each layer may be subjected to changes in accordance the responses to the Comment No. 3.

Section 4.0 Construction Quality Assurance (CQA) Plan

5. (Sections 4.2.2, pages 237 through 239) For the sake of consistency of the testing methods as specified in Section 4.2.11, please use ASTM D2487 to replace ASTM D2488 in Section 4.2.2.

6. (Section 4.2.6, page 260) Please add the QA/QC testing requirements (testing method, frequency, and minimum passing criteria [26 degree]) of the interface angles between Geocomposite Drainage Layer and 3-ft-thick protective soil cover and FML (60-mil textured HDPE) which are the components of the proposed base liner system and to be installed on the 3 (horizontal) to 1 (vertical) side slopes of the proposed Phase 3.

7. (Section 4.2.7, Paragraph (2) - Stone Surrounding Perforated Collection Pipe, page 264) Please provide the QA/QC testing methods and frequency on the stone (NCDOT aggregate standard size No. 5) surrounding the perforated collection piping to ensure that the stone column has a minimum hydraulic conductivity of 0.1 cm/sec or 0.04 inch/sec in consistent with LCRs design in the Section 2.2.4 (on page 139) of the Engineering Plan.

8. (Section 4.2.11, Paragraph 5 (b)(3) - Sample Procedures, on page 274) The testing passing/failure criteria are applicable to HDPE but not applicable to LLDPE. Please revise the testing passing/failure criteria accordingly.

Section 5.0 – Operations Plan

9. The Solid Waste Section conditionally accepts the response to the Comment No. 21 dated January 04, 2011. Wayne County must submit the LFGCCs and LFGTE as-built drawings and a revised Operation Plan with QA/QC document to the Solid Waste Section for review and approval. The Permit To Operate for the new Phase 3 will not be issued to Wayne County until this pre-operational condition is completed fulfilled.

Section 6.0 – Closure Plan

10. In Section 6.1, the estimate of the maximum inventory of waste (1,539, 258 cubic yards) ever on-site over the active life to date of the landfill facility is not consistent with the one (1,539, 760 cubic yards) described in Section 1.2 of the Facility Plan. Please clarify.

11. In the last sentence of the Section 6.1, the estimated schedule of closure (43 years) is likely a typographic error of 33 years (see Comment No. 1). Please make necessary correction.

12. (Section 6.8) The cost item No.8 must also include costs of material (gravel, geotextile, etc.) other than vent pipes for methane gas system as described in Section 6.7 and presented in the previously submitted Permit Application. Please revise the cost estimate according to the Closure Plan and related drawing – Typical Methane Gs Collection Well to Vent Conversion Detail on Drawing No. E-12/Sheet 14 of 17.

Section 7.0 – Post-Closure Plan

13. (Section 7.2) The sum of the total estimated costs in the amount of $2,064,000 for the proposed Post-Closure cares is incorrect. The correct value is $2,154,000. Please make necessary correction.

Please submit DWM the completed written responses and the hard copy of the portions of the Permit Application which are subjected to change and one completed electronic copy of the submittal (the responses letter and the completed new permit application). The Solid Waste

Section appreciates your efforts and cooperation in this matter. If you have any permitting questions, please contact me at (919) 508- 8507.

Sincerely,

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section

cc:
Wayne Sullivan, MESCO
Donna Wilson, DWM
Dennis Shackelford, DWM
Central File
Ed Mussler, Permitting Branch Supervisor
Christine Ritter, DWM
Wes Hare, DWM

CIVIL/SANITARY/ENVIRONMENTAL ENGINEERS
SOLID WASTE MANAGEMENT
Municipal Services Engineering Company, P.A.
SITE PLANNING/SUBDIVISIONS
SUBSURFACE UTILITY ENGINEERING (SUE)

February 2, 2011

Ming-Tai Chao, P.E.
Environmental Engineer II
NCDENR – Solid Waste Section
401 Oberlin Rd.
Raleigh, NC 27605

Re: Permit to Construct Phase 3
Wayne County Municipal Solid Waste Landfill Facility
Permit No. 96-06

Dear Mr. Chao:

In response to your letter January 4, 2011, we submit the following:

General

The agency name has been revised as requested.

Section 1.0 – Facility Plan

Response to DWM Comment Number 1: (Section 1.2. Landfill Capacity)

We have revised the plans and the text. We eliminated Phases 9 and 10 and revised Phases 7 and 8 to reduce the amount fill, and to eliminate the need for a substantial permit amendment.

Response to DWM Comment Number 2: (Section 1.1.2)

The text has been revised.

Response to DWM Comment Number 3: (Section 1.4.2, i. –iii.)

The text has been revised.

Section 2.0 –Engineering Plan

Response to DWM Comment Number 4: (Section 2.1.3)

(i.) The text in question, was mistakenly included and is not relevant to this project. The text has been revised to address this project.

(ii.) The text has been revised.

(iii.) We have raised the subgrade, cohesive soil liner and the protective cover, in the sump area in question, to allow a cushion of vertical separation from the seasonal high groundwater. The drawings have been revised to reflect this change.

(iv.) The requirement for separation is four feet between the waste and the seasonal high groundwater, therefore the amount of separation is acceptable, even with the possible 18 inches of settlement.

Response to DWM Comment Number 5: (Section 2.2.4 Initial Calculation on Page 137)

The text in question, was mistakenly included and is not relevant to this project. The text has been revised to address this project.

Response to DWM Comment Number 6 (Section 2.2.8):

Due to the change in allowable volume, we have revised the Facility Drawings. ECS Limited was given the new highest possible fill height and they have redone the settlement analysis. This Letter has been added to Section 2.2.8.

Response to DWM Comment Number 7 i.-v.: (Engineering Plan Figures)

The Engineering Drawings have been revised as requested.

Section 4.0 –Construction Quality Assurance (CQA) Plan

Response to DWM Comment Number 8:

The text has been revised as requested.

Response to DWM Comment Number 9: (Section 4.1)

The text has been revised as requested.

Response to DWM Comment Number 10, i.-iii.: (Section 4.2.2)

The text has been revised as requested.

Response to DWM Comment Number 11: (Section 4.2.3)

The text in Table 1 of Section 2.4 has been revised as requested.

Response to DWM Comment Number 12: (Section 4.2.3, Subsection 3.5, on page 249)

The text has been revised in Sections 3.3.1 and 4.2.3 as requested.

Response to DWM Comment Number 13: (Section 4.2.4)

i. The text has been revised to address the alternate liners.
ii. We have changed Section 4.2.10 from "Closure of Cohesive Soil Cap" to "Conformance Testing for Interface Friction Angles of Capping Materials". Subsequently, all remaining subsection numbers have been shifted down one number, for example what was Section 4.2.10 is now 4.2.11.

Response to DWM Comment Number 14: (Section 4.2.5)

i. The text has been revised as requested.
ii. The text has been revised as requested.

Response to DWM Comment Number 15: (Section 4.2.6:

We have changed Section 4.2.10 from "Closure of Cohesive Soil Cap" to "Conformance Testing for Interface Friction Angles of Capping Materials". Subsequently, all remaining subsection numbers have been shifted down one number, for example what was Section 4.2.10 is now 4.2.11.

Response to DWM Comment Number 16:(Section 4.2.7)

Please revisions made in the 12/15/2010 revision, (blue text) Section 4.2.7 (2).

Response to DWM Comment Number 17(i. – iii.): (Section 4.2.10)

The text has been revised as requested..

Response to DWM Comment Number 18(i. – iii.): (Section 4.2.11)

The text has been revised as requested.

Response to DWM Comment Number 19(i. – iii.): (Section 4.2.11)

We have changed Section 4.2.10 from "Closure of Cohesive Soil Cap" to "Conformance Testing for Interface Friction Angles of Capping Materials". Subsequently, all remaining subsection numbers have been shifted down one number, for example what was Section 4.2.10 is now 4.2.11.

<u>Section 5.0 – Operation Plan</u>

Response to DWM Comment Number 20(i. – v.):

The text has been revised as requested.

Response to DWM Comment Number 21:

The text has been revised as requested.

Response to DWM Comment Number 22(i. – v.):

At this time, the County is in the process of modifying and expanding the LFGCC system. We are unable to address the items of concern at this time. We will be able to submit LFGCC As-Builts and a revised Operation Plan with the QA/QC documents.

<u>Section 6.0 – Closure Plan</u>

Response to DWM Comment Number 23(Section 6.1):

The text has been revised to be consistent with the Facility Plan.

Response to DWM Comment Number 24(Section 6.3):

The text has been revised.

Response to DWM Comment Number 25(Section 6.6):

The text has been revised to be consistent with the Facility Plan.

Response to DWM Comment Number 26(i.-iii.) (Section 6.8):

The text has been revised to address the differences in acreages.

<u>Section 7.0 – Post-Closure Plan</u>

Response to DWM Comment Number 27(i.-ii.) (Section 7.2):

The text has been revised to address the increase in wells and maintenance.

Please find enclosed one (1) hard copy of the revised drawings and text, and a CD with the revised Permit to Construct application. If you have any questions or need additional information please don't hesitate to give us a call.

Sincerely,
MUNICIPAL ENGINEERING SERVICES CO., PA

Lisa H. Crawford

Lisa H. Crawford
Designer

Enclosures

Cc: w/o Enclosures: Tim Rogers, Solid Waste Director

North Carolina Department of Environment and Natural Resources
Division of Waste Management

Beverly Eaves Perdue
Governor

Dexter R. Matthews
Director

Dee Freeman
Secretary

Solid Waste Section

January 04, 2011

Mr. Tim Rogers, Solid Waste Director
460 B South Landfill Road
Dudley, NC 28333

Re: Comments on Permit To Construct Application for Phase 3 (Permit Application)
Wayne County Municipal Solid Waste Landfill (MSWLF)
Wayne County, North Carolina
Permit No. 96-06, Document ID No. (Doc ID) 12580

Dear Mr. Rogers:

On December 22, 2010, the Division of Waste Management (DWM), Solid Waste Section received the revised Permit to Construct Application for Wayne County MSWLF - Phase 3 (Doc ID 12564) which did not include the *Design Hydrogeologic Study*. This Permit Application is replaced the originally permit application (Doc ID 10887) submitted to the DWM in June 2010. Both applications are prepared and submitted by Municipal Engineering Services Co., Inc. (MESCO) in Garner, North Carolina, on behalf of Wayne County.

The Solid Waste Section has completed a review of the engineering related portions of the new Permit Application in accordance with the Solid Waste Management Rule (Rule), 15A NCAC 13B .1600 et seq. Based on the review, the Solid Waste Section has the following comments on the new submittal, and your responses to the comments will expedite the review of the Permit Application. The Solid Waste Section Hydrogeologist will review the *Design Hydrogeologic Study* (Doc 10382) and may request any additional information related to water quality monitoring and hydro-geology in a separate letter upon completion of his or her review.

General

Please use the correct name of the agency – the Division of Waste Management throughout the Permit Application, not Division of Solid Waste or Department. Please conduct a global search throughout this Permit Application and make necessary corrections.

Section 1.0 – Facility Plan

1. (Section 1.2 Landfill Capacity) This Section describes that the Wayne County MSWLF has a total capacity of 7,585,258 cubic yards (cy), consisting of the current in-place waste volume of 1,539,258 cy (Phases 1 & 2) and the remaining available airspace of 6,045,498 cy (remaining Phases 2 and future Phase 3 through Phase 10). The proposed total capacity is

not consistent with the original approved capacity of 5,004,195 cy as described in the Section 1.1.1 of the Permit Application and the existing Permit Condition No. 3 (Part 1, Attachment 2) of Permit to Construct – Phase 2 issued on February 3, 2004. If County plans:

i. To adopt the originally approved landfill capacity of 5,004,195 cy. County must revise the landfill capacity of each to-be-developed phase in Section 1.2 and the Facility Plan Drawings No. F6/Sheet 8 of 15 through Drawings No. F13/Sheet 15 of 15. Or
ii. To increase the landfill total capacity from 5,004,195 cy to 7,585,258 cy which results in a permit substantial amendment in accordance with NCGS 130A-294(b1)(1) due to more than 10% quantity of solid waste to be disposed in the Wayne County MSWLF. Pursuant to Rule .1603(a)(1)(E) County must submit a Site Study and conduct a local government approval processes according to the Rules .1617 and .1618 and pay the statutorily required permit fee.

Within 30 calendar days after receiving this letter, Wayne County must inform the DWM of the final decision on the landfill total capacity. Should County fail to timely respond this comment, the Solid Waste Section will reject the Permit Application and return the application document back to Wayne County.

2. (Section 1.1.2) The existing PTO for Phase 2 allows Wayne County MSWLF to receive permitted wastes at an average disposal rate of approximately 450 tons per day based on 312 operating days per year. This approved waste disposal rate is greater than the proposed 402 tons per day as described in this Section. If County intends to maintain the disposal rate of 450 tons per day, please make clear statement in the Section 1.1.2; otherwise, the new rate of 402 tons per day will be specified in the new PTO for Phase 3.

3. (Section 1.4.2) Please address the following concerns:
   i. The average monthly flow rate and the peak daily value, collected from layer 4 per acre for a five-year period, are inconsistent with the data show in the HELP Model in Section 2.2.3. Please clarify.
   ii. The values of average head and maximum head on layer 5 per acre for a five-year period are inconsistent with the data show in the HELP Model in Section 2.2.3. Please clarify.
   iii. The layer 4 is a drainage layer, not the HDPE liner. Please correct this typo.

<u>Section 2.0 – Engineering Plan</u>

4. (Section 2.1.3) Please address the following concerns:
   i. The minimum vertical separation distances (between subgrade and seasonal high groundwater; between subgrade and long term seasonal high) described in the subsection are different from the data presented in Table 5 of the *Design Hydrogeologic Study* and Drawing No. E13/Sheet 15 of 17. Please clarify.
   ii. According to the conclusions in Section 2.2.8, the estimated total settlement under the projected waste loads is 18 inches, not 7 inches as described in the Section 2.1.3. Please correct this typo.
   iii. Around the sump area on the eastside of the Phase 3, the vertical separation distance is approximately 3.5 feet to four feet between subgrade and seasonal high groundwater as

shown at the cross-section at Station 2+00 on Drawing No. E13/Sheet 15 of 17. This designed landfill subgrade does not meet the requirement stated in Rule .1624(b)(4).

iv. Has the settlement of the soil strata underneath the landfill, resulting from the wastes loading been considered in the design of landfill base subgrade? When the data in Table 5 of the *Design Hydrogeologic Study* subtracts the estimate settlement of 18 inches, the designed subgrade of the landfill cell around borings P3-3 and P3-13 are less than the minimum four (4) feet separation requirement.

To respond the Comment Nos. 4.iii & 4.iv, County must re-examine the designed landfill cell to ensure that the designed final subdrades of landfill cell meets the requirement stated in Rule .1624(b)(4). Should the landfill base subgrade elevations are changed, County must revise the related information in the Permit Application, such as the total landfill capacity for each to-be-developed phase, tables, figures in the Facility, Engineering, and Operations Plans.

5. (Section 2.2.4 - Initial Calculation on Page 137) The irrelevant information to the Wayne County MSWLF is described in this section, such as the leachate lagoon capacity, calculated amount of leachate from Phase 3 operation by HELP Model, actual leachate generation in the last five years, and the treatment plant receiving leachate generated from the landfill. Please provide the correct facility-specific information.

6. (Section 2.2.8) According to the Figure 2 and the "Project Information" Section, the landfill final grade elevation of 280-ft amsl is inconsistent with that (330-ft amsl) on Facility Plan Drawing No. F12/Sheet 14 of 15. Please address the following concerns resulting from the above-mentioned discrepancy:

   i. The report based on the information as illustrated on Figure 2 and concluded that "the applied load is approximately 8,185 psf, resulting in estimated settlement on the order of 18 inches." Since the settlement of the soil strata underneath the landfill is one of the crucial factors to determine if the final design landfill subgrade meets the vertical separation requirement stated in Rule .1624(b)(4), settlement analysis for the landfill must consider <u>the loading generated from all phases construction and operation</u> according to the Facility Plans. It is evident that approximately 50-feet of addition waste loading has not been considered in the settlement analysis; therefore, please re-run the analysis according to the landfill final grade elevations (Please also consult the responses to the Comment No. 1 for the information).

   ii. Please use the estimated settlement amount (from the above-mentioned comment) to (a) design the final grade elevations of the Phase 3 landfill cells (refer to Comment No. 4. Iv.) and (b) to evaluate if the settlement of the foundation soil (both total settlement and differential settlement) will cause or contribute to the failure of the geosynthetic liners or leachate collection systems.

   iii. Provide the assumptions, references, and calculation processes pertain to the settlement analyses (both total settlement and differential settlement) and the evaluation report stated in the Comment No. 6.ii.

7. (Engineering Plan Figures) Please address the following concerns:

i. (Drawing No. E2/Sheet 4 of 17) The references of details of silt fence and inlet/outlet protections to Sheet 6 of 17 is incorrect. The correct reference is Sheet 7 of 17. Please correct the typo on the drawing.
ii. (Drawing No. E6/Sheet 8 of 17 through Drawing No. E8/Sheet 10 of 17 and E13/ Sheet 15 of 17) The designed final grade lines for each layer may be subjected to changes in accordance the responses to the Comment Nos. 1, 4.iv, & 6.i.
iii. (Drawing No. E14/Sheet 16 of 17) Please provide the typical details of "Typical Pressure Pipe Trench" (force-main lines) and "Leachate System Cleanout" to the drawing.
iv. (Drawing No. E15/Sheet 17 of 17) The reference of details of permanent anchor trench and cohesive clay liner to Sheet 10 of 15 is incorrect. The correct one is Sheet 16 of 17. Please correct the typo on the drawing.
v. The size of the reducer, connecting riser and header leachate pipes, is incorrectly specified as 12" X 8" on Drawing No. E9/Sheet 11 of 17; the correct size shall be 24" X 8" as specified on Drawing No. E15/Sheet 17 of 17. Please make necessary correction.

Section 4.0 Construction Quality Assurance (CQA) Plan

8. Since the "project Engineer" is not defined in the Section 4.1, please conduct a global search throughout the Section 4.0 to ensure the name of "Project Engineer" is replacing by "**Engineer**," "Project Superintendent" is replacing by "**Flexible Membrane Liner Superintendent**," and "CQA Inspector" is replacing by **Construction Observer."**

9. (Section 4.1) This CQA Plan shall be prepared for constructing all landfill components described in the Permit Application including final cover systems; therefore, please revise the Contractor's responsibility by adding "**construction of final cover system and gas venting system**" in the third sentence of the fifth paragraph of this Section.

10. (Sections 4.2.2) Please address the following concerns:
    i. In the Paragraph (i), what provisions are there to repair the holes after the survey stakes are pulled out of the soil surfaces? Please clarify.
    ii. In the Paragraph (l), please add" and mixed in the field using either a plug mill or a soil stabilizer." to the end of the second sentence.
    iii. In the Paragraphs (h) & (n), should the area requires to be reworked or replaced also be retested? Please clarify.

11. (Section 4.2.3) According to Sections 2.2.6 and 2.2.8 of the Engineering Plan, the interface friction angles between geosynthetic material and earthen material are summarized below:

Material Interface	Interface Angle (degree)	Note
Landfill Base (on a 3 to 1 slope)		
Compacted Clay Liner(CCL) / GCL	25	p. 147
GCL/FML (60-mil HDPE)	21	pp.187 & 196
FML(60-mil HDPE)/Geocomposite Drainage Layer	26	pp.190 &195
Geocomposite Drainage Layer/Protective Soil Layer	26	p. 148

Therefore, please revise the minimum criteria of the interface friction angles listed in Table 1 of Subsection 2.4 (on page 245) accordingly.

12. (Section 4.2.3, Subsection 3.5, on page 249) Please address the following concerns for construction and backfilling of the permanent anchor trenches:
    i. Specify the earthen material (type & maximum grain size, etc.) and the minimum compaction effort (determined by ASTM D698) for the compacted backfill in the anchor trenches, which is consistent with the compaction effort noted in the "Permanent Anchor Trench Detail" on Drawing No. E14/Sheet 16 of 17.
    ii. Specify field QC testing methods and frequencies (1 test per xx linear feet) on the compacted backfill in the anchor trenches

13. (Section 4.2.4) Please address the following concerns:
    i. The first sentence (on page 251) of the last paragraph proposes the 60-mil HDPE liner will be placed in direct contact with moist cohesive soil liner. What about the condition of the alternate liners (18-in-thick CCL and GCL)? Please clarify.
    ii. Please add the QA/QC testing requirements (testing method, frequency, and minimum passing criteria [26 degree]) of the interface angles between FML (60-mil textured HDPE) and Geocomposite Drainage Layer.

14. (Section 4.2.5) Please address the following concerns:
    i. (Paragraph (c) – Destructive Testing, on page 259) Please add the specification of "the tensiometer that has a constant separation rate of 2.0 inch per minute for peel and shear" to this subparagraph (2) Procedure for Destructive Testing.
    ii. (Paragraph (d) – Quality Assurance Laboratory Testing, on page 260) The repair procedure must address the repair procedures pertaining to the FML underlain by the alternate liner # 2 (CCL and GCL) conditions. Please clarify

15. (Section 4.2.6) Please add the QA/QC testing requirements (testing method, frequency, and minimum passing criteria [26 degree]) of the interface angles between Geocomposite Drainage Layer and 3-ft-thick protective soil cover.

16. (Section 4.2.7) Please provide the QA/QC testing methods and frequency on the stone surround perforated collection piping to ensure that the stone column has a minimum hydraulic conductivity of 0.1 cm/sec or 0.04 inch/sec consistent with LCRs design in the Section 2.2.4 (on page 139) of the Engineering Plan.

17. (Section 4.2.10, on Page 269) Please address the following concerns:
    i. In the Paragraph (i), what provisions are there to repair the holes after the survey stakes are pulled out of the soil surfaces? Please clarify.
    ii. In the Paragraph (m) please add "such as tire ruts" to the end of the last sentence in consistent with the Section 4.2.2 (m).
    iii. In the Paragraphs (h) & (n), should the area requires to be reworked or replaced also be retested? Please clarify.

18. (Section 4.2.11) Please address the following concerns:
    i. (Paragraph 1 (c) – Verification, on page 272) The CQA testing properties and frequencies shall be consistent with Section 4.2.4. Therefore, add the following paragraph to the Section 4.2.11.(1) Paragraph (c):
    The Engineer will remove a sample from 1 out of 4 rolls delivered to the site and have a third party lab test for thickness, density, carbon black content & dispersion, and all tensile properties. The lab will have been accredited by the Geosynthetic Accreditation Institute (GAI).
    ii. (Paragraph 2 (c) – Method of Deployment, subparagraph (c), on page 272) Specify deployment and installation of the FML panels follow the manufacturer's recommendations and sound and accepted engineering practices.
    iii. (Paragraph 5 (b) - Sample Procedures, on page 274) Add the specification of "the tensiometer that has a constant separation rate of 2.0 inch per minute for peel and shear" to the first step.

19. (Section 4.2.11) With respect to the testing of interface friction angles between the components consisting of the final cover system, the technical specification must be prepared and describe: testing methods and frequencies, and the minimum interface friction angles between:
    i. The 24-inch-thick Protective Soil Cover and the 250-mil-double-bounded drainage composite.
    ii. The 250-mil-double-bounded drainage composite and the 40-mil LLDPE.
    iii. The 40-mil LLDPE and the 18-inch-thick compacted clay liner

    The specified minimum interface friction angles must be equal to or exceeding those designed values concluded from the Section 2.2.9 in the Engineering Plan.

Section 5.0 – Operations Plan

20. Please address the following concerns and make necessary corrections:
    i. The reference for the Explosive Gas Control Plan is incorrect in the ninth paragraph (Section 5.1 on page 289). The Explosive Gas Control Plan is located in Section 5.4 – Appendix II.
    ii. Since the Section 5.3 -Appendix I describes the Waste Screening and Inspection Plan, the reference of the Appendix I analyte for groundwater and surface water sampling in Section 5.3 (the fifth paragraph, Section 5.1 on page 290) of the Operations Plan is incorrect. Please provide the correct reference.
    iii. Please delete "Section 5.4-Appendix II" from the subparagraph b of the Part 2 (Cover Material Requirements) of Section 5.2, which is not relevant to the cover material requirements.
    iv. The reference for the Explosive Gas Control Plan is incorrect in the subparagraph b of the Part 4 (Explosive Gas Control) of Section 5.2. The Explosive Gas Control Plan is located in Section 5.4 – Appendix II.
    v. According to the Engineering Plan in the Permit Application, the leachate generated from the County's MSWLF is treated in the City of Goldsboro wastewater treatment plant.

Kinston wastewater treatment plant stated in the subparagraph d of the Part 12 (Leachate Management Plan) of Section 5.2 is likely a typo.

21. There is a discrepancy of the required schedule for restoring the vegetative ground cover and control erosion between Section 5.1 (2nd paragraph on Page 290) and Section 5.2 (the subparagraph b of the Part 7 – Erosion and Sedimentation Control Requirements on Page 294). Please clarify.

22. The landfill gas collection and control system (LFGCCs) and landfill gas to energy project (LFGTE) are installed and operating at the Wayne County MSWLF. Please address the following concerns:
    i. Provide the as-built drawings to show the layout of the existing gas extraction locations, identifications and survey coordinates of extraction wells and control valves, the header line runs and sizes, the locations of condensate/leachate lockouts or sumps, and the location of flare station.
    ii. Please describe the condensate/leachate handling and management plan.
    iii. Because the LFGCCs and LFGTE are regulated by air quality permits issued by the NC Division of Air Quality, please briefly describe the permit type and submit a copy of the valid permit appended to the Operations Plan.
    iv. Because the LFGCCs and LFGTE are operated during the active-life span of the MSWLF, the Operations Plan needs to describe the routine inspection, repair, and maintenance requirements for the system, the system operator qualification and training (such as SWANA's "Landfill Gas System Operation and Maintenance" training courses), and fire prevention.
    v. Please describe how the operation of LFGCCs is coordinated with daily operations of the MSWLF.

Section 6.0 – Closure Plan

23. In Section 6.1, the estimate of the maximum inventory of waste ever on-site over the active life to date of the landfill facility is 1,626,907 cubic yards; however, this volume is in consistent with the one described in Section 1.2 of the Facility Plan. Please clarify.

24. (Section 6.3) In the Paragraphs (h) & (n), should the area requires to be reworked or replaced also be retested? Please clarify.

25. (Section 6.6) The material specification of the drainage composite stated in Section 6.6 (Geonet thickness of 220 mils) is inconsistent with that (Geonet thickness of 250 mils) stated in Section 4.2.13 and drawings. Additionally, please specify the weight of geotextile (6, 8 or 10 oz/yd^2) of the selected geocomposite. Please clarify.

26. (Section 6.8) please address the following concerns:
    i. The Labor Costs (Cost Item No. 7) of $200,000 dollars are the same amounts for closing a 20-acre site in a nearby county. Since the Wayne County MSWLF, encompassing the 65 acres is subjected to closure; the labor costs for the planned closure activities are

likely be higher than those for closing a 20-acre site. Please revise the labor costs and final total costs.

ii. According to Engineering Plan Drawing No. E11/Sheet 13 of 17, County has and will install a total of approximately 62 gas extraction wells. The wells in the end their service will be converted to gas vents as shown on Drawing No. E12/Sheet 14 of 17. Therefore, for the Cost Item No. 10, the number of wells shall be 62, not 10. Please revise the cost accordingly.

iii. The costs for Engineering and QA/QC of the liners and Certification Report of $200,000 dollars are the same amounts for closing a 20-acre site in a nearby county. Since the Wayne County MSWLF, encompassing the 65 acres is subjected to closure; the Cost Item No. 11 for the QA/QC test shall be higher than those for closing a 20-acre site. Please revise the costs accordingly.

Section 7.0 – Post-Closure Plan

27. (Section 7.2) Please address the following concerns on the cost estimates

i. Please add costs for inspection and maintenance of the security fence, signs, access roads, and vegetation (including mowing) and costs for engineering &certification report.

ii. There are 16 groundwater monitoring wells, not 12 wells subject to semi-annually sampling requirements according to the Ground and Surface Water sampling and analysis Plan in Appendix E of the *Design Hydrogeologic Study*. Please revise the costs associated with water quality monitoring in the post-closure period.

Within 30 calendar days after receiving this letter, Wayne County must submit DWM the completed written responses and the hard copy of the portions of the Permit Application which are subjected to change and one completed electronic copy of the submittal (the responses letter and the completed new permit application). The Solid Waste Section appreciates your efforts and cooperation in this matter. If you have any permitting questions, please contact me at (919) 508- 8507.

Sincerely,

Ming-Tai Chao, P.E.
Environmental Engineer II
Permitting Branch, Solid Waste Section

cc:
Wayne Sullivan, MESCO
Donna Wilson, DWM
Dennis Shackelford, DWM
Central File
Ed Mussler, Permitting Branch Supervisor
Christine Ritter, DWM
Wes Hare, DWM

NCDENR
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
Division of Waste Management
Beverly Eaves Perdue, Governor
Dexter R. Matthews, Director
Dee Freeman, Secretary

Solid Waste Section

June 24, 2010

Fac/Perm/Co ID #	Date	Doc ID#
96-06 Ming Chao	06/24/10	DIN 10930

Mr. Tim Rogers, Solid Waste Director
460 B South Landfill Road
Dudley, NC 28333

Subject: Administrative Review on the Permit to Construct Application – Phase 3
Wayne County MSWLF, Wayne County, North Carolina
Permit No. 96-06, Document ID No. (Doc ID 10930)

Dear Mr. Rogers:

On June 17, 2010 the Division of Waste Management (DWM), Solid Waste Section received the following permit application documents, on your behalf, prepared by Municipal Engineering Services Company, P.A (MESCO), in Garner, North Carolina:

- *Permit to Construct, Wayne County Municipal Solid Waste Landfill Facility, Phase 3* dated April 2010, prepared by MESCO in Garner, North Carolina (Doc ID 10887).
- *Design Hydrogeologic Study - prepared for Wayne County Subtitle D Landfill, Phase 3, Dudley, Wayne County, North Carolina,* dated July 23, 2008, prepared by MESCO in Garner, North Carolina (Doc ID 10382).

Pursuant to NCGS 130A-295.8(e), the DWM conducted an administrative review on the above-referenced permit application documents. Based on this review, the DWM determines that the submittals contain the required components of a complete submission. A determination of completeness means that the application includes required components, but does not mean that the components provide all the technical information that is required for the division to make a decision on the application.

The DWM will conduct a technical review on the application documents in according to Solid Waste Management Rules 15A NCAC 13B .1600 et seq. after Wayne County pays the statutorily required fee invoiced by the Solid Waste Section. If you have any questions, please contact Ming-Tai Chao at (919) 508- 8507 or Christine Ritter at (919) 508-8506.

Sincerely,

Ming-Tai Chao, P.E.
Environmental Engineer II
Solid Waste Section

Christine Ritter
Hydrogeologist
Solid Waste Section

cc: Wayne Sullivan, MESCO
Donna Wilson, DWM
Dennis Shackelford, DWM
Ed Mussler, Permitting Branch Supervisor
Wes Hare, DWM
Central Files

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SECTION 1.0

FACILITY PLAN

Background

The County currently owns and operates a Subtitle D Sanitary Landfill (Permit No. 96-06) located approximately 2.7 miles northwest of Dudley North Carolina, off of S.R. 1129. They also have a Construction/Demolition Landfill and a White Goods Facility. All facilities are located on the Owner's property. The new Phase is adjacent to the existing Phase 2. Access to the landfill will be the same as is presently being used. Waste currently received in the existing Phase will be disposed of in the new Phase.

The old landfill site has recently had a methane collection system installed. The Construction/Demolition landfill is located on top of the old landfill site.

General

The Facility can only accept Municipal Solid Wastes within Wayne County, which includes but is not limited to Household, Industrial, Construction/Demolition and Animal waste. The Facility will not accept any Hazardous or PCB wastes. Tires will continue to be processed at the maintenance facility and the White Goods will continue to be processed at the White Goods Facility.

The Facility will consist of eight (8) phases of development. The first two phases already exists, leaving six (6) phases to be built in the future. Phase 3 parallels existing Phase 2 and is approximately 21 acres in size.

The land use around the proposed facility is mostly agricultural with some rural subdivisions located within two (2) miles of the facility. The landfill will not have any adverse impact on the residents of Wayne County since the proposed landfill is located adjacent to the existing landfill.

1.1 Waste Stream

1.1.1 Waste Types

The Facility will accept Municipal Solid Waste: any solid waste resulting from the operation of residential, commercial, industrial, governmental, or institutional establishments that would normally be collected, processed, and disposed of through a public or private solid waste management service is considered Municipal Solid Waste. The facility has a permitted air space capacity of 5,004,195 cubic yards. The approved gross capacity that is the measured volume between the top of the protective cover and the top of the final cover is 5,365,695 cubic yards.

Construction/Demolition waste and Land Clearing and Inert debris will continue to be disposed of in the existing Construction/Demolition Landfill.

Spoiled foods, animal carcasses, abattoir waste, hatchery waste, and other animal waste will be accepted, and covered immediately upon dumping.

Asbestos waste will be accepted and managed in accordance with 40 CFR 61. The waste will be covered immediately with soil in a manner that will not cause airborne conditions and must be disposed of separate and apart from other solid wastes:

i. At the bottom of the working face or;
ii. In an area not contiguous with other disposal areas. Separate areas will be clearly designated so that asbestos is not exposed by future land disturbing activities.

Wastewater treatment sludges must pass the paint filter test and the TCLP test before they may be accepted and co-disposed in the lined area. Hazardous waste as defined within 15A NCAC 13A, to also include hazardous waste from conditional exempt small quantity generators, Polychlorinated biphenyls (PCB) waste as defined in 40 CFR 761 are prohibited.

1.1.2 Disposal Rates

The Facility is open 5 days per week. The Facility has a permit approved tons per day of 450. The life of the Facility will depend on disposal rates and compaction, which can vary through out the life of the Facility. This variance can either increase or decrease the life of the Facility.

1.1.3 Service Area

The Facility will accept only waste from Wayne County.

1.1.4 Waste Segregation

The Facility will segregate Municipal Solid Waste, Construction/Demolition Waste, Yard Waste, Recyclables, White Goods, and Tires. The Facility will use the current access route from the existing Sanitary Landfill; and the attendant at the existing scale house will direct incoming wastes to their appropriate areas. An attendant is on site to direct segregation of waste during the hours of operation of 7am-5:30pm, Monday, Tuesday, Thursday and Friday, and 7am-5pm on Saturday. Waste segregation will continue to occur at the existing facility, with MSW being the only type of waste being disposed in the new MSWLF units.

1.1.5 Equipment Requirements

The Facility has and uses the following equipment:

1. 826 Cat Compactor
2. Front-end Loaders
3. Pans
4. Dozers
5. Backhoe

1.2 Landfill Capacity

The Life Expectancy calculations were calculated for Phases 2-8 of development with a vertical expansion being included when a Phase is constructed adjacent to the previous Phase. Each successive phase will vary in size due to being able to expand onto the previously filled areas. The Operation Plan of the Engineering Report will delineate this more clearly. Each individual Phase volume other than Phase 2 is estimated. The airspace is a net volume excluding the capping requirements.

LIFE EXPECTANCY CALCULATIONS PHASES 2-8

Given:

Life expectancy based on actual air space used in Annual Report Fiscal Year 08-09 is as follows:

Life expectancy based on using the annual average of 110,200 cubic yards/year, for the first year and an annual increase of 0.83% for each year thereafter.

Phases	Airspace Available	Years of Life
Phase 2	= 245,951 cubic yards	= 2.05 years
Phase 3	= 541,887 cubic yards	= 4.92 years
Phase 4	= 702,461 cubic yards	= 6.12 years
Phase 5	= 687,397 cubic yards	= 5.74 years
Phase 6	= 706,733 cubic yards	= 5.67 years
Phase 7	= 546,382 cubic yards	= 4.20 years
Phase 8	= 395,124 cubic yards	= 2.92 years
	3,825,935 cubic yards	31.61 years

Soil requirements for construction, daily cover and final caps for Phases 2-8
(Assume an 8:1 Trash to soil ratio)

Soil needed for Construction	=	502,298 cubic yards
Soil needed for Daily Cover	=	425,104 cubic yards
Soil needed for Closure	=	361,500 cubic yard
Overall Soil Requirements	=	786,604 cubic yards (soil needed for closure and daily cover)

There is no excess soil available on site. The County also owns property which it will utilize for borrow material as needed. There should be enough borrow material available to complete the landfill. If the need arises the County will purchase additional land to borrow from.

The estimate of the maximum inventory of wastes, ever on-site over the active life to date of the landfill facility is 1,539,760 cubic yards.

Estimated schedule of closure will be approximately 32 years.

1.3 Containment and Environmental Control Systems

The County MSWLF Phase 3 will be constructed with a Base Liner System consisting of a cohesive soil liner with a permeability no greater than 1.0 x 10^{-7} cm/sec. or 1.0 x 10^{-5} cm/sec. with a reinforced Geosynthetic clay liner, sixty (60) mil High Density Polyethylene (HDPE) liner, 3' of protective cover, 250 mil composite drainage net and leachate collection system consisting of leachate trenches and pipes to collect the leachate. The leachate will be pumped into a leachate lagoon. The waste will be covered daily with on-site soils to control disease vectors. The cap system will consist of twelve inches (12") of bridging material (temporary cover), eighteen inches (18") of soil liner with a permeability no greater than 1.0 × 10^{-5} cm/sec, forty (40) mil Linear Low Density Polyethylene (LLDPE) flexible membrane liner, drainage layer, and twenty four inches (24") of protective/erosive layer. The cap will contain a gas venting system consisting of a series of washed stone trenches below the soil liner that will be vented through pipes that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

1.4 Leachate Management

1.4.1 Performance and Design Concepts

A HELP model has been created for the design of the leachate collection system, along with performance calculations which are located in Section 2.2.3 of this report. Leachate is pumped directly to the City of Goldsboro sewerage facilities and the water is treated in the City's wastewater regional treatment facility. There are limitations on the daily flow according to the non-significant industrial user pretreatment permit (attached) issued to the landfill by the City of Goldsboro. Consequently, leachate is continuously pumped from the lagoon until the low water float turns off the pump(s).

1.4.2 Normal Operating Conditions

The average monthly values of leachate generation are located in the HELP model Section 2.2.3 of this report, and performance calculations are in Section 2.2.4 of this report. The average monthly flow collected from layer 4 (Drainage Net) per acre for a five year period is 1.86 inches for January, 1.90 inches for February, 1.37 inches for March, 0.90 inches for April, 0.64 inches for May, 0.59 inches for June, 0.72 inches for July, 1.67 inches for August, 2.29 inches for September, 0.96 inches for October, 0.93 inches for November and 0.83 inches for December.

Surge Volumes created by storm events are calculated in the HELP model and performance calculations in Section 2.2.3 of this report. The surge or peak daily values for years one thru five are 0.65 inches per acre collected from layer 4 (Drainage Net), average head on layer 5 (HDPE Liner) 0.02 inches and the maximum head on layer 5 is 0.46 inches.

1.4.3 Leachate Management System

Leachate pipeline operation capacity is located in the performance calculations in Section 2.2.4 of this report.

Capacity of the lagoon is located in the performance calculations in Section 2.1.7 of this report.

Final Disposal plans and applicable discharge limits, including documented approval of the wastewater treatment plant. Appropriate documentation is located in Section 2.1.7 of this report.

1.4.4 Contingency Plan

In the event the Leachate Lagoon or the City of Goldsboro Wastewater Treatment Plant (WWTP) cannot handle a storm surge, the flow of leachate will be stopped from the MSWLF facility until such a time as the leachate can either be recirculated, held in the lagoon or sent to the Goldsboro WWTP. In the case of extreme emergency situations the County will apply for acceptance into a private Treatment Plant and they will pump and haul the leachate to the private WWTP. Any abnormal storm events can be handled. If any rain or other event requires storage of leachate or storm water in the cell, the Division will be notified immediately followed by written communication.

1.5 Special Engineering Features

There are no special engineering features.

1.6 Facility Drawings

1.6.1 Title Sheet
1.6.2 Index and Vicinity Map
1.6.3 Existing Conditions
1.6.4 Proposed Subgrade
1.6.5 Leachate Collection System
1.6.6 Fill Remaining in Phase 2
1.6.7 Phase 3 Fill
1.6.8 Phase 4 Fill
1.6.9 Phase 5 Fill
1.6.10 Phase 6 Fill
1.6.11 Phase 7 Fill
1.6.12 Final Fill
1.6.13 Baseline Profile and Cross Sections

WAYNE COUNTY
MUNICIPAL SOLID WASTE
LANDFILL FACILITY

REVISED FACILITY PLAN

Permit Number: 96-06

Site Location: 460 B South Landfill Road
Dudley, NC 28333

Applicant: Wayne County

Applicant's Address: 224 E. Walnut St., 3rd Floor
Goldsboro, NC 27530

BOARD OF COMMISSIONERS

C. Munroe "Jack" Best, Jr - Chairman
J.D. Evans - Vice-Chairman
Roland M. "Bud" Gray
Wilbur E. "Andy" Anderson
John M. Bell
Steve Keen
Dr. Sandra McCullen

COUNTY MANAGER

William "Lee" Smith, III

SOLID WASTE DIRECTOR

Tim Rogers

Engineer

Municipal Engineering Services Company, P.A.
Garner, NC - Morehead City, NC - Boone, NC

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE
4/1/2011

by ______________________
Professional Engineer
(Garner Office)

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	NO REVISIONS THIS SHEET
1/14/2011	LHC	2	REVISED SHEET NUMBERS
11/1/2010	LCH	1	REVISED SHEET NUMBERS

SCALE:	1:1
DATE:	3/11/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	T1
SHEET NO.	1 OF 13

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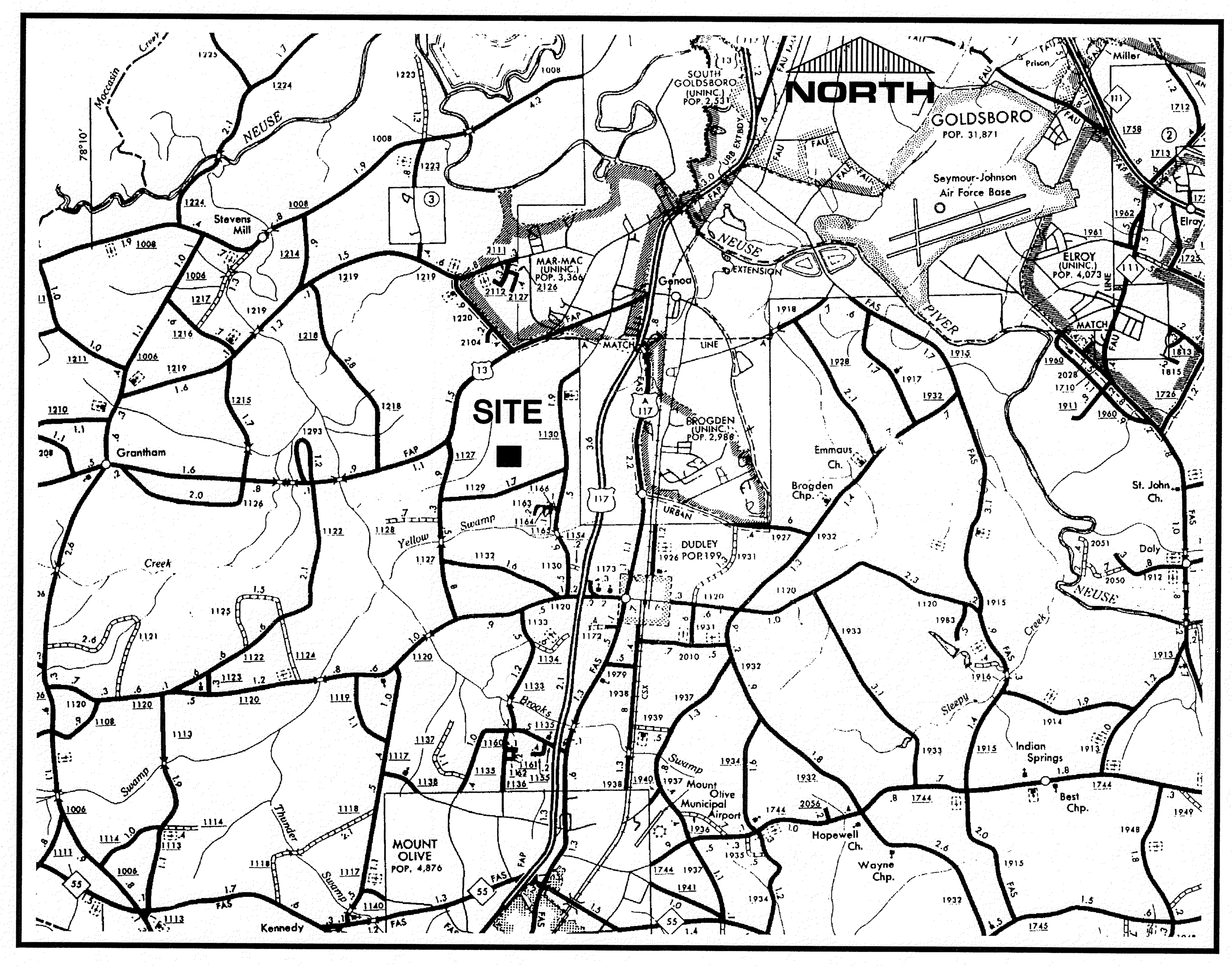
INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION
1	T1	TITLE SHEET
2	T2	INDEX AND VICINITY MAP
3	F1	EXISTING CONDITIONS
4	F2	PROPOSED SUBGRADE
5	F3	LEACHATE COLLECTION SYSTEM
6	F4	FILL REMAINING IN PHASE 2
7	F5	PHASE 3 FILL PLAN
8	F6	PHASE 4 FILL PLAN
9	F7	PHASE 5 FILL PLAN
10	F8	PHASE 6 FILL PLAN
11	F9	PHASE 7 FILL PLAN
12	F10	FINAL FILL PLAN
13	F11	BASELINE PROFILE AND CROSS SECTIONS



VICINITY MAP

LICENSE NUMBER: C-0281

Municipal Services Engineering Company, P.A.

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	NO REVISIONS THIS SHEET
1/14/2011	LHC	2	REVISED INDEX AND SHEET NUMBER
11/1/2010	LCH	1	REVISED INDEX AND SHEET NUMBER

INDEX AND VICINITY MAP

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6202 JIMMY D. WOODIE
4/1/2011

SCALE: 1:1
DATE: 3/11/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G06096
DRAWING NO. T2
SHEET NO. 2 OF 13

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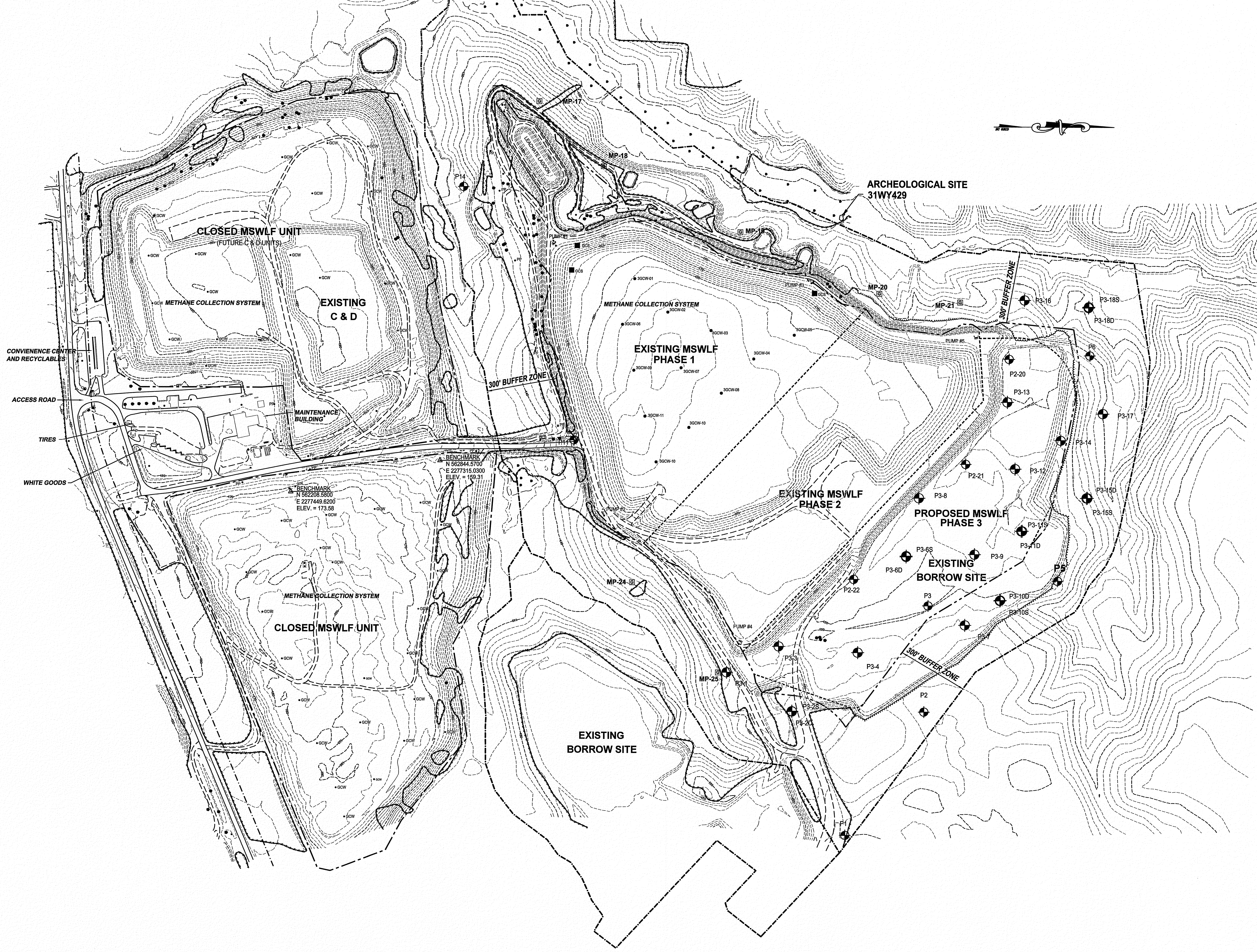
NOTES:

1. THERE ARE NO AIRPORTS LOCATED WITHIN 10,000 FEET OF THE SITE.
2. THE SITE IS NOT LOCATED IN THE FLOODPLAINS.
3. THE SITE IS NOT LOCATED IN WETLANDS.
4. THERE ARE NO FAULT AREAS.
5. THE SITE IS LOCATED IN A SEISMIC IMPACT ZONE.
6. THE SITE IS NOT LOCATED IN UNSTABLE AREAS.
7. THERE ARE NO ARCHIOLOGICAL OR HISTORICAL AREAS ON THE SITE.
8. THE SITE IS NOT LOCATED IN A STATE NATURE OR HISTORIC PRESERVE.
9. THE SITE IS NOT LOCATED IN A WATER SUPPLY WATERSHED.
10. THERE ARE NO ENDANGERED OR THREATENED SPECIES.

TOPOGRAPHY IS FROM AERIAL PHOTOGRAPHY FLOWN AND A TOP0GRAPHIC MAP WAS PROVIDED BY DARREL S. MILLER, PLS ON 8/17/2007 AND SUPPLEMENTED WITH FIELD SURVEYS BY MUNICIPAL ENGINEERING SERVICES COMPANY, PA.



LEGEND

	EXISTING CONTOURS
	PROPERTY LINE
	EXISITING UNPAVED ROAD
	EXISTING CREEK, STREAM, ETC.
	EXISTING DIVERSION DITCHES
	CLOSED MSWLF SANITARY UNIT
	300' BUFFER ZONE
	MSWLF PHASE LIMITS
	EXISTING CHAINLINK FENCE
	TREE LINE (AERIAL MAPPING)
	TREE LINE (SURVEYED)
	TREES/SHRUBS
GCS	GAS COLLECTION SUMP
3GCW-01	EXISTING GAS COLLECTION WELL
PP	POWER POLE
MP-11 G	EXISTING METHANE MONITORING PROBE
P3-17	EXISTING PIEZOMETERS

LICENSE NUMBER: C-4281
Municipal Services
Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
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P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

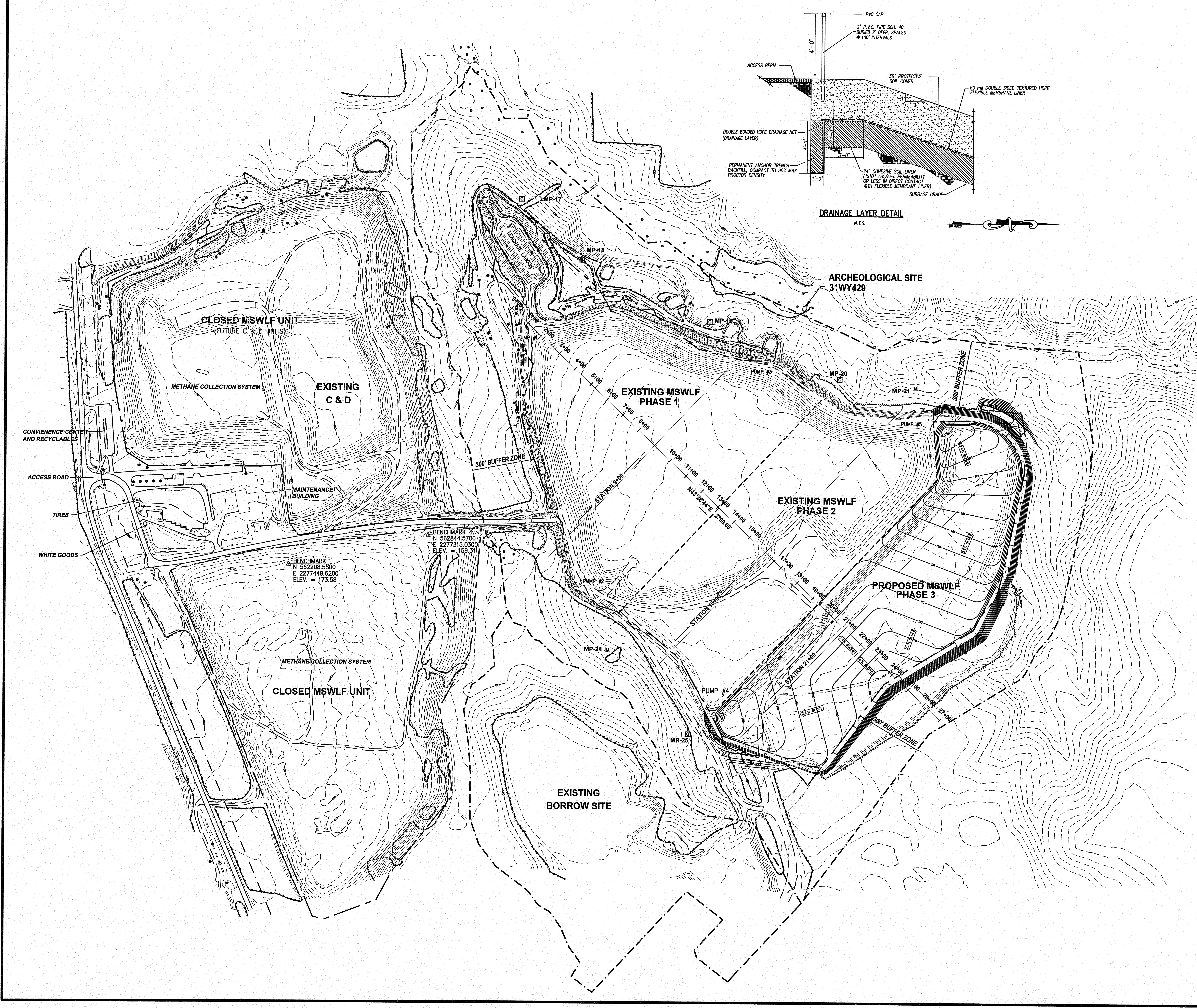
DATE	BY	REV.	DESCRIPTION
5/19/2011	LHC	4	REVISED EXIST. METHANE PROBE LOCATIONS
3/17/2011	LHC	3	NO REVISIONS THIS SHEET
1/14/2011	LHC	2	REVISED SHEET NUMBER
10/26/2010	LHC	1	ADDED EXIST. GAS COLLECTION WELLS, CHANGED SHEET NUMBER

FACILITY PLAN
EXISTING CONDITIONS

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6262 JIMMY D. WOODIE

5/19/2011

SCALE:	1" = 200'
DATE:	12/16/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. F1	SHEET NO. 3 OF 13



LEGEND

- EXISTING CONTOURS
- PROPOSED SUBGRADE CONTOURS
- PROPERTY LINE
- EXISITING UNPAVED ROAD
- EXISTING CREEK, STREAM, ETC.
- EXISTING DIVERSION DITCHES
- CLOSED MSWLF SANITARY UNIT
- 300' BUFFER ZONE
- MSWLF PHASE LIMITS
- EXISTING CHAINLINK FENCE
- TREE LINE (AERIAL MAPPING)
- TREE LINE (SURVEYED)
- TREES/SHRUBS
- MP-11 G EXISTING METHANE MONITORING PROBE

LICENSE NUMBER: C-0281
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MUNICIPAL SOLID WASTE LANDFILL FACILITY WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
5/19/2011	LHC	4	REVISED EXIST. METHANE PROBE LOCATIONS
3/17/2011	LHC	3	REVISED SUBGRADE
1/14/2011	LHC	2	REVISED SHEET NUMBERS
11/1/2010	LCH	1	ADDED BASELINE FOR PROFILE AND CROSS SECTIONS

FACILITY PLAN PROPOSED SUBGRADE

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6182 JIMMY D. WOODIE
5/19/2011

SCALE: 1" = 200'
DATE: 12/16/08
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G06096
DRAWING NO. F2
SHEET NO. 4 OF 13

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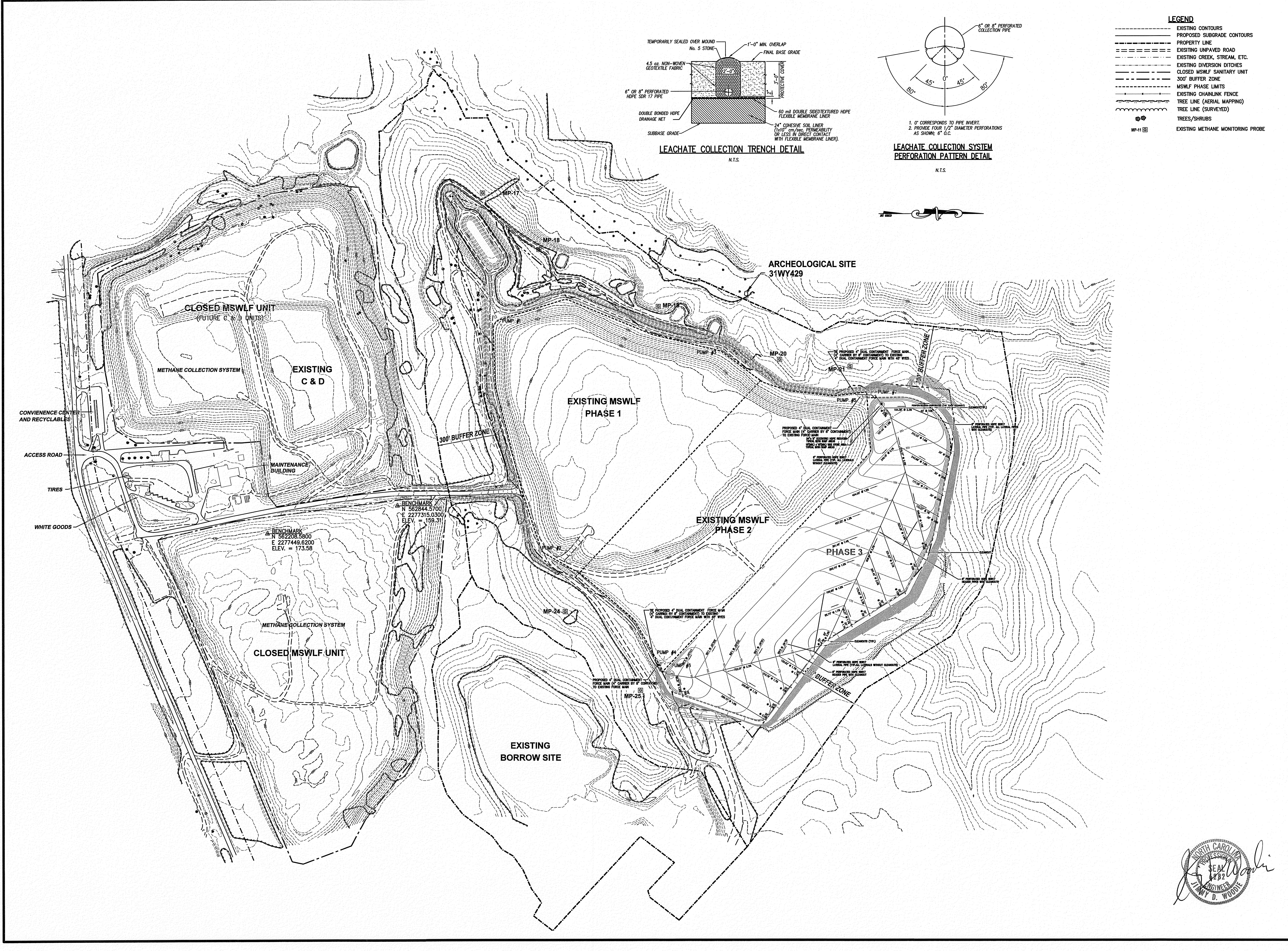

LICENSE NUMBER: C-0281

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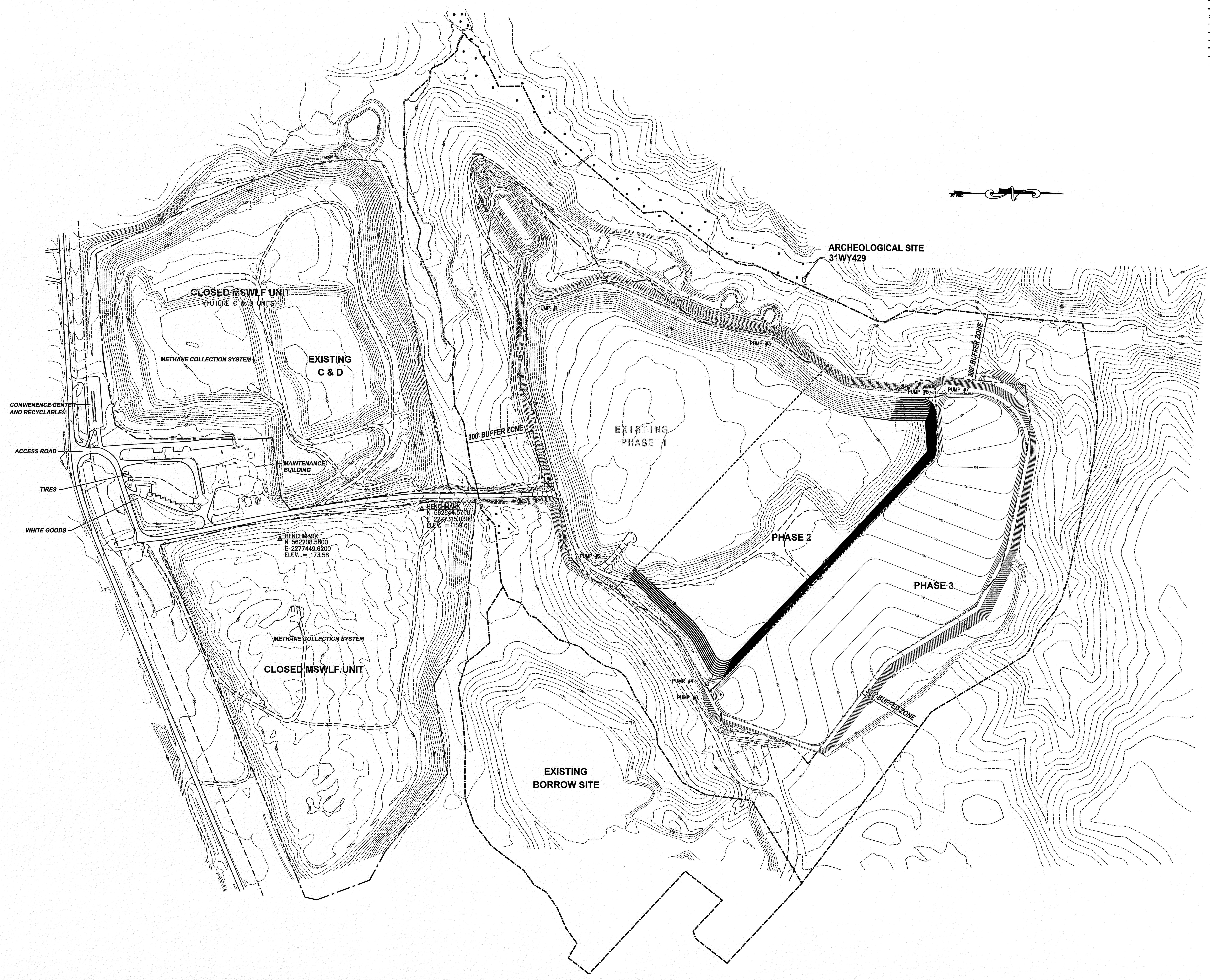
MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
5/19/2011	LHC	4	REVISED EXIST. METHANE PROBE LOCATIONS
3/17/2011	LHC	3	REVISED PROTECTIVE COVER AND LEACHATE SYSTEM
1/14/2011	LHC	2	REVISED SHEET NUMBERS
11/1/2010	LCH	1	REVISED SHEET NUMBERS AND LEACHATE SYSTEM

FACILITY PLAN
LEACHATE COLLECTION SYSTEM

SCALE:	1" = 200'
DATE:	12/16/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	F3
SHEET NO.	5 OF 13



LEGEND

----------	EXISTING CONTOURS
————	PROPOSED FILL CONTOURS
—·—·—·	PROPERTY LINE
=========	EXISITING UNPAVED ROAD
—··—··—	EXISTING CREEK, STREAM, ETC.
-··-··-··	EXISTING DIVERSION DITCHES
—— - —— -	CLOSED MSWLF SANITARY UNIT
—— - - ——	300' BUFFER ZONE
- - - - - -	MSWLF PHASE LIMITS
—x—x—x—	EXISTING CHAINLINK FENCE

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED PHASE 3 PROTECTIVE COVER
1/14/2011	LHC	2	REVISED SHEET NUMBERS
11/1/2010	LCH	1	REVISED SHEET NUMBERS

FACILITY PLAN
REMAINING PHASE 2 FILL PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 8282 JIMMY D. WOODIE

J. Woodie 4/1/2011

SCALE:	1" = 200'
DATE:	12/16/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. F4	SHEET NO. 6 OF 13

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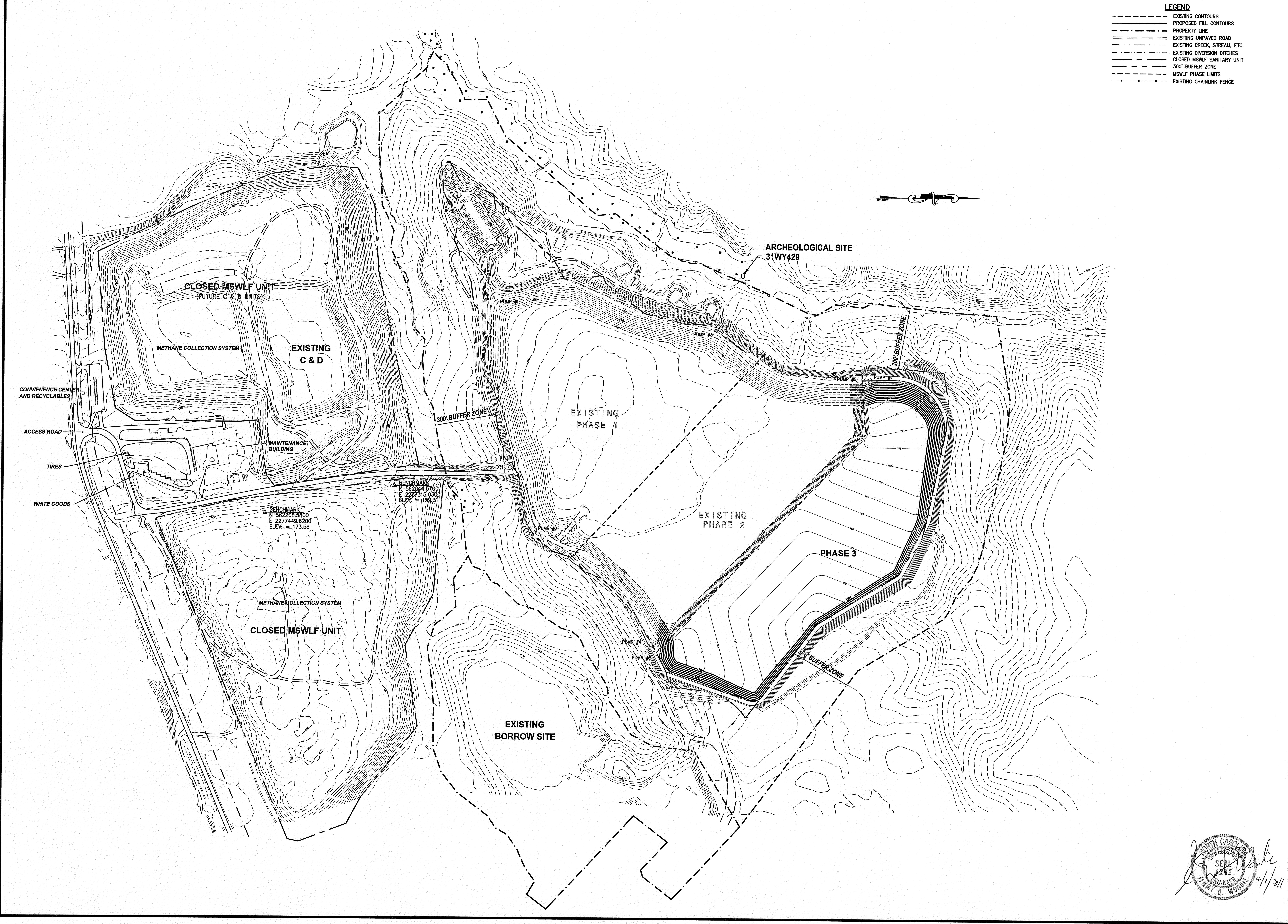

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED PROTECTIVE COVER AND FILL PLAN
1/14/2011	LHC	2	REVISED SHEET NUMBERS
11/1/2010	LCH	1	REVISED SHEET NUMBERS

FACILITY PLAN
PHASE 3 FILL PLAN

SCALE:	1" = 200'
DATE:	12/16/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. F5	SHEET NO. 7 OF 13

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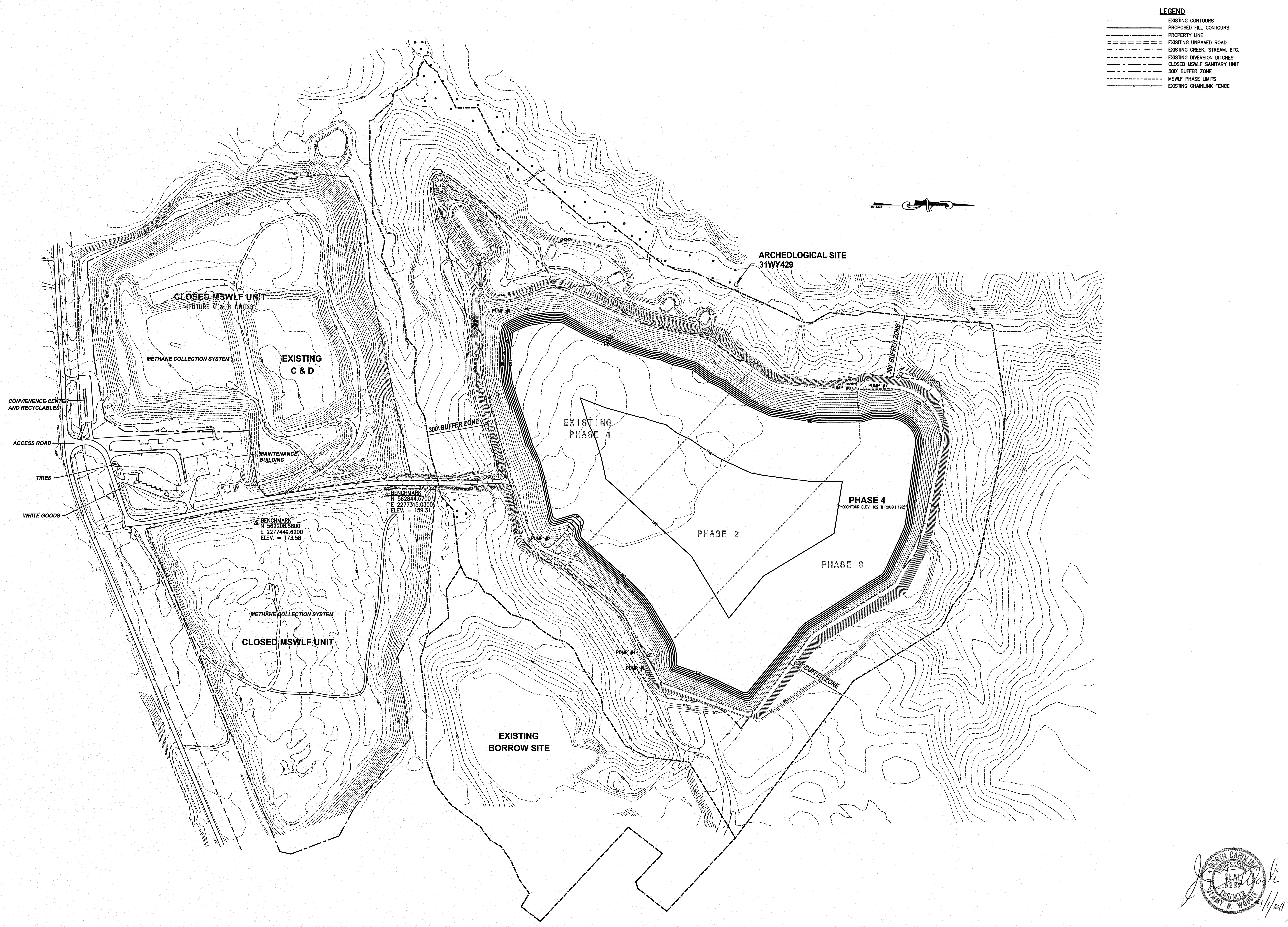

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED FILL PLAN
1/14/2011	LHC	2	REVISED SHEET NUMBERS
11/1/2010	LCH	1	REVISED SHEET NUMBERS

FACILITY PLAN
PHASE 4 FILL PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6262 JIMMY D. WOODIE
4/1/2011

SCALE: 1" = 200'
DATE: 12/16/08
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G06096
DRAWING NO. F6
SHEET NO. 8 OF 13

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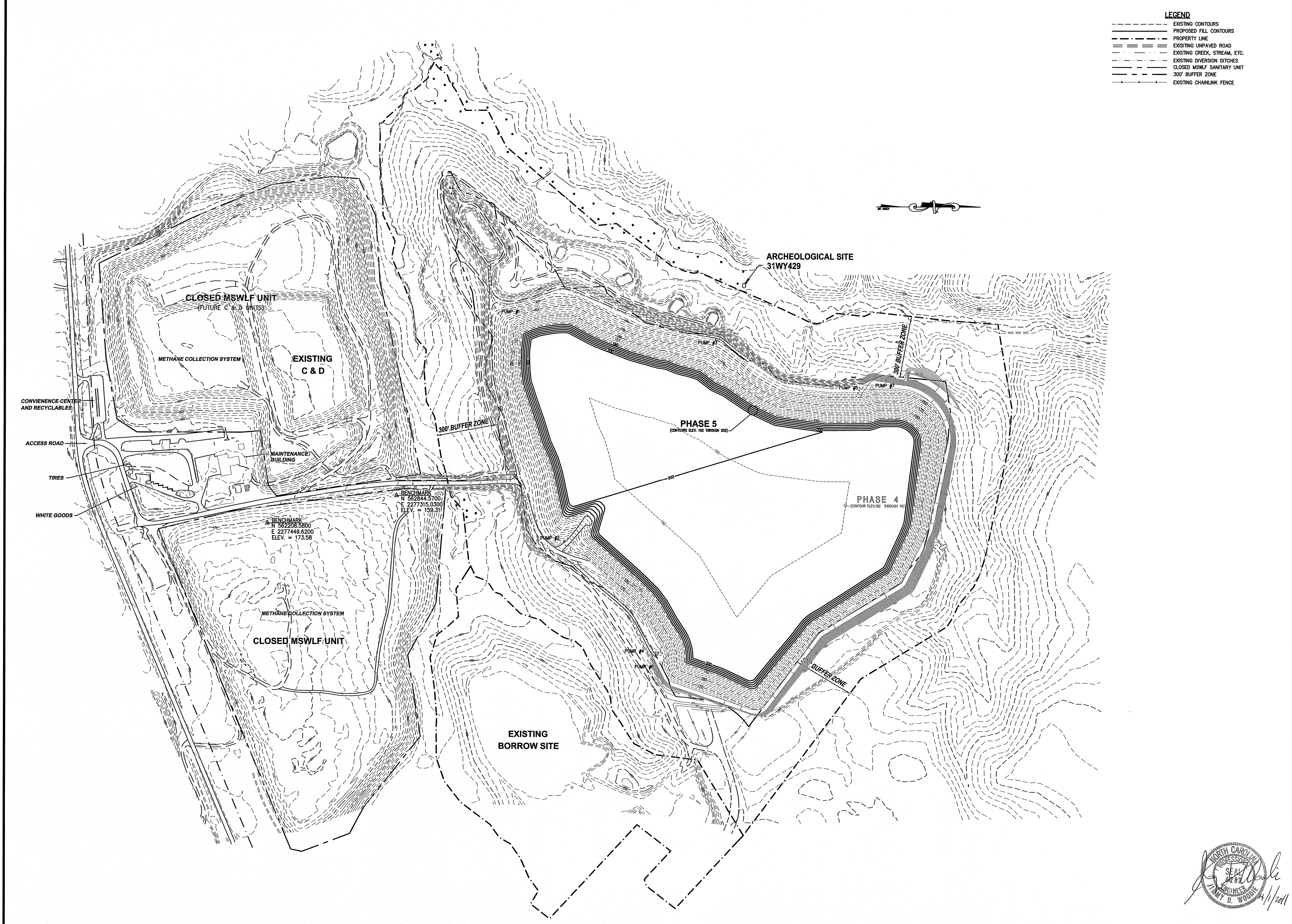

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED FILL PLAN
1/14/2011	LHC	2	REVISED SHEET NUMBERS
11/1/2010	LCH	1	REVISED SHEET NUMBERS

FACILITY PLAN
PHASE 5 FILL PLAN

NORTH CAROLINA PROFESSIONAL SEAL 028?? ENGINEER JIMMY D. WOODIE

4/1/2011

SCALE:	1" = 200'
DATE:	12/16/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. F7	SHEET NO. 9 OF 13

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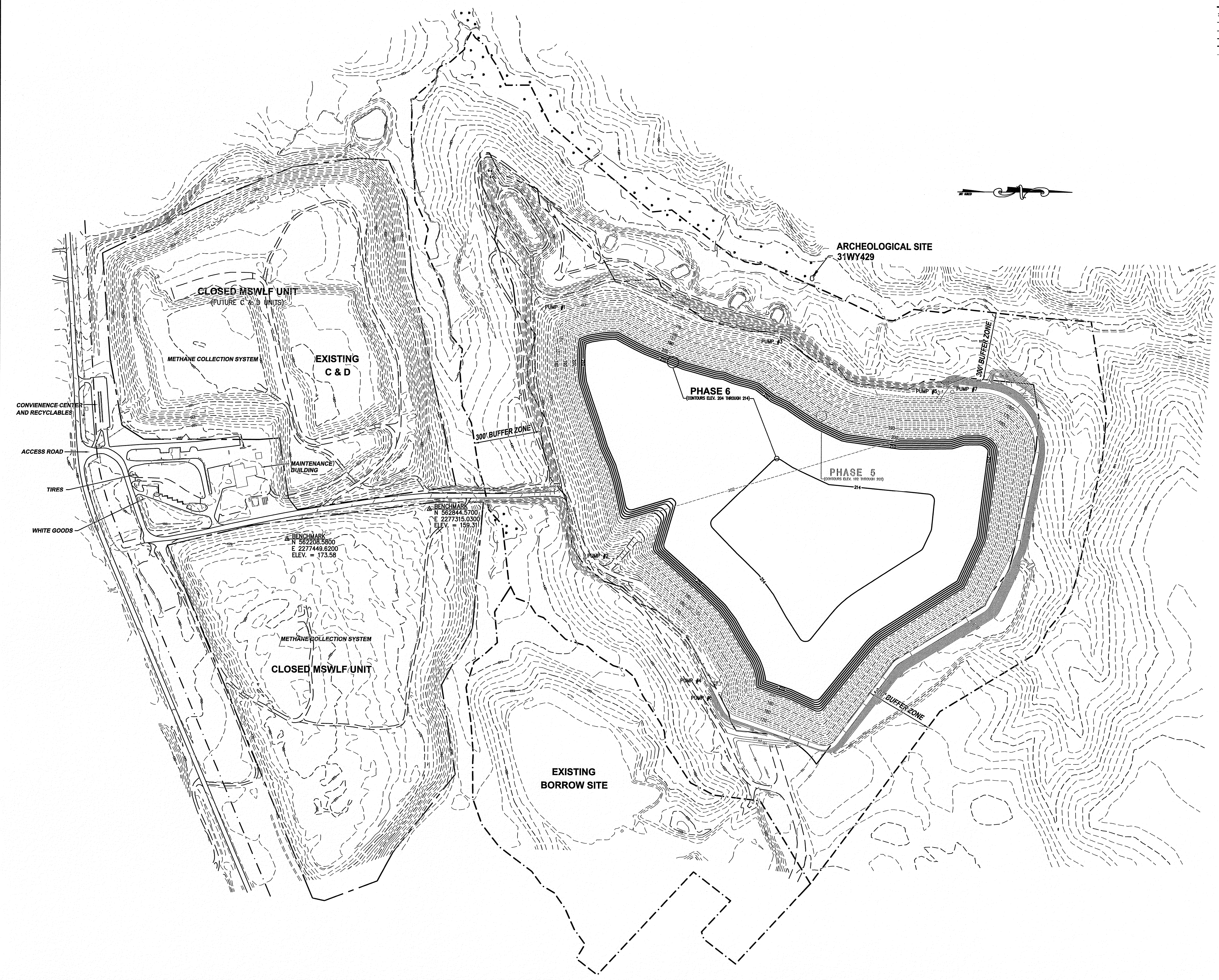
LEGEND

- EXISTING CONTOURS
- PROPOSED FILL CONTOURS
- PROPERTY LINE
- EXISITING UNPAVED ROAD
- EXISTING CREEK, STREAM, ETC.
- EXISTING DIVERSION DITCHES
- CLOSED MSWLF SANITARY UNIT
- 300' BUFFER ZONE
- EXISTING CHAINLINK FENCE



LICENSE NUMBER: C-0281

Municipal Services — P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393

Engineering Company, P.A. — P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILIITY
WAYNE COUNTY NORTH CAROLINA

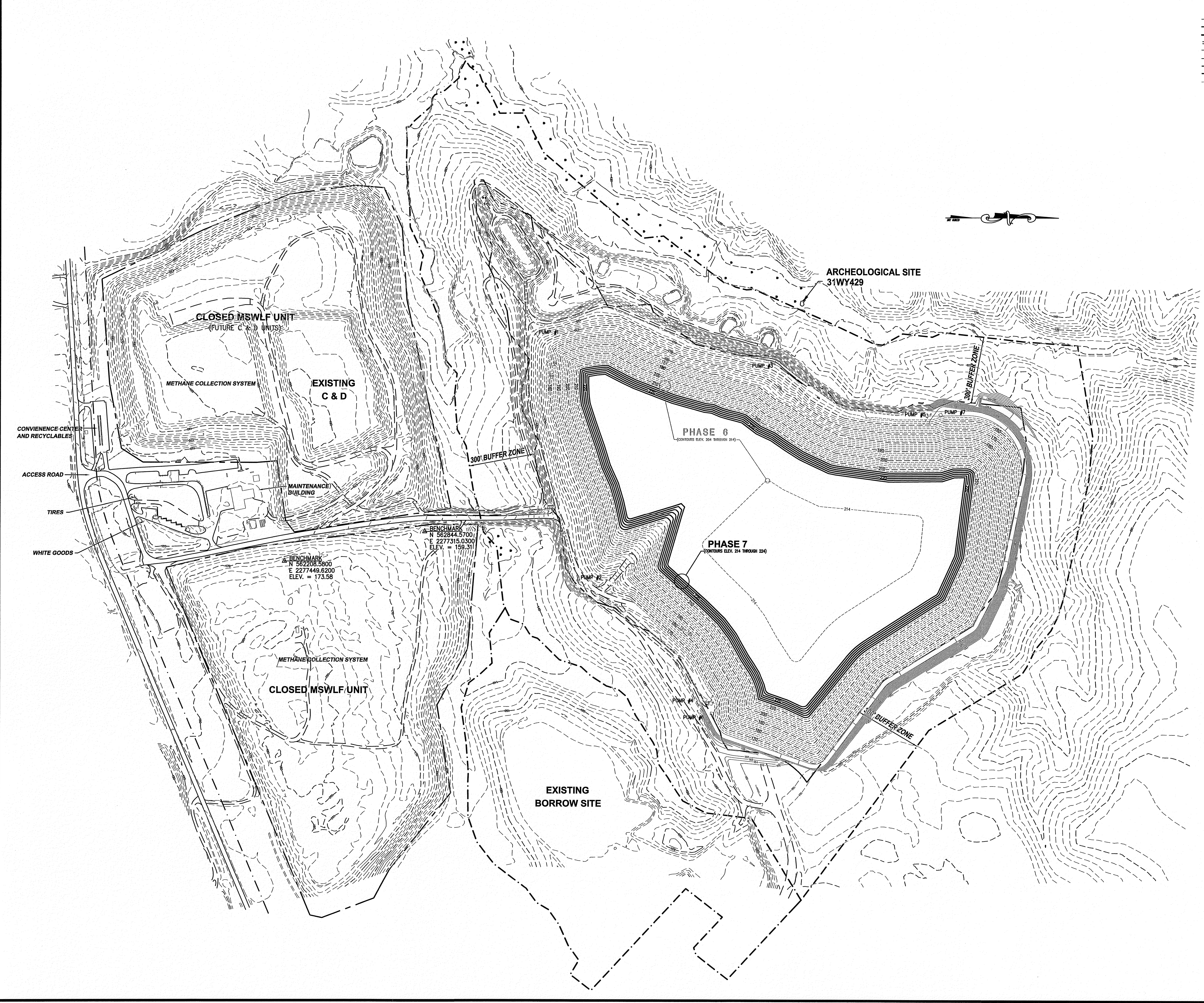
DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED FILL PLAN
1/14/2011	LHC	2	REVISED SHEET NUMBERS
11/1/2010	LCH	1	REVISED SHEET NUMBERS

FACILITY PLAN
PHASE 6 FILL PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6602 TIMMY D. WOODIE

4/1/2011

SCALE: 1" = 200'
DATE: 12/16/08
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER: G06096
DRAWING NO.: F8
SHEET NO.: 10 OF 13



LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

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(919) 772-5393

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(252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED FILL PLAN
1/14/2011	LHC	2	REVISED SHEET NUMBERS AND FILL PLAN
11/1/2010	LCH	1	REVISED SHEET NUMBERS

FACILITY PLAN
PHASE 7 FILL PLAN

SCALE: 1" = 200'
DATE: 12/16/08
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE

PROJECT NUMBER: G06096

DRAWING NO.: F9
SHEET NO.: 11 OF 13

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE
4/1/2011

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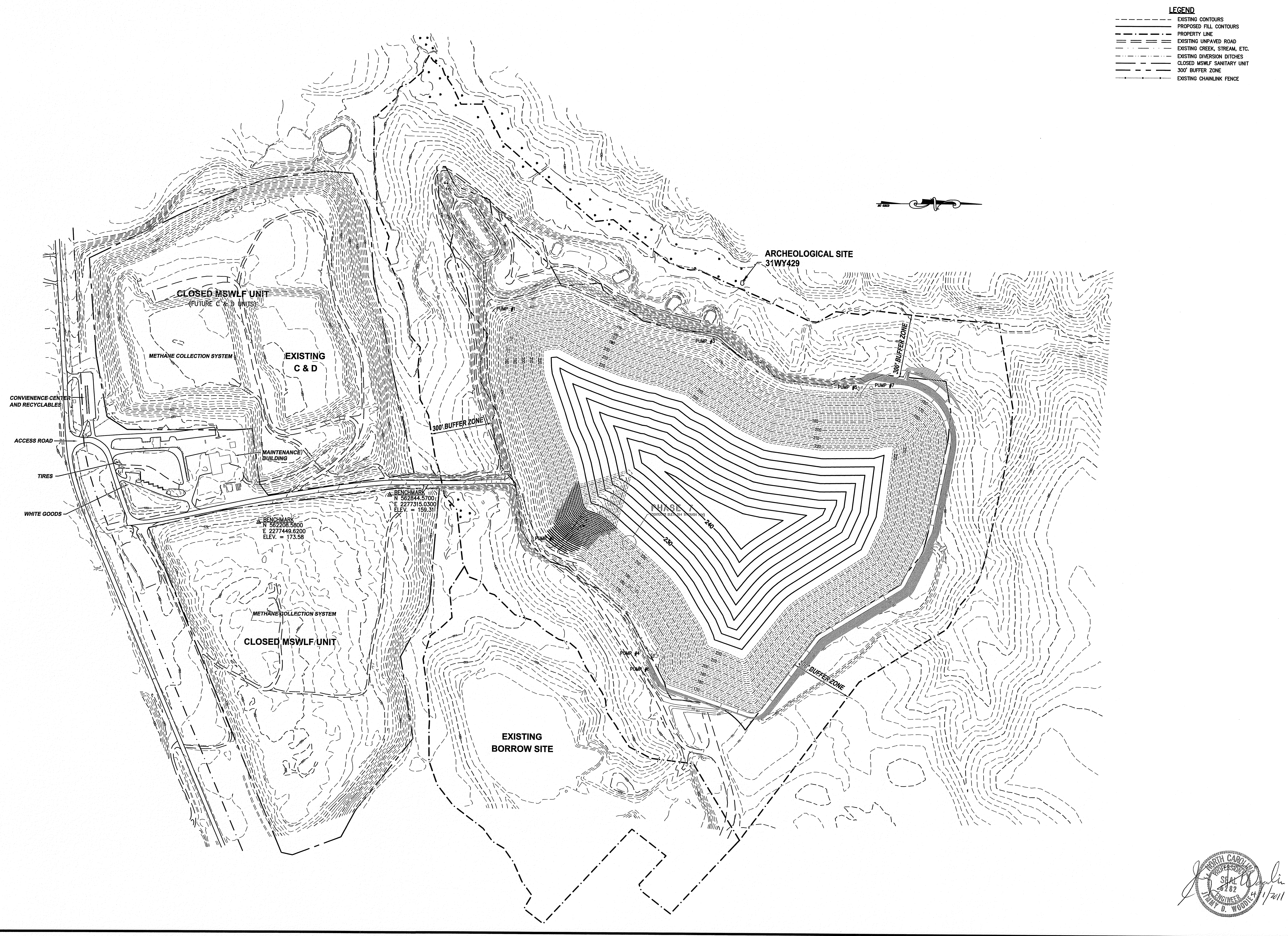

LICENSE NUMBER: C-0281

Municipal Engineering
Services Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED FILL PLAN
1/14/2011	LCH	2	REVISED PROPOSED FILL AND SHEET NUMBERS
11/1/2010	LCH	1	REVISED SHEET NUMBERS

FACILITY PLAN
FINAL FILL PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE 4/1/2011

SCALE:	1" = 200'
DATE:	12/16/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. F10	SHEET NO. 12 OF 13

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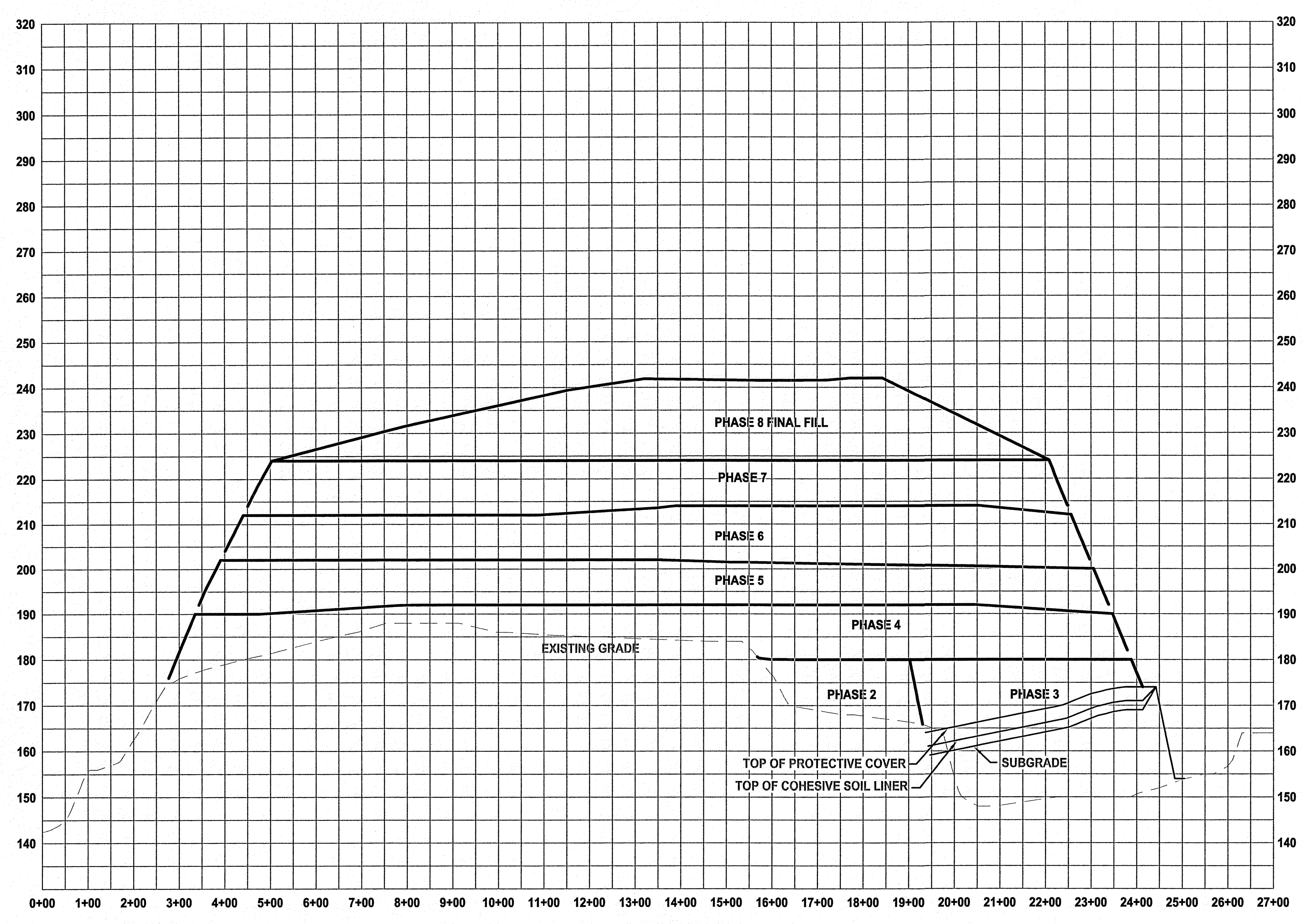

BASELINE PROFILE

SCALE: HORIZ.: 1" = 200'
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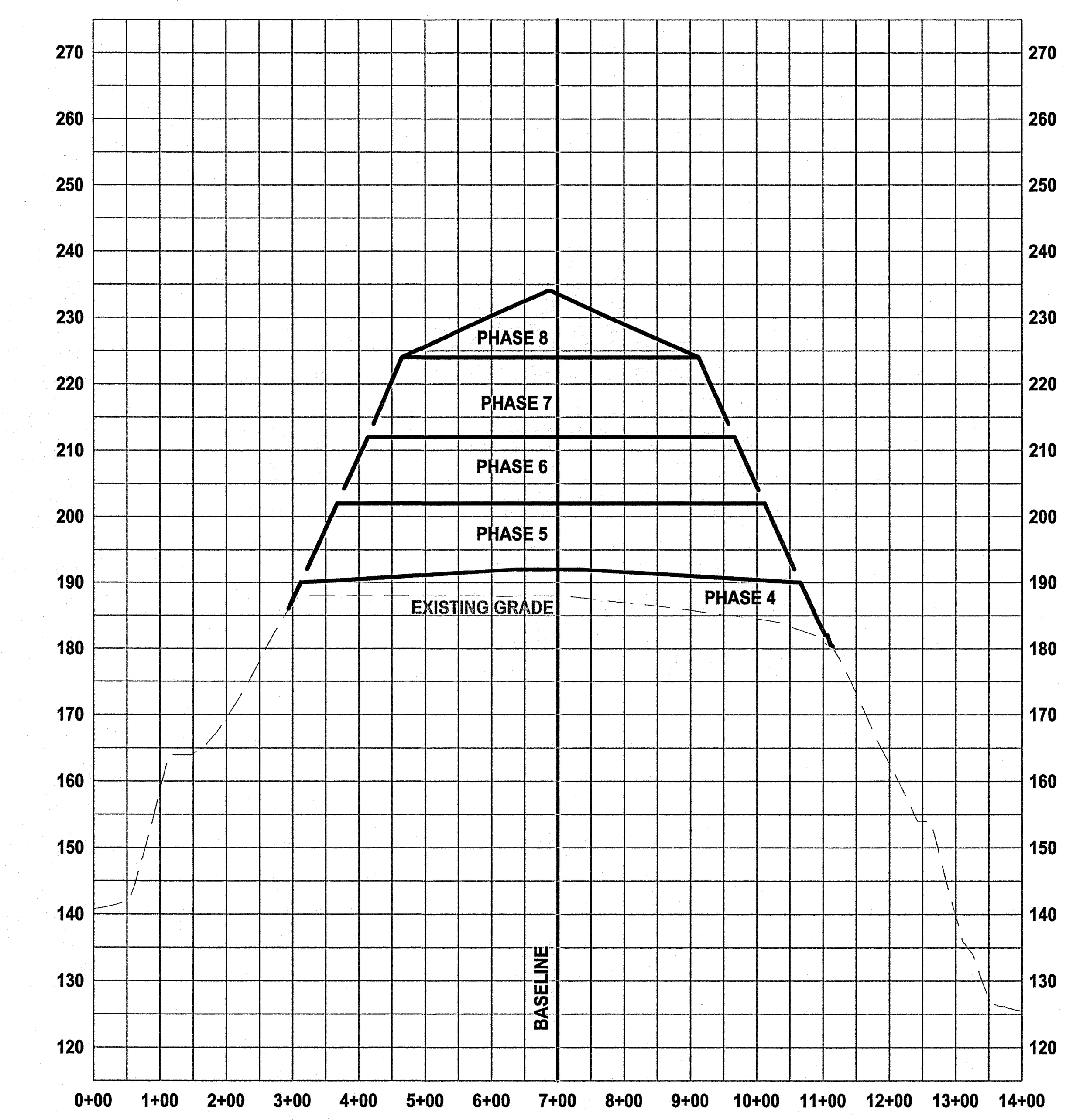
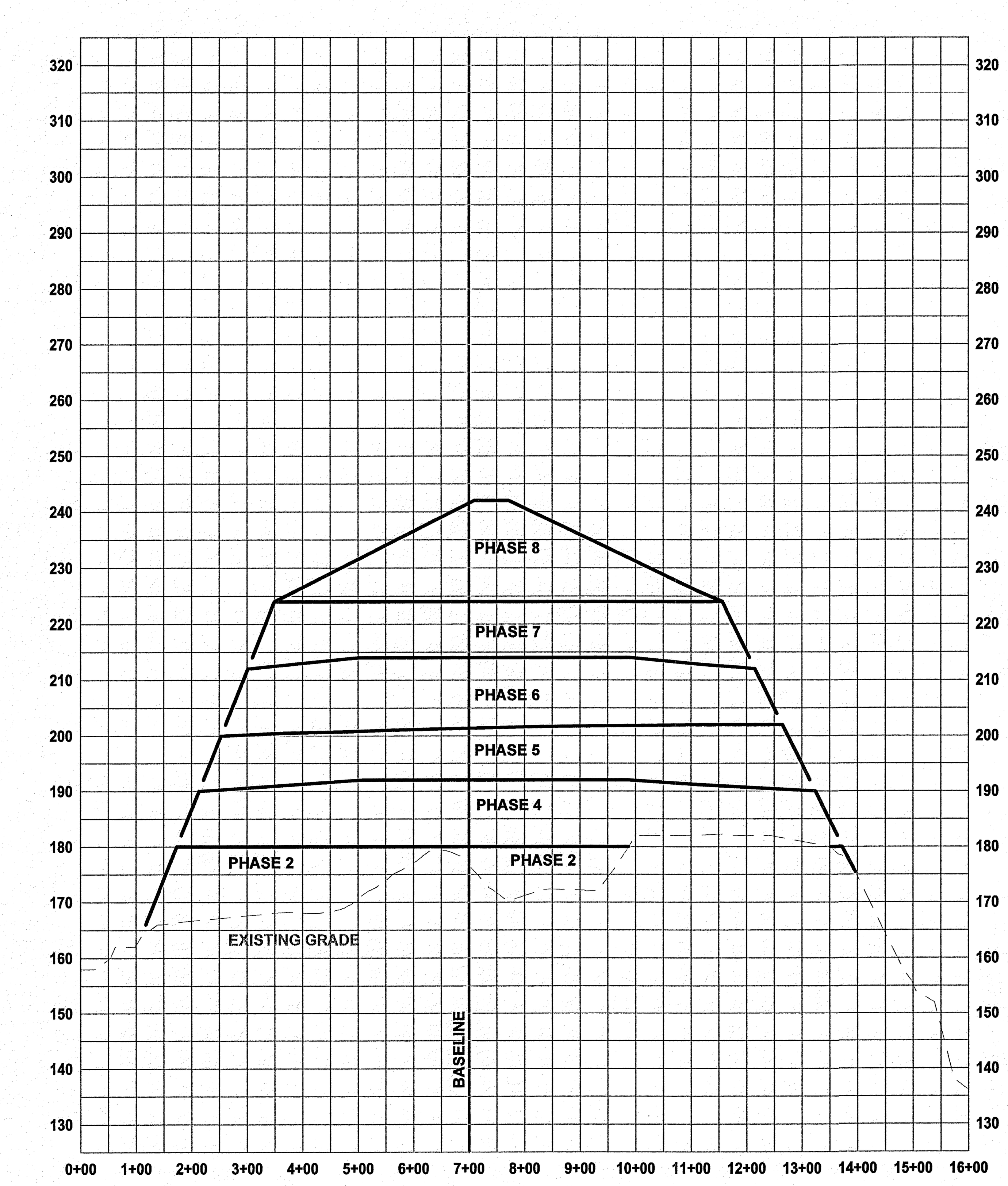


STATION 9+00

SCALE: HORIZ.: 1" = 200'
VERT.: 1" = 20'

NOTE

THESE CROSS SECTIONS ARE INTENDED TO SHOW THE CROSS SECTIONS AT SPECIFIC POINTS AS DEFINED BY THE BASELINE GRID ON SHEET 4 OF 13.



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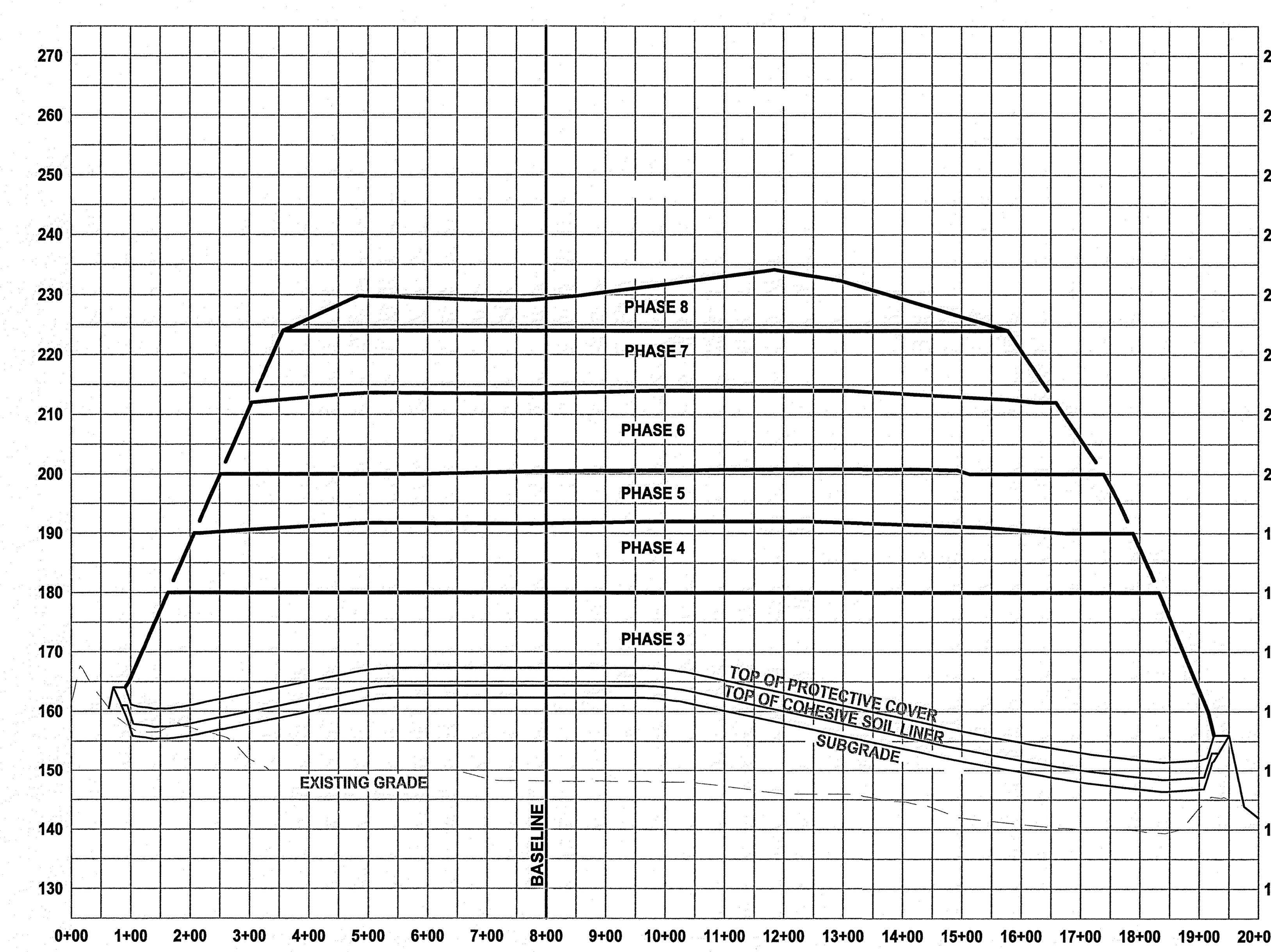

STATION 21+00

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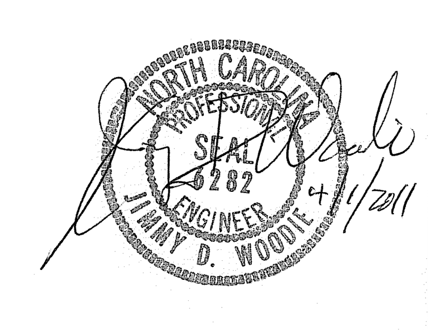
VERT.: 1" = 20'



LICENSE NUMBER: C-0281

Municipal Services
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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

REV.	BY	DATE	DESCRIPTION
2	LHC	3/17/2011	REVISED BASELINER SYSTEM ON CROSS SECTIONS
1	LHC	1/14/2011	REVISED FILL PLAN AND SHEET NUMBERS

FACILITY PLAN
BASELINE PROFILE AND CROSS SECTIONS

SCALE:	1" = 200'
DATE:	12/16/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	F11
SHEET NO.	13 OF 13

SECTION 2.0

ENGINEERING PLAN

CERTIFICATION

This plan was prepared by the undersigned Professional Engineer. This plan meets all the requirements of Rule 0.1620.

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

5/13/2011

Jimmy D. Woodie, PE
License No. 6282

2.1 Analysis of the Facility Design

The MSWLF unit shall be located a minimum of 300’ from the property lines, 500’ from existing residences/wells, and 50’ from any stream, river or lake, and the post settlement subbase elevation shall be prepared a minimum of four feet above the seasonal high groundwater table and bedrock. The landfill subgrade shall be adequately free of organic material and consist of on site soils.

The base liner system consists of a 60 mil HDPE geomembrane liner which is installed above and in direct uniform contact with a compacted clay liner.

The alternate liner system consists of a 60 mil. HDPE geomembrane liner which is installed above and in direct contact with a geosynthetic clay liner (GCL) and a compacted clay liner.

The County will cap their landfill within 180 days after the final receipt of solid waste. The cap system will consist of 12 inches bridging material (temporary cover), 18 inches of soil liner with a permeability no greater than 1.0 x 10^{-5} cm/sec, 40 mil. Linear Low Density Polyethylene (LLDPE), drainage layer, 24 inches of protective/erosive layer. The cap contains a gas venting system consisting of a series of washed stone trenches below the soil liner that will be vented through pipes that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

2.1.1 Base Liner System Standards

The base liner system consists of a geomembrane liner, which is installed above and in direct uniform contact with a compacted clay liner.

1. The site shall meet the following design requirements for Landfill subgrade.

   The landfill subgrade shall be adequately free of organic material and consist of on site soils.

2. The site shall meet the following material requirements for the Base Liner System:

   The soil materials used in construction of the compacted clay liner may consist of on-site sources and may posses adequate native properties or may require bentonite conditioning to meet the permeability requirement. However, if on-site soils are not available, the off site soils will be used. The soil shall be free of particles greater than ¾ inch in dimension.

   The compacted clay liner shall be 24 inches (0.61 m) thick with a permeability not to exceed 1.0 x 10^{-7} cm/sec.

   The geomembrane liner material shall be high density polyethylene geomembrane with a thickness of 60 mils. which has a demonstrated water vapor transmission rate of not more than 0.03 gm/m^2 day. The liner and seaming materials shall have chemical and physical resistance not adversely affected by environmental exposure, waste placement and leachate generation.

3. The site shall meet the following material requirements for the Alternate Liner System:

   The soil materials used in construction of the compacted clay liner may consist of on-site sources and may posses adequate native properties or may require bentonite conditioning to meet the permeability requirement. However, if on-site soils are not available, the off site soils will be used. The soil shall be free of particles greater than ¾ inch in dimension.

   The compacted clay liner shall be 18 inches thick with a permeability not to exceed 1.0 x 10^{-5} cm/sec and a reinforced GCL.

The geomembrane liner material shall be high density polyethylene geomembrane with a thickness of 60 mils. which has a demonstrated water vapor transmission rate of not more than 0.03 gm/m^2-day. The liner and seaming materials shall have chemical and physical resistance not adversely affected by environmental exposure, waste placement and leachate generation.

4. The site shall meet the following design requirements for the Leachate Collection System:

The design of the leachate collection system is to have path for leachate to move that does require it to flow thru any type of geotextile. This allows for some redundancy in the system. The leachate is going to follow the path of least resistance to the low point (sump) of the landfill. The path will be vertical or near vertical flow thru the waste to the three feet of protective cover. Some of the leachate will percolate thru the protective cover to the drainage net; however, the largest volume will flow along the interface of the protective cover and the in-place waste. It will flow along this interface until the flow is intercepts by a leachate trench where the geotextile has been folded back to expose the stone in the trench. The leachate flows vertically thru the rock to the drainage net. A portion of the flow will be in the drainage net; but, the majority will flow on top of the net thru the stone until the flow is deep enough to flow thru the holes in the pipe that is part of the leachate collection line. Once the leachate is deep enough in the trench to flow into the pipe, it will flow in the pipe to the sump. In the times of low flow, this may not happen until the leachate is near or reaches the sump. Once the leachate is in the sump, it will be stored until the pump is automatically turned on and the leachate is pumped to the lagoon.

The leachate that is collect in the drainage net will also flow to the sump. During low flows, the drainage net may convey the majority of the liquid until it reaches the sump. Once it reaches the sump, it will flow back thru the geotextile covering the drainage net and fill the sump in the same manner as if the leachate flowed thru the stone and/or pipe network.

The critical flow capacity of the system is not for leachate that has flowed thru waste but for storm water that has come in contact with waste. The County landfill is divided into two drainage areas with two separate sumps. Once waste is placed into one of the sumps, the storm water in the drainage area becomes leachate because there are no diversions for storm water until the height of the waste reaches the surrounding berm height. Once the waste has reached the surrounding berm height, it can be diverted as surface runoff as long as it has not come in contact with waste.

The geometry of the landfill shall control and contain the volume of leachate generated by the 24-hour, 25-year storm.

The collection pipe along with the drainage net flow capacity shall drain the critical volume of leachate generated by the 24-hour, 25-year storm.

The Leachate Collection System includes a pipe network with clean-outs and geotextile and filter fabrics.

The Leachate Collection Piping has a minimum nominal diameter of six inches.

The chemical properties of the pipe and all materials used in installation shall not be adversely affected by waste placement or leachate generated by the landfill.

The pipe provides adequate structural strength to support the maximum static and dynamic loads and stresses imposed by the overlying materials and any equipment used in construction and operation of the landfill.

The Geosynthetic filter materials have adequate permeability and soil particle retention, and chemical and physical resistance which is not adversely affected by waste placement, and overlying material or leachate generated by the landfill.

2.1.2 Horizontal Separation Requirements

1. The MSWLF units are located a minimum of 300' from the property lines.
2. The MSWLF units are located a minimum of 500' from existing residences/wells.
3. The MSWLF units are located a minimum of 50' from any stream, river, or lake.

2.1.3 Vertical Separation Requirements

Phase 3 has a minimum vertical separation between waste and seasonal high ground water. Considering settlement of 1.5 ft. (18 ins.), the waste elevation exceeds the minimum requirement of four feet above the seasonal high ground-water table.

2.1.4 Location Coordinates and Survey Control

Survey control coordinates are shown on the drawings and any additional information required will be furnished upon request.

2.1.5 Sedimentation and Erosion Control Plan

The Sedimentation and Erosion control plan has been completed for the 24-hour, 25-year storm. A copy is submitted under Section 2.2.2 of this application.

2.1.6 Cap System Standards

The County will cap their landfill within 180 days after the final receipt of solid waste. The cap system will consist of 12 inches bridging material (temporary cover), 18 inches of soil liner with a permeability no greater than 1.0×10^{-5} cm/sec, 40 mil. Linear Low Density Polyethylene (LLDPE), drainage layer, 24 inches of protective/erosive layer. The cap contains a gas venting system that consists of a series of washed stone trenches below the soil liner that will be vented through pipes with membrane boots that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

Prior to beginning closure, the County will notify the Division that a notice of the intent to close the unit has been placed in the operating record. The County will begin closure activities no later than thirty (30) days after the date on which the landfill receives the final wastes or if the landfill has remaining capacity and there is a reasonable likelihood that the landfill will receive additional wastes, no later than one year after the most recent receipt of wastes. Extensions beyond the one-year deadline for beginning closure, may be granted by the Division if the County demonstrates that the landfill has the capacity to receive additional waste and the County has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the closed landfill.

The County will complete closure activities in accordance with the closure plan within 180 days following the final receipt of waste. Extensions of the closure period may be granted by the Division if the County demonstrates that closure will, of necessity, take longer than one hundred eighty (180) days and the County has taken and will continue to take all steps to prevent threats of human health and environment from the enclosed landfill.

Following closure of the landfill, the County will record a notation on the deed to the landfill property and notify the Division that the notation has been recorded and a copy has been placed in the operating record. The notation on the deed will in perpetuity notify any potential purchaser of the property that the land has been used as a landfill and its use is restricted under the closure plan approved by the Division. The County may request permission from the Division to remove the notation from the deed if all waste is removed from the landfill.

2.1.7 Leachate Storage Requirements

The County's existing leachate lagoon was designed and built with a minimum of two feet of freeboard. Odor and vector controls are practiced when necessary. A groundwater monitoring system has been installed. The lagoon is protected from external damage by an 8' high chain link fence.

The management of leachate is a major daily operational task. The generation of leachate should always be kept to a minimum. The leachate that is generated will be pumped to the City of Goldsboro Wastewater Treatment Plant. The leachate is treated according to the pre-treatment agreement with the City of Goldsboro, The reason for this testing is to assure the City that the leachate will not harm the biological processes in their treatment facility. The County also records rainfall events as they occur and leachate generation to track the effect rainfall amounts have on the amount of leachate that is generated.

The leachate will be collected in the existing double lined lagoon, which will hold approximately 1,012,029 gallons at 8 feet deep. The Lagoon is 10 feet deep which allows for 2 feet of free board. In the event that the lagoon fills up faster than it can be pumped by forcemain to the City of Goldsboro WWTP, the control valves on the leachate lines can be turned off which will allow the lagoon to be drawn down. Once the leachate levels have been lowered, the valves can be opened. Leachate will be a management problem from the time the garbage is placed in the landfill until long after closure has taken place. Consequently, it is imperative that stormwater be diverted away from any solid waste and managed properly.

All stormwater falling outside of the existing lined areas will be diverted away from the lined section through the use of diversion berms and ditches. Stormwater that falls within the lined area but does not come in contact with solid waste can be diverted to the perimeter areas of the landfill.

The County will close the leachate lagoon within 180 days after liquid collection has ceased.

All solid waste will be removed from the leachate lagoon, connecting sewer lines, and manholes. All solid waste removed will be properly handled and disposed of according to Federal and State requirements. All connecting lines will be disconnected and securely capped or plugged.

All waste residues, contaminated system components (composite liner system), contaminated subsoils, structures and equipment contaminated with waste will be removed and appropriately disposed. If the groundwater surrounding the impoundment is contaminated, other corrective actions to remediate a contaminant plume will be performed if required by the Division. If the groundwater, surrounding the lagoon is found not to be contaminated, the liner system may remain in place if drained and cleaned to remove all traces of waste, and both liners punctured so that drainage is allowed. The lagoon is to be backfilled and re-graded to the surrounding topography.

2.1.8 Existing Landfill Leachate Permit and Flow Data

The County has pumped 2,985,257 gallons of leachate from January 1, 2010 thru October 31, 2010 to the City of Goldsboro Waste Water Treatment Plant.

March 3, 2000

Utility Agreement between the County of Wayne and City of Goldsboro to Treat Wastewater

County Attorney E. B. Borden Parker stated the State of North Carolina would not renew the permit for the Genoa wastewater treatment plant without improvements being made and placing it on another site. The City of Goldsboro has agreed to treat the wastewater and monitor the wastewater, but not take over the system. The County of Wayne is responsible for the new line to the City of Goldsboro wastewater treatment plant and from the Genoa wastewater treatment plant to the users. The City of Goldsboro will treat the County of Wayne as an outside user. The County shall pay the City two times the City's prevailing rate for an outside user who has not purchased reserved capacity for the volume of exceedance multiplied by the number of days in the billing cycle for any 30 days the County exceeds 10,000 gallons over 400,000 gallons per day. The rate for exceeding 25,000 gallons per day is equal to three times the City's prevailing rate for an outside user. The County of Wayne is responsible for any damage it causes the City of Goldsboro wastewater treatment plant. Satellite annexation users and Brogden Middle School are not counted in the County's gallons per day allocation. The County will need to install a sampling station at the landfill due to the leachate. Inflow and infiltration must be stopped so the County does not have to pay for it. If the manhole has unacceptable odors, the county will need to install a device to filter out odors. The County is not getting out of sewer business; we are only getting out of the sewer treatment business. The City will be the entity to give permits for significant industrial users and the County will be one with the landfill. The County of Wayne will have to adopt Goldsboro's sewer ordinance. The State of North Carolina is requiring all municipalities and counties to adopt storm water ordinances and programs. Wayne County's will have to be the same as Goldsboro's.

Al Hodge with the Division of Water Quality of the North Carolina Department of Environment and Natural Resources urged the Board of Commissioners to approve the agreement with the City of Goldsboro. The Division of Water Quality supports centralized wastewater treatment systems. Centralized systems tend to do a better job of treating wastewater. If the County does not approve the agreement, the Genoa wastewater treatment plant would have to be built on another site. The agreement is best for the environment and best for the County of Wayne. He recommended the County remove leaking ground water and water running into the manhole covers. Mr. Hodge expected the permit for the City of Goldsboro to increase its effluent to be approved by the end of the year. Wastewater treatment has become very expensive. He stressed the need to search for alternate methods of using wastewater; such as irrigation uses, outside uses and for toilets.

County Manager Will R. Sullivan stated the effluent for the County of Wayne will remain at 400,000 gallons per day. There is no automatic increase for the County of Wayne even if the City of Goldsboro receives an increase in its effluent.

Upon motion of Commissioner Wilbur E. Anderson, the Board of Commissioners unanimously approved and authorized an utility agreement between the County of Wayne and City of Goldsboro to treat wastewater, attached hereto as Attachment D.

Chairman Atlas Price, Jr. thanked the City of Goldsboro, County Manager Will R. Sullivan, County Attorney E. B. Borden Parker and Buildings and Grounds Superintendent Brant Brown for their cooperation in bringing the agreement to fruition.

STATE OF NORTH CAROLINA

COUNTY OF WAYNE

UTILITY AGREEMENT-CITY AND COUNTY

THIS AGREEMENT, made and entered into this 3rd day of March, 2000 by and between THE CITY OF GOLDSBORO, a municipal corporation existing under the laws of the State of North Carolina (hereinafter called "the City"), and WAYNE COUNTY, a body politic existing under the laws of the State of North Carolina (hereinafter called "the COUNTY".

W I T N E S S E T H:

WHEREAS, the City is the owner and operator of a wastewater treatment plant, which is being expanded to at least 14.2 MGD of treated capacity; and

WHEREAS, the County has reviewed and analyzed many different options relative treatment of it's wastewater at the Genoa Wastewater Treatment Plant; and

WHEREAS, the most cost effective, environmentally sound, and best long term method of wastewater disposal for the County is achieved by abandoning the County's existing wastewater treatment facility and conveying wastewater to the City's wastewater treatment plant.

NOW, THEREFORE, for and in consideration of the respective rights, powers, duties and obligations hereinafter set forth to be performed by the City and the County, the parties mutually agree as follows:

F:\wp7\08\COG\GSNORAG.WPD

1. Definitions

a.	County -	County of Wayne
b.	City -	City of Goldsboro
c.	MGD -	Million Gallons Per Day
d.	GPD -	Gallons Per Day
e.	GPM -	Gallons Per Minute
f.	IU -	An industrial user that does not fall under the criteria for a SIU
g.	IUP -	Industrial User Permit
h.	SIU -	Significant Industrial User (See definition in current Sewer Use Ordinance)
i.	NPDES -	National Pollutant Discharge Elimination System
j.	SUO -	Sewer Use Ordinance
k.	EPA -	Environmental Protection Agency
l.	CERCLA -	Comprehensive Environmental Response, Compensation and Liability Act
m.	DENR -	Department of Environment, and Natural Resources
n.	RU -	Residential User - A single-family or multi-family residential user
o.	NRU -	Non-Residential User - A wastewater contributor that is not a single-family or multi-family residential user.

2. Users to be Served: Since the sewer capacity of the City and its waste treatment plant is limited, the ability of the City to serve its users within the City must have a first priority. However, under the terms of this Agreement, the City and County have agreed upon a priority for providing sewer service to certain areas outside the City of Goldsboro in the following order:

(a) Those users in the area of Wayne County which are currently being provided sewer service by the Genoa WasteWater Treatment Plant as shown on Exhibit "A";

(b) Those users to which the County has obligated itself to provide sewer service as shown on Exhibit "B";

(c) Those potential users who are experiencing sewer problems on existing septic tanks or improper soil conditions so septic tanks cannot be installed and are located so that they can connect with the Genoa WasteWater Treatment Plant;

(d) Those users in (a) and (b) above who have requested additional sewer service; and

(e) Additional users who desire sewer service through the Genoa WasteWater Treatment Plant.

Except for the users referred to in (a) and (b) above, the County shall obtain the City's concurrence and approval before the addition of any non-residential user or increased flow on existing non-residential users. Additionally, the extension of sewer service to any other governmental entity shall require the City's approval and/or a separate agreement.

Even though the City has agreed to extend sewer service to the current users set forth on Exhibit "A" and to fulfill the commitment of the County to the users set forth on Exhibit "B", it is understood and agreed that the total monthly flow from all county users (excluding Brogden Middle School), shall not exceed 400,000 GPD. Users annexed into the City shall not be included in computing the total monthly flow allowed the County. Further, the County shall adopt a fee schedule of flow exceedences for the users shown on Exhibits "A" and "B" that have a permitted daily flow and any additional users assigned a permitted daily flow hereinafter served by the City to insure that the aggregate monthly flow of its customers shall not exceed 400,000 GPD. Finally, County acknowledges and has agreed that City's Sewer Use

Ordinance allows City to regulate significant industrial users, industrial users, residential users and non-residential users.

3. Construction of Line, Meter and Maintenance, by County: The County shall be responsible for the design and construction of the wastewater conveyance system from it's Genoa plant to the City's wastewater treatment plant culminating at the influent structure. In order to limit flows to those specified in this Agreement, capacity of the wastewater conveyance system from the County's system shall be limited to 1.5 of the maximum daily flow allowable under this Agreement. This limitation on capacity shall be designed into the proposed system and approved by the City. The methods of flow constraints shall include, but shall not be limited to, one or more of the following:

a. Pump station design; the pump station will be designed to not exceed 417 GPM maximum pumping capacity. (417 GPM = 400,000 gal. x 1.5)

b. Force main design;

c. Restricting valves;

d. or A semi-permanent flow constriction designed into the system.

At the time the City's wastewater treatment expansion is completed to at least 14.2 MGD, the aforementioned flow constraint may be adjusted to accommodate additional flows provided the City has additional capacity. The system to be designed and constructed by the County shall consist of the following elements:

a. One (1) 0.60 MGD(peak day) pumping station to be located as determined by the County's Engineer.

b. A twelve inch (12") force main from the Genoa plant to the City's wastewater treatment plant.

c. A flow meter to be located as determined by the City's Engineer between the County's force main and the City's wastewater treatment plant.

d. All wastewater shall flow through a bar screen before entering a force main. The screen shall have not more than 3/8 inch spaces between the bars before entering a force main.

e. The City reserves the right to require the County to install such odor control/reaeration facilities as the City deems necessary from time to time to prevent odors or septic conditions.

f. County shall be responsible for the operation and maintenance of its collection system, the pumping station, force main, and odor control/re-aeration facilities.

4. Metering Facility - Maintenance: The point of flow measurement shall be installed at a location to be approved by the City so as to provide accurate measurements. It shall be designed by the County's engineer and approved by the City Public Utilities Director and installed at the County's expense. A vault shall be constructed with a magnetic flow measuring device which will measure, display and transmit flow information to the City's SCADA system. The metering device shall be capable of instantaneous measurement to a prescribed accuracy with continuous readout of

flow rate and totalized flow. The in-line meter shall be recalibrated every 6 months or sooner, if needed, by an independent contractor employed by the City. The maintenance of the metering facility shall be performed by the City. The County shall reimburse the City for the actual cost of said maintenance and re-calibration and the replacement and/or repair thereof which shall be billed by the City on a monthly basis. The City shall have access to the meter at all times.

5. Sampling Stations:

(a) The County shall construct a suitable wastewater sampling station for use by the City at the County's expense. This facility shall be integrated with the metering facility as previously described under Section 4 above and approved by the City. This wastewater sampling station shall include a refrigerated sampler with the capabilities of timed volume/flow proportional, sequential sampling device, housed in a locked compartment. The maintenance of this sampling station shall be performed by the City. The County shall reimburse the City for the cost of the maintenance, replacement and/or repair thereof, including utility cost, which shall be billed by the City on a monthly basis.

(b) The County shall also construct a sampling station for use by the City at the County's expense to accept the County's landfill Leachate. This sampling station shall be located at the County landfill with a twenty-four hour composite sampling station and flow meter acceptable to the City. In addition, the County shall be treated by the City as an SIU for its landfill Leachate with its permit allowing up to 15,000 gallons per day. In the event the County's Leachate causes a toxicity or other problem for the City and its wastewater plant, then the County, after written notice from the City, shall immediately cease to discharge its Leachate into the City's collection system until the County can provide adequate pretreatment to resolve the problem. The mainenance of this sampling station shall be performed by the City. The County shall reimburse the City for the cost of the maintenance, replacement and/or repair thereof which shall be billed by the City on a monthly basis.

6. City Review:

a. The City shall receive a copy of the State-approved engineering drawings for the County's forced main from the Genoa plant to the City's wastewater treatment plant prior to the construction of these facilities, along with a copy of notice to proceed and a copy of the certificate of completion submitted by the County to DENR along with a copy of DENR's final approval.

b. The County shall provide the City with a list of all current non-residential users who discharge into the County's existing system. Each non-residential user shall be required to obtain written permission from the City to continue to discharge into the County's existing system. The City reserves the right to require a new discharge permit for all of the County's existing non-residential users in accordance with the City's current policies and procedures. Further, all new non-residential users, or expanding existing non-residential users, who discharge industrial and/or domestic wastewater into the County's system shall obtain written permission from the City or, in the City's discretion, a discharge permit from the City before connecting to the County's wastewater conveyance system.

c. The County shall provide the City with copies of all proposed applications to be forwarded to DENR for non-discharge permits for all sewer main extensions for the City's approval. The City's approval shall be based upon the subsequent approval by DENR, and the City's ability to accept additional customers.

7. Limitations on Acceptance of County Flows and Effluent Limits: Due to limitations of its current NPDES permit, the City is unable to accept additional flows and effluent from the County's system. Therefore, it is necessary for the City's wastewater treatment plant to be expanded to at least 14.2 MGD or have the City's permit re-rated to 700,000 GPD.

Before the County can connect to the City's wastewater treatment plant, the City must have its permit re-rated or its plant expanded to 14.2 MGD, and the acceptance of the County's wastewater by the City approved by DENR. Further, the County agrees to transfer all of its nitrogen poundage and all other additional effluent rights or privileges under its current Genoa NPDES permit without cost to the City.

8. City's Rates: On a monthly basis, the County shall pay to the City an amount equal to the City's prevailing rate for an outside the City user who has not purchased reserve capacity. In

the event there are sewer users served by the County who have been annexed into the City, then and in that event these users will be charged for sewer as inside the City users based upon the user's monthly metered water flow. Any credit due a user located in an annexed area who is billed by the County shall receive a refund from the City on a semi-annual and not monthly basis. The County shall be responsible for the payment of all bills to the City for any and all users (including other governmental entities) who are served on the County's wastewater conveyance system. In the event there are surcharges, these surcharges (see Exhibit C, Resolution No. 1995-64, paragraph 3) shall be paid monthly to the City by the County in an amount equal to the City's prevailing rate charged other similar users.

All bills received by the County under this Agreement, are due and payable within fifteen (15) days after receipt thereof. The City shall provide the County forty-five (45) days written notice of any rate changes enacted by the City.

9. Monitoring Charges: In addition to the rates set forth in Section 8 above, the County shall be required to pay to the City monitoring charges.

For the purpose of determining these monitoring charges, the City shall collect at the sampling station flow proportional composite samples, and shall analyze these samples at a minimum of not less than one time per week. The results of the analysis of said samples shall be utilized in determining the sampling criteria as shown in Exhibit D (Sewer Regulations, Chapter 51 of the City of Goldsboro Code of Ordinances). Upon request, the City shall provide the County equal split portions of the samples which have been taken for analysis by the City. The analysis reports shall be submitted monthly in writing to the County. The discovery by the City of violations of the discharge limitations by the County as shown on Exhibit D shall be verbally reported to the County within 24 hours of becoming aware of the violation. A written report shall be issued within thirty (30) days. The County shall reimburse the City quarterly for its cost in collecting samples and preparing these analysis (See Exhibit C).

10. Monthly Flow Limitations - Exceedences: As set forth in Section 7, this Agreement is subject to the re-rating of the City's current permit or to a new expanded permit being issued to the City for 14.2 MGD and approval by DENR.

The County's average monthly flow shall not exceed 400,000 GPD. When the County's average monthly flow reaches 320,000 GPD, the City and County shall immediately meet for the purpose of addressing the County's average monthly flow and its customers and potential flow problems. In the event the County's average monthly flow reaches 360,000 GPD, the County shall issue a moratorium on any additional customers or increases in flow from existing customers and shall again meet with the City to address its average monthly flow and potential flow problems. In the event the County's average monthly flow exceeds 400,000 GPD, the County shall immediately take steps to reduce the monthly flow of its customers and shall present to the City its plan for said reduction in that regard.

In the event the County's average monthly flow exceeds 400,000 GPD for a period of thirty (30) days, the County shall pay to the City the following:

(a) For any 30 days that the County's monthly exceedance is 10,000 GPD, the County shall pay to the City an amount equal to two times the City's prevailing rate for an outside the City user who has not purchased reserved capacity for the volume of the exceedence multiplied by the number of days in the billing cycle;

(b) For any 30 days that the County's monthly exceedance is 25,000 GPD or greater, the County shall pay to the City an amount equal to three times the City's prevailing rate for an outside the City user who has not purchased reserved capacity for the volume of the exceedence multiplied by the number of days in the billing cycle; and

(c) In the event the exceedence over 400,000 GPD is not corrected by the County within 120 days, after its first monthly flow exceedence, this exceedence shall constitute a breach of this Agreement and cause for the City to terminate this agreement as provided for under Section 22.

11. <u>County's User Charge System</u>: The County shall establish and maintain a User Charge system which shall generate sufficient revenue to provide for the complete and adequate operation of its sewerage system and its maintenance. The County shall also maintain, at all times during the term of this agreement,

sufficient funds to finance the cost of any capital improvements that may be necessary to maintain its sewerage system. Such user charges shall be updated from time to time to remain in compliance with all federal and State laws and regulations, including an ongoing effort and commitment to resolve the County's inflow and infiltration problems, it may be necessary to maintain its sewer system.

12. County's Rates: The County shall charge and collect sewer connection fees in an amount not less than those charged by the City. In addition, the County shall not charge wastewater sewer service to any user within the service area unless such charge is at a rate equal or greater than City's charges to supply wastewater sewer service to the County.

13. County's Sewer Use Ordinance and Storm Water Management Plan:

a. The County shall adopt the City's Sewer Use Ordinance (including all amendments and additions thereto). In the event the County contracts with another governmental entity to perform its duties and obligations under this Agreement, the contract shall be subjected to the City's approval. The sewer use ordinance adopted by the County shall comply with all current State and/or EPA regulations and shall be updated from time to time to meet all future federal and State requirements. The sewer use ordinance adopted by the County shall be forwarded to the City.

(b) The County shall adopt a Storm Water Management Plan which shall be no less stringent than the City's Storm Water Management Plan. Further, any additional governmental entity which shall become a user of the County shall likewise adopt a similar Storm Water Management Plan. Any Storm Water Management Plan adopted by the County or any other governmental entity shall comply with all current State and/or EPA regulations which shall be updated from time to time to meet all future Federal and State requirements. Any Storm Water Management Plan shall be approved by the City prior to its adoption by the County or any other governmental entity.

14. <u>Industrial Pre-Treatment Program</u>: The City shall administer and issue all permits for the industrial pre-treatment program for the County or any other governmental entity which conveys wastewater to the City. If any enforcement action is needed, the City shall follow its enforcement policy and, when necessary, the County shall terminate the non-residential user's water and/or sewer service after written notification to such user from the City. It shall be the City's responsibility to collect any and all fines and penalties from any SIU. The City shall notify the County of any civil penalty to be assessed against a non-residential user. The City shall assess and collect civil penalties of the County's non-residential users in accordance with the City's policies and procedures. The failure by the County to terminate a non-residential user's water and/or sewer service

shall constitute a breach of this Agreement and cause for the City to terminate this Agreement as provided for under Section 22.

15. Emergency Condition: In the event an emergency condition arises at the City's wastewater treatment facility, the County, after notice, shall immediately take such remedial action in order to assist the City in the elimination of the emergency condition. The County shall and does hereby assume and agree to indemnify and hold harmless the City, its successors and assigns, from and against any and all losses, fines, costs, and expenses, including attorney fees, from damage to the City's system or other property caused by, or in any way resulting from an emergency event caused by the County. Finally, the City shall and does hereby assume and agree to indemnify and hold harmless the County, its successors and assigns, from and against any and all losses, fines, costs, and expenses, including attorney fees, from damage to the County's system or other property caused by, or in any way resulting from an emergency event caused by the City, provided the County has utilized a proper remedial action in resolving the emergency conditions.

16. Interference, Pass-Through Biological Upset: The County shall and does hereby assume and agree to hold harmless the City, its successors and assigns, from harm and against any and all losses, fines, costs, and expenses, including attorney fees, from damage caused by or in any way resulting from a biological upset of the City's treatment facility as a result of the levels of

metals or toxic contaminants contained in the wastewater being discharged by the County to City's wastewater treatment plant.

17. Environmental Liability: The County shall and does hereby assume and agree to hold harmless the City, its successors and assigns, from and against all losses, costs, expenses, including attorney fees, fines and penalties caused by, or in any way resulting from, any claim resulting from wastewater being discharged by the County to the City's wastewater treatment plant, or as a result of any other discharges, including a spill, from the County or any of its users.

18. Force Majeure: In the event either the City or the County is unable, in whole or in part, by reason of force majeure to carry out its obligations, other than to make payments for wastewater treatment services received, it is agreed that on giving notice of such force majeure as soon as possible after the occurrence of the cause relied upon, then the obligation of the City or the County, so far as each may be affected by such force majeure, shall be suspended from performance hereunder during the continuance of any inability to obtain permit, but for no longer period and such cause shall be, as far as possible, be remedied with all due speed. The term "force majeure" shall mean acts of God, strikes, lockouts or other industrial disturbances, acts of public enemy, war, blockades, riots, landslides, droughts, storms, floods or washouts, arrest and restraints of governments and people, civil disturbances, explosions, unavoidable breakage, accident to machinery and equipment and sanitary sewer lines,

inability to obtain permits or materials and equipment and supplies, and any other cause not within the control of the City or the County, which by the exercise of reasonable diligence by the City of the County, is not preventable.

19. Term: This Agreement shall be effective after the date of its approval by the County and the City. It shall continue for a period of twenty (20) years from the date upon which wastewater sewer service is first treated for the County, pursuant to the terms of this Agreement. The City shall, prior to the beginning of the seventeenth year of the term of this Agreement, give notice to the County of its desire to renew this Agreement. Upon giving such notice, the City and the County shall negotiate in good faith with reference to a renewal agreement based upon the same rate format contained in this Agreement. However, without cause, the County may terminate this Agreement at any time upon one year's written notice.

20. Arbitration: Any dispute concerning this Agreement shall, at the request of either the City or the County, be submitted to and determined by an arbitration panel of three (3) arbitrators, pursuant to the terms of this section and the Uniform Arbitration Act (hereafter "the Act") as adopted by the State of North Carolina, and its general statutes in Section 1-567.1 through 1-567.29, as amended. The City and the County shall each appoint one (1) qualified member to the arbitration panel, and these appointees shall select a third member. A majority vote of the arbitration panel shall control and be binding on the City and

the County without recourse, except as otherwise provided in the Act. If the two (2) arbitrators first chosen can not agree on the selection of a third arbitrator, then, upon application by the City or the County, such third arbitrator shall be appointed by the Court having jurisdiction over such matters as provided in the Act. To be qualified, such third arbitrator shall be a professional engineer with experience in production and delivery of sanitary sewer service, a certified public accountant, or a practicing attorney with experience in municipal utility matters. Pursuant to the Act, the cost to be paid by the City and the County associated with arbitration shall be determined by the arbitration panel. The City and the County shall each continue to perform all other obligations under the terms of this Agreement pending final resolution of any dispute arising out of or relating to this Agreement which has been submitted to arbitration. Neither the City nor the County may violate any federal, state, or local law or regulation regarding the wastewater sewer service being provided herein during the course of pursuing its' rights under this section, or shall the user be denied the wastewater sewer service necessary to reasonably maintain the public health and safety.

21. Discrimination: It is specifically agreed by both parties hereto, as part of consideration of the signing of this Agreement, that neither the County nor the City, its agents, officials, employees, or servants shall discriminate in any manner on the basis of race, color, creed, sexual orientation, or

national origin with reference to the subject matter of this Agreement.

22. Nonpayment and/Default: The City may terminate this Agreement and terminate the County's right to discharge wastewater to the City's wastewater treatment plant one hundred and twenty (120) days after written notification to the County by the City for the non-payment of fees, cost, charges or fines as set forth in this Agreement, or for the breach by the County of any other condition contained in this Agreement.

23. Waivers: Neither the failure nor the delay on the part of the City or County hereto to exercise any right, power, or privilege hereunder shall operate as a waiver hereof, nor shall any single or partial exercise of any other right, power, or privilege, nor shall any custom or practice at variance with the terms of this Agreement constitute a waiver of the right of either party to demand exact compliance with such terms.

24. Invalid Terms: Should any one or more of the provisions contained in this Agreement be held invalid, illegal, or unenforceable in any respect, the validity, legality and enforceability of the remaining provisions contained in this Agreement shall not in any way be affected or impaired thereby, and this Agreement shall otherwise remain in full force and effect.

25. Controlling Law: This Agreement and the rights and obligations of the parties hereunder shall be construed and interpreted in accordance with laws of the State of North

Carolina, and shall be binding upon and inure to the benefit of their successors and, with consent of the other party, the assigns of either party hereto.

26. Notices: Any notices required or permitted under this Agreement, including address changes, shall be made in writing, either by mailing registered or certified mail, return receipt requested, and postage prepaid, to the other party at the address shown herein for that party, or at such different address for that party, notice of which has been properly given hereunder, or by personally delivering such a notice to an officer of the other party. The notice, if mailed as provided for herein, shall be deemed given on the day of receipt or refusal to accept receipt, and if personally delivered, on the date of delivery. The addresses are as follows:

To the City: City Manager
City of Goldsboro
P. O. Drawer A
Goldsboro, NC 27533

To the County: County Manager
County of Wayne
P.O. Box 227
Goldsboro, NC 27533-0227

27. Entire Agreement: This Agreement reflects and contains the entire and only agreement between the parties related to the subject matter herein, and, as such, supersedes all negotiations, commitments and agreements, whether oral or otherwise.

28. Amendments: This Agreement may be amended only by an instrument in writing executed by both parties hereto.

IN WITNESS WHEREOF, The City and the County have caused this Agreement to be executed its Mayor and Chairman respectively, their corporate seals to be affixed and attested by their respective Clerks, all by the authority of their respective governmental bodies the day and year first written.

CITY OF GOLDSBORO

BY:____________________
Mayor

ATTEST:

____
City Clerk

APPROVED (as to form only)
W. Borrell Everett, Jr.
City Attorney

County of Wayne
Wayne County Board of Commissioners
BY: ____________________
Chairman

ATTEST:
Marcia R. Wilson
County Clerk

APPROVED (as to form only)

____
County Attorney

NORTH CAROLINA
WAYNE COUNTY

This the ______ day of ________________, 2000, personally came before me ____________________, a Notary Public in and for said State and County, SANDRA JUSTICE, who by me duly sworn, says that she knows the common seal of the CITY OF GOLDSBORO and is acquainted with ____________________, who is the Mayor ____________ of said municipal corporation; that she, the said SANDRA JUSTICE, is its Clerk; and that she saw the Mayor sign the foregoing instrument; and that she, the said Clerk, saw the said common seal of said corporation affixed thereto, and that she, the said Clerk, signed her name in attestation of said instrument in the presence of said Mayor of said municipal corporation.

Witness my hand and seal this the ______ day of ________, 2000.

____
Notary Public

My Commission Expires:
____

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NORTH CAROLINA
WAYNE COUNTY

This the 13th day of March, 2000, personally came before me Cynthia B. Furcron, a Notary Public in and for said State and County, MARCIA WILSON, who by me duly sworn, says that she knows the common seal of the WAYNE COUNTY BOARD OF COMMISSIONERS and is acquainted with ATLAS PRICE, who is the Chairman of said body politic; that she, the said MARCIA WILSON is its Clerk; and that she saw the Mayor sign the foregoing instrument; and that she, the said Clerk, saw the said common seal of said body politic affixed thereto, and that she, the said Clerk, signed her name in attestation of said instrument in the presence of said Chairman of the Wayne County Board of Commissioners.

Witness my hand and seal this the 13th day of March, 2000.

Cynthia B. Furcron
Notary Public

My Commission Expires:
April 20, 2003

2.2 Summary of the Facility Design

Several factors have been looked at in the design and stability of the landfill. The first is earthwork calculations to see if the facility will need to borrow material from another source. For the construction of Phase 3 the facility will need 420,898 cubic yards of off-site soil. An additional 68,586 cubic yards will be needed for daily cover and an additional 149,919 cubic yards will be needed for closure. An Erosion Control plan has been developed and approved by the Land Quality Section of NCDENR, and the calculations are in section 2.2.2.

HELP Model Summary

A Model, "Hydrologic Evaluation of Landfill Performance" (HELP) has been performed to simulate precipitation and leachate generation under certain conditions. The output can be found in Section 2.2.3. The analysis is done through the landfill with 8 ft. of solid waste with no runoff for the 1st year of operation and with 25 ft. of solid waste with no runoff for the 1st through the 5th year of operation. Simulation was also done on a closed landfill. The peak daily head on the liner of 0.372 inches occurs after 1 year of operation with 8 ft. of solid waste and no surface runoff. The peak daily head on the liner for the 1st five years is 0.370 inches. The drainage layer (layer 5) is a double bonded 250 mil thick drainage net.

Leachate Collection System Calculations Summary

The leachate collection system consists of a 250 mil double bonded drainage net that is the drainage layer, stone filled trenches and collection pipes. The adequacy of the drainage layer is demonstrated in the HELP models (see sec.2.2.3).

Calculations have been performed for the Leachate Collection Pipes, and are located in Section 2.2.4. The calculations uses Manning's equation and the orifice equation to determine the adequacy of the leachate piping system to drain the leachate. The system adequately drains the 24hr 25yr storm. See calculations in section 2.2.4.

Strength of the HDPE leachate pipe calculations have been done and are located in section 2.2.5. The SDR 17 HDPE pipe can handle the loads created by at least 250' of waste. See section 2.2.5 for calculations.

Liner System Calculation Summary

Several calculations were done for the stress on the textured flexible geomembrane liner during construction. The thermal stress on the liner created by the temperature changing 100°F is 0.67% which is well within the 13% elongation yield limit. (see sec. 2.2.6) The self-weight stress on the textured flexible geomembrane liner shows that on a 3:1 slope the total length of slope allowed far exceeds the longest slope design (see sec. 2.2.6).

The Anchor trench has also been analyzed and the design depth of the Anchor trench is 4.0 ft. which allows pullout just prior to liner failure. (see sec. 2.2.6). An analysis of the drainage net for anchor trench requirements was analyzed and no anchor trench was required; however, the drainage net will be placed in the same anchor trench as the flexible membrane liner.(see sec.2.2.6).

The factor of safety for the sliding of the protective soil cover was analyzed showing a factor of safety greater than 1 for the interface between the soil and double bonded drainage net. (see sec. 2.2.6). The stresses due to the placement of protective cover were also analyzed (see sec. 2.2.6). Soil placed on the 3:1 embankment 50 ft. high does not effect the drainage net or the liner. The soil is buttressed enough at the base to have a negative effect on the slopes.

The geotechnical evaluation report by ECS, Ltd. states that the proposed plan is suitable and falls within acceptable safety factors. The report is located in Section 2.2.8.

2.2.1 <u>Earthwork Calculations</u>

Required soil for:

*Subbase preparation Phase 3:	336,282 cubic yards
*Composite Liner System Phase 3:	65,094 cubic yards
*Protective Cover Phase 3:	100,922 cubic yards
Total Soil required for Construction Phase 3:	**502,298 cubic yards**

Required soil for:

Daily Cover Phase 3:	60,210 cubic yards
Closure System Phase 3:	152,460 cubic yards
Total Soil required To build, operate and close Phase 3:	**714,968 cubic yards**

*Determined by AutoCADD computer program.

2.2.2 Erosion Control

North Carolina Department of Environment and Natural Resources
Division of Land Resources
Land Quality Section

James D. Simons, PG, PE
Director and State Geologist

Beverly Eaves Perdue, Governor
Dee Freeman, Secretary

May 19, 2010

LETTER OF APPROVAL WITH MODIFICATIONS

County of Wayne
ATTN: Mr. William Lee Smith, III, County Manager
Post Office Box 227
Goldsboro, North Carolina 27533

RECEIVED
MAY 20 2010
Municipal Engineering Services
Company, PA

RE: Erosion and Sedimentation Control Plan No. WAYNE-2010-029
Project Name: County Landfill, Phase 3
Location: SR 1129 County: Wayne
River Basin: Neuse
Date Received by LQS: April 29, 2010
Acres Approved: 42 Project Type: New
Project Description: Landfill Expansion, as shown on the submitted plan dated April 23, 2010

Dear Sir:

This office has reviewed the subject erosion and sedimentation control plan. We find the plan to be acceptable and hereby issue this Letter of Approval with Modifications. The modifications required for approval are listed on the attached pages. This plan approval shall expire three (3) years following the date of approval, if no land-disturbing activity has been undertaken, as required by 15A NCAC 4B.0129, unless modified by other legislation.

Please be advised that 15A NCAC 4B.0118(a) requires that a copy of the approved erosion and sedimentation control plan be on file at the job site. Also, you should consider this letter as giving the Notice required by G.S. 113A-61.1(a) of our right of periodic inspection to ensure compliance with the approved plan.

North Carolina's Sedimentation Pollution Control Program is performance oriented, requiring protection of existing natural resources and adjoining properties. If, following the commencement of this project, it is determined that the erosion and sedimentation control plan is inadequate to meet the requirements of the Sedimentation Pollution Control Act of 1973 (G.S. 113A-51 through 66), this office may require revisions to the plan and implementation of the revisions to ensure compliance with the Act.

Acceptance and approval of this plan is conditioned upon your compliance with Federal and State water quality laws, regulations and rules. In addition, local city or county ordinances or rules may also apply to this land-disturbing activity. This approval does not supersede any other permit or approval.

Washington Regional Office
943 Washington Square Mall, Washington, North Carolina 27889 • Phone: 252-946-6481 / FAX: 252-975-3716
Internet: http://www.dlr.enr.state.nc.us/pages/landqualitysection.html

County of Wayne
ATTN: Mr. William Lee Smith, III, County Manager
May 19, 2010
Page 2

Please be aware that your project will be covered by the enclosed NPDES General Stormwater Permit NCG010000 (Construction Activities). You should first become familiar with all of the requirements for compliance with the enclosed permit.

Please note that this approval is based in part on the accuracy of the information provided in the Financial Responsibility/Ownership Form, which you have submitted. You are required to file an amended form if there is any change in the information included on the form. In addition, 15A NCAC 4B.0127(c) requires that you notify this office of the proposed starting date for this project (using the enclosed Project Information Sheet). Please notify us if you plan to have a preconstruction conference.

Please be advised that a rule to protect and maintain existing buffers along watercourses in the Neuse River Basin became effective on July 22, 1997. The Neuse River Riparian Area Protection and Maintenance Rule (15A NCAC 2B.0233) applies to the 50-foot wide zone directly adjacent to surface waters (intermittent streams, perennial streams, lakes, ponds, and estuaries) in the Neuse River Basin. For more information about this riparian area rule, please contact the Division of Water Quality's Wetland/401 Unit at 919-733-1786, or DWQ in our regional office at 252-946-6481.

Sincerely,

Robert James Belvin, PE
Assistant Regional Engineer

Enclosures

cc w/o enc: Jimmy D Woodie, PE, Municipal Engineering Services
Alton Hodge, Division of Water Quality

Erosion and Sedimentation Control Plan No. WAYNE-2010-029
Project Name: County Landfill, Phase 3
May 19, 2010
Modifications
Page 1

1. **AS THE DECLARED RESPONSIBLE PARTY, YOUR LEGAL RESPONSIBILITY** is to understand the Act and comply with the following minimum requirements of the Act:

   A. In the event of a conflict between the requirements of the Sedimentation Pollution Control Act, the submitted plan and/or the contract specifications, the more restrictive requirement shall prevail;

   B. The land-disturbing activity shall be conducted in accordance with the approved erosion and sedimentation contorl plan;

   C. The **LATEST APPROVED** erosion and sediment control plan will be used during periodic unannounced inspections to determine compliance and a copy of the plan must be on file at the job site. If it is determined that the implemented plan is inadequate, this office may require the installation of additional measures and/or that the plan be revised to comply with state law;

   D. All revisions, including those required by other local, state or federal agencies, which affect site layout, drainage patterns, limits of disturbance and/or disturbed acreage must be submitted to this office for approval a minimum of 15 days prior to the start of construction;

   E. Revisions exceeding the approved scope of this project without prior approval of the plan showing the changes can be considered a violation. Failure to comply with any part of the approved plan or with any requirements of this program could result in appropriate legal action (civil or criminal) against the financially responsible party. Legal actions include Stop Work Orders and the assessing of a civil penalty of up to $5000 for the initial violation plus an additional penalty of up to $5000 per day for each day the site is out of compliance;

   F. The **CERTIFICATE OF PLAN APPROVAL must be posted** at the primary entrance to the job site and remain until the site is permanently stabilized;

   G. In cases of natural disaster related changes to the proposed land disturbing activity, all appropriate actions and adequate measure installations may be performed to prevent sediment damage, prior to submitting and receiving approval of the revised plan. A revised plan must be submitted for approval as soon as possible, but no later than 15 days after all emergency actions have been performed;

H. Erosion and sediment control measures or devices are to be installed to safely withstand the runoff resulting from a 10 year storm event - 6.5 - 7 inches in 24 hours or at the rate of 6.5 - 7 inches in 1 hour;

I. Unless the off-site borrow and/or disposal sites are identified in the erosion control plan, no earthen material is to be brought on or removed from the project site;

J. Buffer zone, sufficient to restrain visible sedimentation within the 25% of the width closest to the land disturbance, must be provided and maintained between the land-disturbing activity and any adjacent property or watercourse;

K. In order to comply with the intent of the Act, the scheduling of the land-disturbing activities is to be such that both the area of exposure and the time between the land disturbance and the providing of a ground cover is minimized;

L. Unless a temporary, manufactured, lining material has been specified, a clean straw mulch must be applied, at the minimum rate of 2 tons/acre, to all seeded areas. The mulch must cover at least 75% of the seeded area after it is either tacked, with an acceptable tacking material, or crimped in place;

M. New or affected cut or filled slopes must be at an angle that can be retained by vegetative cover, AND **must be provided with a ground cover** sufficient to restrain erosion **within 21 calendar days of completion of any phase (rough or final) of grading** (ANNUAL RYE GRASS IS NOT in the APPROVED seeding specifications NOR is it an ACCEPTABLE substitute for the providing of a temporary ground cover);

N. A **permanent ground cover**, sufficient restrain erosion, **must be provided** within the shorter of 15 working or 90 calendar days (if in a High Quality Zone, the shorter of 15 working or 60 calendar days) after completion of construction or development on any portion of the tract (ANNUAL RYE GRASS IS NOT in the APPROVED seeding specifications NOR is it an ACCEPTABLE substitute for the providing of a nurse cover for the permanent grass cover);

2. Adequate and appropriate measures must be properly installed downstream, within the limits of disturbance, of any land disturbing activity to prevent sediment from leaving the limits of disturbance, entering existing drainage systems, impacting an on-site natural watercourse or adjoining property.

3. Silt fences are not appropriate for areas of concentrated flow such as swales ditches, or spillway outfalls. Provide adequate and appropriate measures for all construction within areas of concentrated flow.

4. Provide an overall site plan identifying the limits of disturbance associated with all existing permits and new permits.

REVISION TO APROVED
EROSION CONTROL PLAN

FOR

WAYNE COUNTY
MUNICIPAL SOLID WASTE LANDFILL FACILITY
PHASE 3

DUDLEY, NORTH CAROLINA

G06096

March 2009

Prepared by:
Municipal Engineering Services Co., PA
Garner, NC ◆ Boone, NC ◆ Morehead City, NC
Phone: (919)772-5393 Fax: (919)773-1176

DRAINAGE/DISTURBED AREAS

Stage 1
(Clearing and Grubbing)

Drainage/ Disturbed Areas

Area Designation	Acres	C factor	
DA1	8.94	0.45	Drainage
DA2	3.79	0.25	Drainage
DA3	12.33	0.45	Re-Disturbed
DA4	3.12	0.25	Re-Disturbed
DA5	22.82	0.35	Re-Disturbed
DA6	6.39	0.35	Drainage
P1	0.88	0.35	Drainage/Disturbed
P2	1.08	0.35	Drainage/Disturbed

Stage 2
(Landfill Construction)

Drainage/ Disturbed Areas

Area Designation	Area (ac.)	C factor	
ST1	2.38	0.45	Drainage/Disturbed
ST2	0.49	0.45	Drainage/Disturbed

Total Disturbed
41.23 acres
(38.27 acres disturbed in previously approved plan
and 2.96 acres newly disturbed in this plan)

Runoff Coefficient
NC Erosion Control Manual Table 8.03b
C = varies (see above)

Rainfall Intensity

NC Erosion Control Manual Fig. 8.03c
Rainfall Intensity Chart for Raleigh

I = 6.19

Raleigh, North Carolina 35.8706N, 78.7864W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	5.58	4.46	3.74	2.58	1.62	0.94	0.66	0.40	0.24	0.14
10	7.08	5.66	4.78	3.46	2.25	1.33	0.95	0.58	0.34	0.021
25	7.78	6.19	5.24	3.88	2.58	1.54	1.11	0.68	0.41	0.24
100	8.64	[illegible]	5.78	4.43	3.05	1.85	1.36	0.84	0.51	0.30

USE
6.19

STAGE 1   CALCULATIONS
(Clearing and Grubbing)

Check Existing Riser Basin 1

Disturbed/Drainage area to Basin 1

Area Designation	Acres	C factor
DA1	8.94	0.45
DA2	3.79	0.25
DA3	12.33	0.45
DA4	3.12	0.25
DA5	22.82	0.35
DA6	6.39	0.35
	57.39	

Find Composite C:

$$\begin{aligned} 8.94 \times 0.45 &= 4.02 \\ 3.79 \times 0.25 &= 0.95 \\ 12.33 \times 0.45 &= 5.55 \\ 3.12 \times 0.25 &= 0.78 \\ 22.82 \times 0.25 &= 7.99 \\ 6.39 \times 0.35 &= \underline{1.19} \\ & 20.48 \end{aligned}$$

Combined C factor ÷ acreage = Composite C = 20.48 ÷ 57.39 = 0.36 = Composite C

$Q_{(25)}$ = CIA= (.36)(6.19)(57.39) = 127.89 cfs

Storage Capacity:

Capacity needed is 1800 ft^3/acre(disturbed)
Capacity = (1800)(38.27) = 68,886 ft^3

Due to the location and the shape of the basin the average end method of calculating the storage of the basin is as follows:

Exist. bottom area at elevation 138 = 12,247
Exist. Spillway area at elevation 140 = 53,711

therefore:
12,247 + 53,711 = 65,958 ÷ 2 = (32,979)(2') = 65,958 ft^3

Storage volume Required = 68,886 cubic feet
Provided = 65,958 cubic feet

The actual storage capacity of the basin is not adequate to contain the runoff. Therefore, the basin shall be enlarged as shown on the plans. The total square feet of contour elevation 140 will be increased to 61,263 square feet.

This gives a Storage Volume Provided = 73,510 cubic feet, which is adequate to contain runoff.

Check existing Emergency Spillway for Existing Basin #1:

Given: 18' wide
3:1 side slope
1.5' depth

Required Flow: Q_{25} = 127.89cfs

n =	0.03
B =	18.00
S =	0.005
Y =	1.5
M =	3
Depth =	1.5

W =	27	
R =	1.227861	R value
Q =	135.5467	Flow
A =	33.75	Adjusted Area of flow
P =	27.48683	Adjusted Wetted Perimeter
V =	4.016199	Va =5.0

The Spillway is adequate to control emergency flow.

Design Culvert #1 :

Area Draining Into Proposed Culvert #1

P1 and P2 = 1.96 acs.
i = 6.19 in/hr
C = 0.35

$Q_{(10)}$ = CiA = (0.35)(6.19)(1.96) = 4.25 cfs

Size pipe for driveway:

$D = 16[Qn \div \sqrt{s}]^{.375} =$

$D = 16[(4.25)(.013) \div \sqrt{.01}]^{.375} = 12.81"$ required

Use 18" RCP

Outlet Protection:
(sized for 10 cfs min.)

L = 10' W = 11.5' d_{50} = 6" 13.5" min. thickness

<u>STAGE 2 CALCULATIONS</u>
(Landfill Construction)

DESIGN SEDIMENT TRAP #1

<u>Areas Draining Into Sediment Trap #1</u>

Area Designation	Acres	C factor	Intensity
ST1	2.38	0.45	6.19

$Q_{(25)}$ = CIA= (.45)(6.19)(2.38) = 6.63 cfs

Surface Area Required: 435sq.ft./Peak cfs

Surface area S = 435(6.63) = 2884 sq.ft.

Storage Capacity:

Capacity needed is 3600 ft^3/acre(disturbed)
Capacity = (3600)(2.38) = 8568 ft^3

Due to the location and the shape of the basin the average end method of calculating the storage of the basin is as follows:

bottom area	138.5	= 4,416
Spillway	140	= 7,815

therefore:
4416 + 7815 = 12,231 ÷ 2 = (6115.5)(1.5')= 9,173 ft^3

Storage volume required = 8,568 cubic feet
Provided = 9,173 cubic feet

The actual storage capacity of the basin is adequate to contain the runoff.

Emergency Spillway:

Must pass 25-year storm: 6.63 cfs

Use: 6' wide Spillway 3:1 Side Slope 18' Top Width

n =		0.03	6" stone
B =		6.00	
S =		0.005	
Y =		2	
M =		3	
Depth =		2	
W =	18		
R =	1.286925	R value	
Q =	99.45559	Flow	
A =	24	Adjusted Area of flow	
P =	18.64911	Adjusted Wetted Perimeter	
V =	4.143983		Va =8.0
Shear Stress	0.624		2.0 max = 6" stone

<u>Elevations:</u>

Top of Berm	142.0'
Emergency Spillway	140.0'
Bottom Elevation	138.5

DESIGN SEDIMENT BASIN #1

Areas Draining Into Sediment Basin #1

Area Designation	Acres	C factor	Intensity
ST2	4.49	0.45	6.19
DA6	6.39	0.35	6.19
	10.88		

Find Composite C:

4.49 x 0.45 = 2.02
6.39 x 0.35 = 2.24
4.26

Combined C factor ÷ acreage = Composite C = 4.26 ÷ 10.88 = 0.39 = Composite C

$Q_{(25)}$ = CIA= (.39)(6.19)(10.88) = 26.27 cfs

Surface Area Required: 435sq.ft./Peak cfs

Surface area S = 435(26.27) = 11,428 sq.ft.

Storage Capacity:

Capacity needed is 1800 ft^3/acre
Capacity = (1800)(10.88) = 19,584 ft^3

Due to the location and the shape of the basin the average end method of calculating the storage of the basin is as follows:

bottom area	148	= 12,369
	150	= 25,902
Spillway	152	= 40,349

therefore:

12369 + 25902 = 38,271 ÷ 2 = (19135.5)(2')= 38,271 ft^3
25902 + 40349 = 66,251 ÷ 2 = (33125.5)(2')= 66,251 ft^3
104,522 ft^3

Storage volume required = 19,584 cubic feet
Provided = 104,522 cubic feet

The actual storage capacity of the basin is adequate to contain the runoff.

Principal spillway barrel size:

Size for a 25 year storm:

C = 0.39 (composite C)

I = 6.19

A = 10.88 acres (total drainage area)

$Q_{(25)}$ = CIA= (0.39)(6.19)(10.88) = 26.27 cfs

Q = 26.27 cfs   n = .024   s = .015

D = 16 (Q n $\div\sqrt{s}$)$^{.375}$ Use corrugated metal pipe

D = 16[(26.27)(.024)$\div\sqrt{.015}$]$^{.375}$ = 29.58" Use 30" CMP

Outlet Protection

L = 18' W = 20.5' d_{50} = 9" 20.25" min. thickness

Riser pipe for Principal spillway:

1.5 times the diameter of the barrel = 44.37" Use 48" CMP

Footing for riser pipe:

Given :   r = 2.0'   h = 3.5'

Weight of water: $\pi r^2 h(62.4)$ = 2,745

Concrete: 150 lbs per ft^3

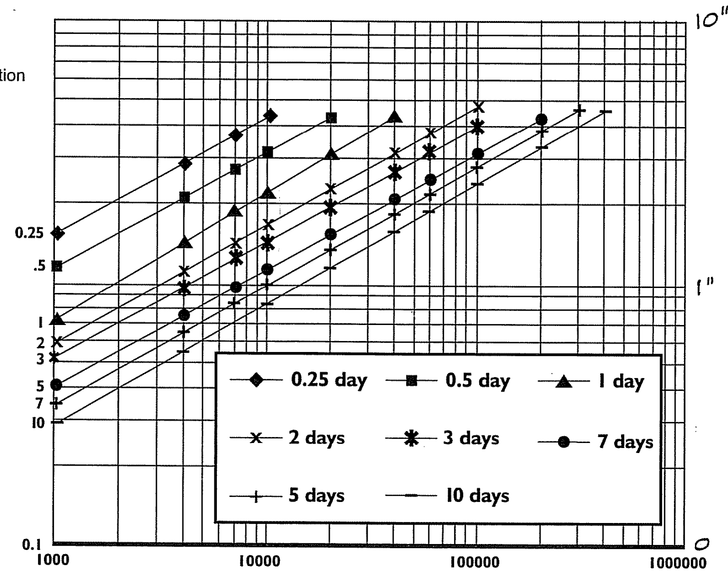
18.3 ft^3 of concrete needed

Use 25 ft^3 of concrete

1' x 5' x 5' footing

Skimmer: Use skimmer designed with 3" orifice diameter. (Determined by using chart below found in NC Erosion Control Manual) Based on Basin Volume of 19,584 cubic feet and 1 day dewatering time.

Figure 6.64b Skimmer orifice diameter as a function of the basin volume and basin dewatering time.



Emergency Spillway:

Must pass 25-year storm: 26.27 cfs

Use: 12' wide Spillway 3:1 Side Slope 24' Top Width

n =	0.03	6" stone
B =	12.00	
S =	0.005	
Y =	2	
M =	3	
Depth =	2	

W =	24	
R =	1.460499	R value
Q =	162.3127	Flow
A =	36	Adjusted Area of flow
P =	24.64911	Adjusted Wetted Perimeter
V =	4.508687	Va =5.0

Shear Stress = 0.624 2.00 max 6" stone

Elevations:

Top of Berm	154.0'
Emergency Spillway	152.0'
Riser Crest	151.5'
Barrel Inlet	148.0'
Barrel Outlet	147.5'
Bottom Elevation	148.0'

<u>Design Diversion Ditch #1 :</u>

<u>Areas Draining Into Diversion Ditch #1</u>

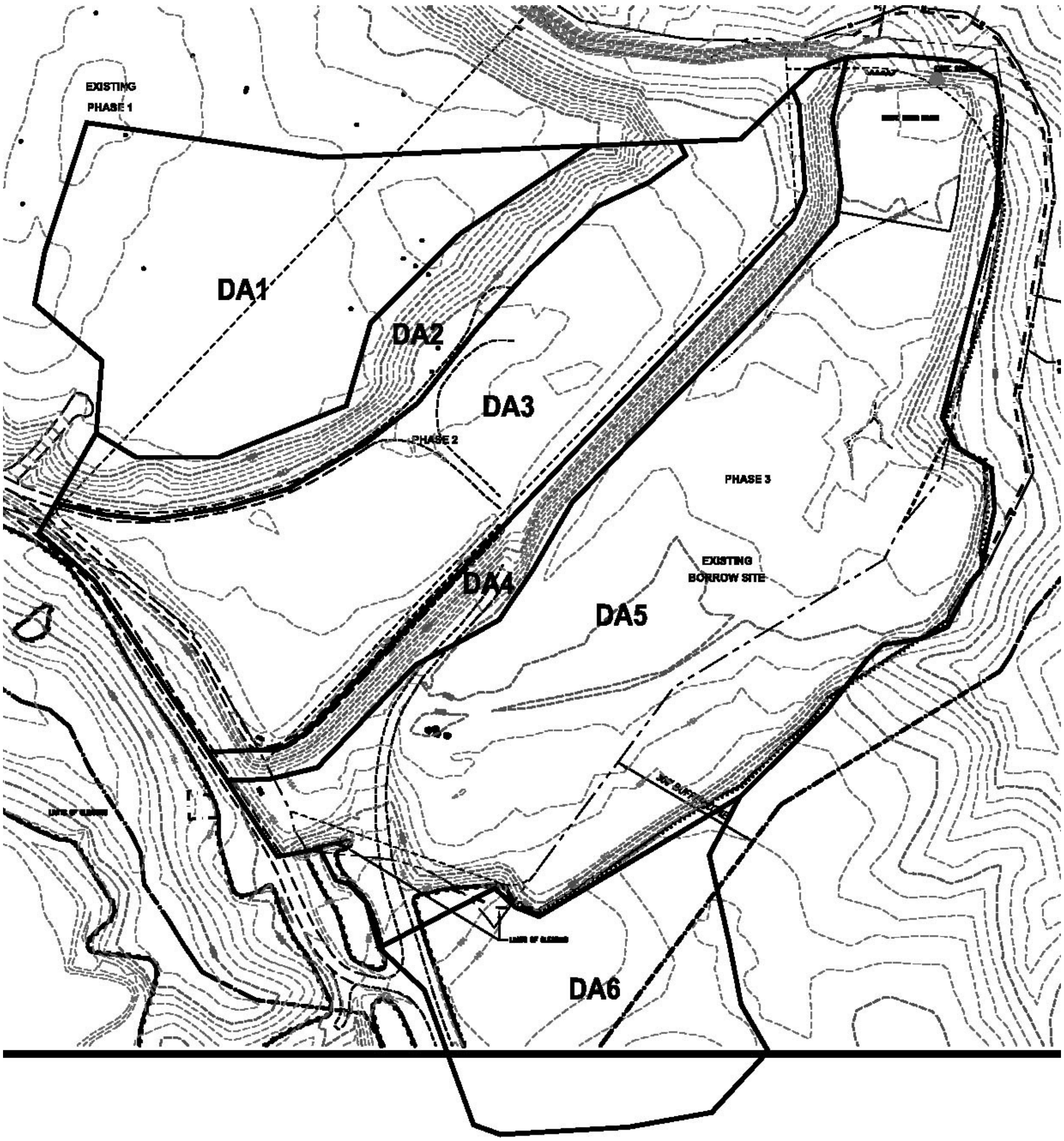
Area Designation	Acres	C factor	Intensity
P2	1.08	0.45	6.19

$$Q_{(25)} = CIA = (.45)(6.19)(1.08) = 3.01 \text{ cfs}$$

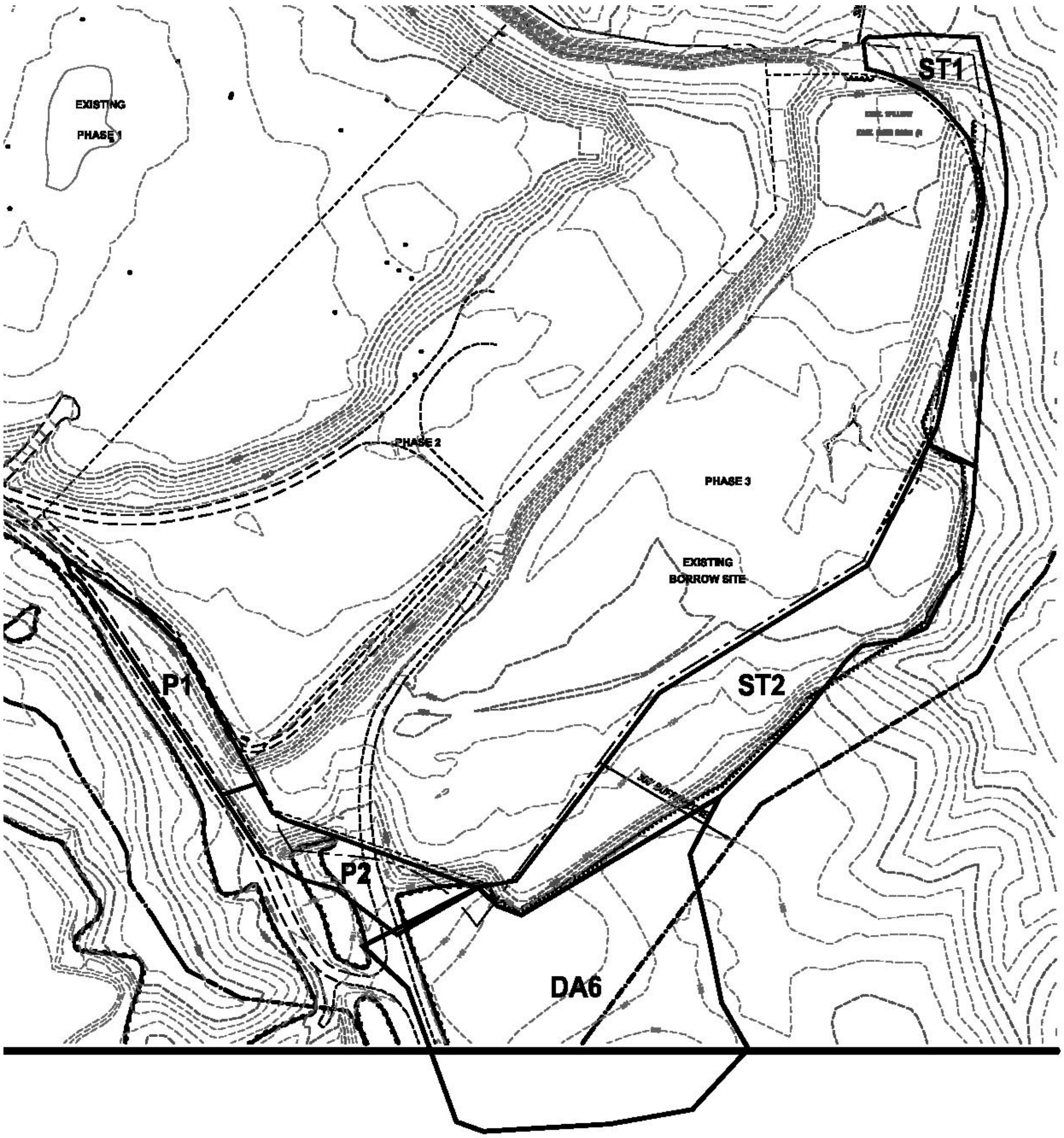
n =	0.03	grass lined
B =	0.00	
S =	0.018	
Y =	1	
M =	3	
Depth =	1	

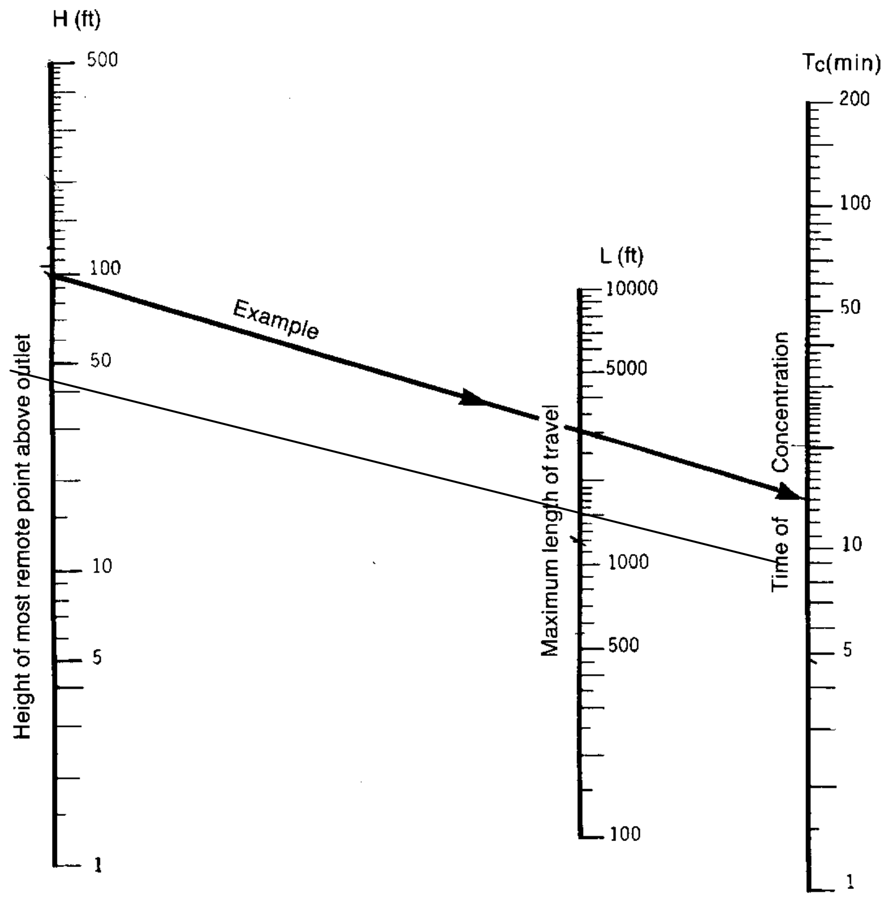
W =	6			
R =	0.474342	R value		
Q =	12.12595	Flow		
A =	3	Adjusted Area of flow		
P =	6.324555	Adjusted Wetted Perimeter		
V =	4.041985	Va =5.0	Allowable	Grass lined channels
Shear Stress	1.1232	0-.45	jute netting	
		<u>.46-1.45</u>	<u>straw with net</u>	
		1.45-2.00	synthetic mat	

<u>Reference Materials</u>


EXISTING
PHASE 1
DA1
DA2
DA3
PHASE 2
DA4
PHASE 3
EXISTING
BORROW SITE
DA5
DA6

Drainage/Disturbed Areas





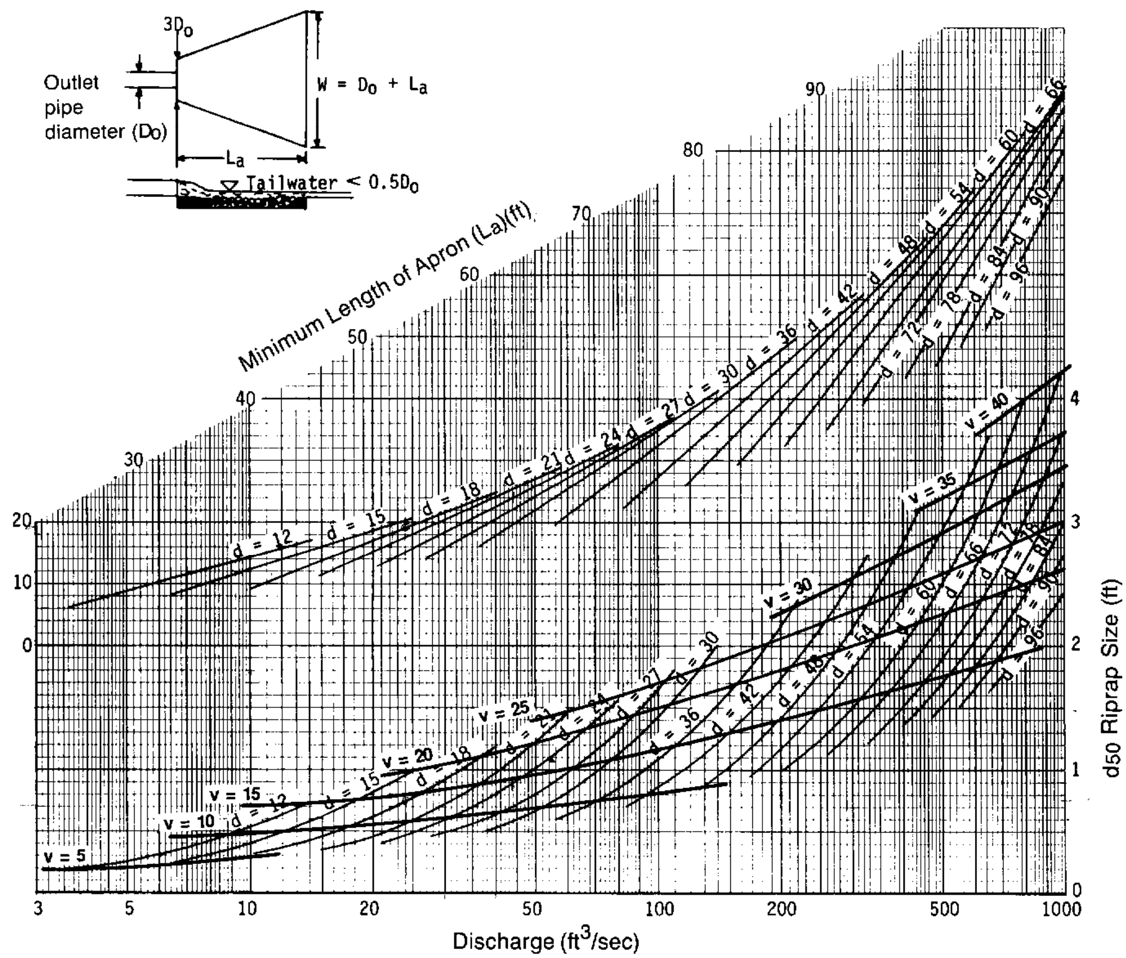
Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.



Curves may not be extrapolated.

Figure 8.06a Design of outlet protection protection from a round pipe flowing full, minimum tailwater condition (T_w < 0.5 diameter).

2.2.3 HELP Model

INSERT FIRST HELP MODEL
STANDARD LINER SYSTEM (Alt. 1)
PHASE 3 OPEN 1^{st} YEAR

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04    (13 MARCH 1995)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\WAYNE1.D4
TEMPERATURE DATA FILE:        C:\HELP3\WAYNE1.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\WAYNE1.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\WAYNE1.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\WAYNE.D10
OUTPUT DATA FILE:             C:\HELP3\Wayne.OUT
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TIME: 15:40 DATE: 10/01/2009

****

TITLE: Wayne Co. Phase 3 Open 1st Year (Alt. 1)

****

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


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER  12
          THICKNESS                   =     12.00    INCHES
          POROSITY                    =      0.4710 VOL/VOL
          FIELD CAPACITY              =      0.3420 VOL/VOL
          WILTING POINT               =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.3113 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	96.00	INCHES
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0726	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00	INCHES
POROSITY	=	0.4790	VOL/VOL
FIELD CAPACITY	=	0.3710	VOL/VOL
WILTING POINT	=	0.2510	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4314	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES

POROSITY	=	0.0000 VOL/VOL
FIELD CAPACITY	=	0.0000 VOL/VOL
WILTING POINT	=	0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY	=	4.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	4.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 6

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4270 VOL/VOL
FIELD CAPACITY	=	0.4180 VOL/VOL
WILTING POINT	=	0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #12 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	91.70	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.430	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.332	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.710	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	36.487	INCHES
TOTAL INITIAL WATER	=	36.487	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.00
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.07	3.73	4.15	3.40	4.01	4.34
6.40	5.77	4.77	2.84	3.25	3.46

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.50	43.50	51.50	61.50	69.30	75.90
79.70	78.80	73.20	61.80	52.40	43.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.35 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.17	171227.125	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	35.134	127536.766	74.48
DRAINAGE COLLECTED FROM LAYER 4	12.0350	43686.902	25.51

PERC./LEAKAGE THROUGH LAYER 6	0.000003	0.010	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0011		
CHANGE IN WATER STORAGE	0.001	3.379	0.00
SOIL WATER AT START OF YEAR	36.487	132448.312	
SOIL WATER AT END OF YEAR	36.488	132451.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.069	0.00

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.69	4.49	3.27	1.63	1.94	6.85
	7.43	7.75	2.56	3.57	0.80	5.19
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.436	1.926	3.002	2.474	2.867	5.357
	6.192	4.364	2.866	3.385	0.395	0.870
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.6545	0.4259	2.1411	0.6815	0.3048	0.0001
	0.0013	1.8489	1.5869	1.3420	0.6555	1.3924
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0018	0.0005	0.0023	0.0007	0.0003	0.0000
	0.0000	0.0020	0.0017	0.0014	0.0007	0.0015
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

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

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.17 (0.000)	171227.1	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	35.134 (0.0000)	127536.77	74.484
LATERAL DRAINAGE COLLECTED FROM LAYER 4	12.03496 (0.00000)	43686.902	25.51401
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.010	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.001 (0.000)		
CHANGE IN WATER STORAGE	0.001 (0.0000)	3.38	0.002

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	2.94	10672.200
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.30165	1094.97534
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00017
AVERAGE HEAD ON TOP OF LAYER 5	0.010	
MAXIMUM HEAD ON TOP OF LAYER 5	0.311	
SNOW WATER	1.65	5989.4712
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2708	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1232	

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

****

****

FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	3.7283	0.3107
2	6.9688	0.0726
3	15.5405	0.4317
4	0.0025	0.0100
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

****
****

INSERT SECOND HELP MODEL
STANDARD LINER SYSTEM (Alt. 1)
PHASE 3 OPEN 5 YEARS w/25 FT. OF SOLID WASTE

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\WAYNE1.D4
TEMPERATURE DATA FILE:       C:\HELP3\WAYNE1.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\WAYNE1.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\WAYNE1.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\WAYNE2.D10
OUTPUT DATA FILE:            C:\HELP3\Wayne2.OUT
```

TIME: 15:41 DATE: 10/01/2009

****

TITLE: Wayne Co. Phase 3 Open 5 Years w/25 ft. of Solid Waste (Alt. 1)

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


                                   LAYER  1
                                   --------

                      TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER  12
          THICKNESS                  =     12.00    INCHES
          POROSITY                   =      0.4710 VOL/VOL
          FIELD CAPACITY             =      0.3420 VOL/VOL
          WILTING POINT              =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.3109 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	300.00	INCHES
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0729	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00	INCHES
POROSITY	=	0.4790	VOL/VOL
FIELD CAPACITY	=	0.3710	VOL/VOL
WILTING POINT	=	0.2510	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4471	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES

```
POROSITY                      =       0.0000 VOL/VOL
FIELD CAPACITY                =       0.0000 VOL/VOL
WILTING POINT                 =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY           =       4.00    HOLES/ACRE
FML INSTALLATION DEFECTS      =       4.00    HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                         LAYER  6
                         --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  16
THICKNESS                     =      24.00    INCHES
POROSITY                      =       0.4270 VOL/VOL
FIELD CAPACITY                =       0.4180 VOL/VOL
WILTING POINT                 =       0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.100000001000E-06 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF  200. FEET.

SCS RUNOFF CURVE NUMBER            =      91.70
FRACTION OF AREA ALLOWING RUNOFF   =      50.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =       1.000   ACRES
EVAPORATIVE ZONE DEPTH             =      22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =       4.426   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =       7.332   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =       2.710   INCHES
INITIAL SNOW WATER                 =       0.000   INCHES
INITIAL WATER IN LAYER MATERIALS   =      51.947   INCHES
TOTAL INITIAL WATER                =      51.947   INCHES
TOTAL SUBSURFACE INFLOW            =       0.00    INCHES/YEAR


          EVAPOTRANSPIRATION AND WEATHER DATA
          -----------------------------------

NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         RALEIGH               NORTH CAROLINA
```

```
STATION LATITUDE                              =  35.87 DEGREES
MAXIMUM LEAF AREA INDEX                       =   3.00
START OF GROWING SEASON (JULIAN DATE)         =    86
END OF GROWING SEASON (JULIAN DATE)           =   310
EVAPORATIVE ZONE DEPTH                        =  22.0  INCHES
AVERAGE ANNUAL WIND SPEED                     =   7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY         =  66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY         =  70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY         =  78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY         =  72.00 %
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.07	3.73	4.15	3.40	4.01	4.34
6.40	5.77	4.77	2.84	3.25	3.46

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.50	43.50	51.50	61.50	69.30	75.90
79.70	78.80	73.20	61.80	52.40	43.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.35 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.17	171227.125	100.00
RUNOFF	2.922	10606.174	6.19
EVAPOTRANSPIRATION	34.737	126096.398	73.64
DRAINAGE COLLECTED FROM LAYER 4	9.5142	34536.723	20.17

PERC./LEAKAGE THROUGH LAYER 6	0.000002	0.009	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0009		
CHANGE IN WATER STORAGE	-0.003	-12.213	-0.01
SOIL WATER AT START OF YEAR	51.947	188568.828	
SOIL WATER AT END OF YEAR	51.944	188556.609	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.027	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	51.97	188651.125	100.00
RUNOFF	4.642	16851.811	8.93
EVAPOTRANSPIRATION	34.147	123952.344	65.70
DRAINAGE COLLECTED FROM LAYER 4	15.3364	55671.238	29.51
PERC./LEAKAGE THROUGH LAYER 6	0.000004	0.013	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0014		
CHANGE IN WATER STORAGE	-2.155	-7824.280	-4.15
SOIL WATER AT START OF YEAR	51.944	188556.609	
SOIL WATER AT END OF YEAR	49.789	180732.328	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.001	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	76.47	277586.125	100.00
RUNOFF	11.782	42767.832	15.41
EVAPOTRANSPIRATION	34.491	125200.812	45.10
DRAINAGE COLLECTED FROM LAYER 4	29.9091	108570.070	39.11
PERC./LEAKAGE THROUGH LAYER 6	0.000006	0.020	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0028		
CHANGE IN WATER STORAGE	0.289	1047.303	0.38
SOIL WATER AT START OF YEAR	49.789	180732.328	
SOIL WATER AT END OF YEAR	50.077	181779.641	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.094	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.20	171335.984	100.00
RUNOFF	3.196	11601.604	6.77
EVAPOTRANSPIRATION	34.319	124578.398	72.71
DRAINAGE COLLECTED FROM LAYER 4	7.5199	27297.225	15.93
PERC./LEAKAGE THROUGH LAYER 6	0.000002	0.009	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0007		
CHANGE IN WATER STORAGE	2.155	7823.477	4.57
SOIL WATER AT START OF YEAR	50.077	181779.641	

SOIL WATER AT END OF YEAR	52.232	189603.109	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0097	35.275	0.02

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.93	170355.922	100.00
RUNOFF	3.452	12530.854	7.36
EVAPOTRANSPIRATION	33.674	122237.586	71.75
DRAINAGE COLLECTED FROM LAYER 4	10.9622	39792.621	23.36
PERC./LEAKAGE THROUGH LAYER 6	0.000003	0.011	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0010		
CHANGE IN WATER STORAGE	-1.158	-4205.191	-2.47
SOIL WATER AT START OF YEAR	52.232	189603.109	
SOIL WATER AT END OF YEAR	51.074	185397.922	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

****

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

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

PRECIPITATION

TOTALS	3.76	3.07	4.93	3.07	3.87	6.42
	6.67	8.13	4.06	3.91	2.85	3.20
STD. DEVIATIONS	3.40	1.03	1.47	2.21	2.89	2.35
	3.34	7.69	2.46	2.80	1.88	1.41

RUNOFF

TOTALS	0.360	0.153	0.339	0.124	0.260	0.524
	0.713	1.280	0.619	0.339	0.201	0.287
STD. DEVIATIONS	0.546	0.105	0.233	0.200	0.529	0.341
	0.579	2.090	0.729	0.432	0.206	0.185

EVAPOTRANSPIRATION

TOTALS	1.479	1.914	2.910	3.429	3.687	4.325
	5.130	3.823	2.363	2.860	1.300	1.054
STD. DEVIATIONS	0.227	0.182	0.070	0.839	1.554	1.287
	1.672	1.212	0.827	0.393	0.540	0.190

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.8553	1.8908	1.3673	0.9030	0.6366	0.5916
	0.7168	1.6717	2.2856	0.9645	0.9333	0.8319
STD. DEVIATIONS	0.8598	2.3780	0.7316	0.3213	0.4831	0.9817
	0.8468	2.4984	3.4998	0.2481	0.6791	0.4312

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0020	0.0022	0.0015	0.0010	0.0007	0.0006
	0.0008	0.0018	0.0025	0.0010	0.0010	0.0009
STD. DEVIATIONS	0.0009	0.0028	0.0008	0.0004	0.0005	0.0011
	0.0009	0.0027	0.0039	0.0003	0.0007	0.0005

****

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

	INCHES		CU. FEET	PERCENT
PRECIPITATION	53.95	(12.766)	195831.3	100.00
RUNOFF	5.199	(3.7381)	18871.65	9.637
EVAPOTRANSPIRATION	34.274	(0.3993)	124413.12	63.531
LATERAL DRAINAGE COLLECTED FROM LAYER 4	14.64837	(9.00175)	53173.570	27.15275
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000	(0.00000)	0.012	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.001	(0.001)		
CHANGE IN WATER STORAGE	-0.175	(1.6251)	-634.18	-0.324

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.78	24611.400
RUNOFF	2.592	9409.1426
DRAINAGE COLLECTED FROM LAYER 4	0.64909	2356.20142
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00033
AVERAGE HEAD ON TOP OF LAYER 5	0.022	
MAXIMUM HEAD ON TOP OF LAYER 5	0.456	
SNOW WATER	1.65	5989.4712

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2728

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1232

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

****

FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	3.8180	0.3182
2	22.8162	0.0761
3	14.1874	0.3941
4	0.0043	0.0172
5	0.0000	0.0000
6	10.2480	0.4270
SNOW WATER	0.000	

INSERT FINAL HELP MODEL
STANDARD LINER SYSTEM (Alt. 1)
PHASE 3 CLOSED

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\WAYNE1.D4
TEMPERATURE DATA FILE:        C:\HELP3\WAYNE1.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\WAYNE1.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\WAYNE1.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\WAYNEC.D10
OUTPUT DATA FILE:             C:\HELP3\WayneC.OUT
```

TIME: 15:43 DATE: 10/01/2009

****

TITLE: Wayne Co. Phase 3 Closed (Alt. 1)

****

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


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER  12
          THICKNESS                  =    24.00    INCHES
          POROSITY                   =     0.4710 VOL/VOL
          FIELD CAPACITY             =     0.3420 VOL/VOL
          WILTING POINT              =     0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.3501 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0281	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	5.00	PERCENT
DRAINAGE LENGTH	=	300.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	4.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	4.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 23

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4610	VOL/VOL
FIELD CAPACITY	=	0.3600	VOL/VOL
WILTING POINT	=	0.2030	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4610	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.900000032000E-05	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12

```
THICKNESS                   =       12.00    INCHES
POROSITY                    =       0.4710 VOL/VOL
FIELD CAPACITY              =       0.3420 VOL/VOL
WILTING POINT               =       0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   0.419999997000E-04 CM/SEC
```

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

```
THICKNESS                   =      360.00    INCHES
POROSITY                    =       0.1680 VOL/VOL
FIELD CAPACITY              =       0.0730 VOL/VOL
WILTING POINT               =       0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   0.100000005000E-02 CM/SEC
```

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

```
THICKNESS                   =       36.00    INCHES
POROSITY                    =       0.4790 VOL/VOL
FIELD CAPACITY              =       0.3710 VOL/VOL
WILTING POINT               =       0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.3710 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =   0.249999994000E-04 CM/SEC
```

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

```
THICKNESS                   =        0.25    INCHES
POROSITY                    =       0.8500 VOL/VOL
FIELD CAPACITY              =       0.0100 VOL/VOL
WILTING POINT               =       0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =       0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.   =    33.0000000000       CM/SEC
SLOPE                       =        2.00    PERCENT
DRAINAGE LENGTH             =      100.0     FEET
```

```
                     LAYER  9
                     --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06    INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      4.00    HOLES/ACRE
FML INSTALLATION DEFECTS     =      4.00    HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                     LAYER 10
                     --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  16
THICKNESS                    =     24.00    INCHES
POROSITY                     =      0.4270 VOL/VOL
FIELD CAPACITY               =      0.4180 VOL/VOL
WILTING POINT                =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000001000E-06 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF  200. FEET.

SCS RUNOFF CURVE NUMBER            =     91.70
FRACTION OF AREA ALLOWING RUNOFF   =    100.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =      1.000   ACRES
EVAPORATIVE ZONE DEPTH             =     22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =      7.638   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =     10.362   INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE =      4.620   INCHES
INITIAL SNOW WATER                 =      0.000   INCHES
INITIAL WATER IN LAYER MATERIALS   =     70.697   INCHES
TOTAL INITIAL WATER                =     70.697   INCHES
TOTAL SUBSURFACE INFLOW            =      0.00    INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.00
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.07	3.73	4.15	3.40	4.01	4.34
6.40	5.77	4.77	2.84	3.25	3.46

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.50	43.50	51.50	61.50	69.30	75.90
79.70	78.80	73.20	61.80	52.40	43.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.35 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT

	--------	----------	-------
PRECIPITATION	47.17	171227.125	100.00
RUNOFF	6.125	22234.236	12.99
EVAPOTRANSPIRATION	36.551	132681.469	77.49
DRAINAGE COLLECTED FROM LAYER 2	4.4931	16310.127	9.53
PERC./LEAKAGE THROUGH LAYER 4	0.000080	0.290	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0013		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.290	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.000	0.969	0.00
SOIL WATER AT START OF YEAR	70.697	256629.609	
SOIL WATER AT END OF YEAR	70.697	256630.578	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.030	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
	--------	----------	-------
PRECIPITATION	51.97	188651.125	100.00
RUNOFF	9.594	34826.180	18.46
EVAPOTRANSPIRATION	36.439	132272.812	70.12
DRAINAGE COLLECTED FROM LAYER 2	6.4017	23238.273	12.32
PERC./LEAKAGE THROUGH LAYER 4	0.000118	0.427	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.427	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00

AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.465	-1686.524	-0.89
SOIL WATER AT START OF YEAR	70.697	256630.578	
SOIL WATER AT END OF YEAR	70.233	254944.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.027	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	76.47	277586.125	100.00
RUNOFF	24.813	90072.242	32.45
EVAPOTRANSPIRATION	34.733	126080.547	45.42
DRAINAGE COLLECTED FROM LAYER 2	16.9111	61387.254	22.11
PERC./LEAKAGE THROUGH LAYER 4	0.000281	1.019	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0049		
DRAINAGE COLLECTED FROM LAYER 8	0.0003	1.018	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.001	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.012	45.115	0.02
SOIL WATER AT START OF YEAR	70.233	254944.047	
SOIL WATER AT END OF YEAR	70.245	254989.172	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.043	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.20	171335.984	100.00
RUNOFF	6.647	24127.512	14.08
EVAPOTRANSPIRATION	35.544	129022.984	75.30
DRAINAGE COLLECTED FROM LAYER 2	4.6390	16839.553	9.83
PERC./LEAKAGE THROUGH LAYER 4	0.000082	0.299	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.298	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.361	1310.486	0.76
SOIL WATER AT START OF YEAR	70.245	254989.172	
SOIL WATER AT END OF YEAR	70.606	256299.656	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0097	35.156	0.02

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.93	170355.922	100.00
RUNOFF	7.110	25810.369	15.15
EVAPOTRANSPIRATION	35.046	127218.562	74.68

DRAINAGE COLLECTED FROM LAYER 2	4.1297	14990.926	8.80
PERC./LEAKAGE THROUGH LAYER 4	0.000078	0.285	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0012		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.285	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.643	2335.716	1.37
SOIL WATER AT START OF YEAR	70.606	256299.656	
SOIL WATER AT END OF YEAR	71.249	258635.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.056	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.76	3.07	4.93	3.07	3.87	6.42
	6.67	8.13	4.06	3.91	2.85	3.20
STD. DEVIATIONS	3.40	1.03	1.47	2.21	2.89	2.35
	3.34	7.69	2.46	2.80	1.88	1.41
RUNOFF						
TOTALS	0.814	0.356	0.742	0.279	0.534	1.018
	1.400	2.649	1.302	0.706	0.423	0.635
STD. DEVIATIONS	1.230	0.243	0.501	0.453	1.078	0.644
	1.129	4.383	1.531	0.860	0.421	0.396
EVAPOTRANSPIRATION						
TOTALS	1.466	1.903	2.909	3.495	4.562	4.291

	5.374	3.752	2.260	3.116	1.511	1.025
STD. DEVIATIONS	0.213	0.183	0.079	0.773	1.132	1.381
	1.286	1.192	0.758	0.225	0.124	0.176

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	1.2263	0.9087	1.0667	0.5196	0.3049	0.0239
	0.0877	0.7803	0.6148	0.4160	0.4762	0.8897
STD. DEVIATIONS	1.3626	0.9416	0.5818	0.6168	0.4691	0.0518
	0.1635	1.7413	1.1397	0.4136	0.5671	0.4968

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 8

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0042	0.0034	0.0037	0.0018	0.0010	0.0001
	0.0003	0.0027	0.0022	0.0014	0.0017	0.0030
STD. DEVIATIONS	0.0047	0.0036	0.0020	0.0022	0.0016	0.0002
	0.0006	0.0060	0.0040	0.0014	0.0020	0.0017

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

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

	INCHES		CU. FEET	PERCENT
PRECIPITATION	53.95	(12.766)	195831.3	100.00
RUNOFF	10.858	(7.9140)	39414.11	20.127
EVAPOTRANSPIRATION	35.663	(0.8140)	129455.27	66.106
LATERAL DRAINAGE COLLECTED FROM LAYER 2	7.31494	(5.43573)	26553.227	13.55924
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00013	(0.00009)	0.464	0.00024
AVERAGE HEAD ON TOP OF LAYER 3	0.002	(0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00013	(0.00009)	0.464	0.00024
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.111	(0.4181)	401.15	0.205

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.78	24611.400
RUNOFF	5.257	19083.2070
DRAINAGE COLLECTED FROM LAYER 2	0.63696	2312.15381
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000009	0.03203
AVERAGE HEAD ON TOP OF LAYER 3	0.068	
MAXIMUM HEAD ON TOP OF LAYER 3	2.464	
DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03202
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	-0.003	
SNOW WATER	1.65	5989.4712

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4265
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	8.9439	0.3727
2	0.0170	0.0849
3	0.0000	0.0000
4	8.2980	0.4610
5	4.1040	0.3420
6	26.2800	0.0730
7	13.3560	0.3710
8	0.0025	0.0100
9	0.0000	0.0000
10	10.2480	0.4270
SNOW WATER	0.000	

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INSERT FIRST HELP MODEL
ALTERNATE LINER SYSTEM (Alt. 2)
PHASE 3 OPEN 1^{st} YEAR

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**                                                                        **
**                                                                        **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE             **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                 **
**                    USAE WATERWAYS EXPERIMENT STATION                   **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY           **
**                                                                        **
**                                                                        **
****************************************************************************
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PRECIPITATION DATA FILE:     C:\HELP3\WAYNE1.D4
TEMPERATURE DATA FILE:       C:\HELP3\WAYNE1.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\WAYNE1.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\WAYNE1.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\WAYNEA.D10
OUTPUT DATA FILE:            C:\HELP3\WayneA.OUT
```

TIME: 15:47 DATE: 10/01/2009

****

TITLE: Wayne Co. Phase 3 Open 1st Year (Alt. 2)

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


                                LAYER  1
                                --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER  12
           THICKNESS                 =     12.00    INCHES
           POROSITY                  =      0.4710 VOL/VOL
           FIELD CAPACITY            =      0.3420 VOL/VOL
           WILTING POINT             =      0.2100 VOL/VOL
           INITIAL SOIL WATER CONTENT =     0.3113 VOL/VOL
           EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
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                    LAYER  2
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          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  19
THICKNESS                    =     96.00    INCHES
POROSITY                     =      0.1680 VOL/VOL
FIELD CAPACITY               =      0.0730 VOL/VOL
WILTING POINT                =      0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0726 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                    LAYER  3
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  14
THICKNESS                    =     36.00    INCHES
POROSITY                     =      0.4790 VOL/VOL
FIELD CAPACITY               =      0.3710 VOL/VOL
WILTING POINT                =      0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.4314 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.249999994000E-04 CM/SEC


                    LAYER  4
                    --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  34
THICKNESS                    =      0.25    INCHES
POROSITY                     =      0.8500 VOL/VOL
FIELD CAPACITY               =      0.0100 VOL/VOL
WILTING POINT                =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =   33.0000000000     CM/SEC
SLOPE                        =      2.00    PERCENT
DRAINAGE LENGTH              =    100.0     FEET


                    LAYER  5
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            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06    INCHES
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POROSITY                      =       0.0000 VOL/VOL
FIELD CAPACITY                =       0.0000 VOL/VOL
WILTING POINT                 =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY           =       4.00    HOLES/ACRE
FML INSTALLATION DEFECTS      =       4.00    HOLES/ACRE
FML PLACEMENT QUALITY         =   3 - GOOD


                        LAYER  6
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                     =       0.24    INCHES
POROSITY                      =       0.7500 VOL/VOL
FIELD CAPACITY                =       0.7470 VOL/VOL
WILTING POINT                 =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.7470 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   0.300000003000E-08 CM/SEC


                        LAYER  7
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  23
THICKNESS                     =      18.00    INCHES
POROSITY                      =       0.4610 VOL/VOL
FIELD CAPACITY                =       0.3600 VOL/VOL
WILTING POINT                 =       0.2030 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.4610 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   0.900000032000E-05 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF  200. FEET.

SCS RUNOFF CURVE NUMBER            =      91.70
FRACTION OF AREA ALLOWING RUNOFF   =       0.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =       1.000   ACRES
EVAPORATIVE ZONE DEPTH             =      22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =       4.430   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =       7.332   INCHES
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LOWER LIMIT OF EVAPORATIVE STORAGE   =      2.710  INCHES
INITIAL SNOW WATER                   =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS     =     34.716  INCHES
TOTAL INITIAL WATER                  =     34.716  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

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NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         RALEIGH              NORTH CAROLINA

     STATION LATITUDE                          = 35.87 DEGREES
     MAXIMUM LEAF AREA INDEX                   =  3.00
     START OF GROWING SEASON (JULIAN DATE)     =    86
     END OF GROWING SEASON (JULIAN DATE)       =   310
     EVAPORATIVE ZONE DEPTH                    = 22.0  INCHES
     AVERAGE ANNUAL WIND SPEED                 =  7.70 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY     = 66.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY     = 70.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY     = 78.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY     = 72.00 %
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NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR     RALEIGH              NORTH CAROLINA
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NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.07	3.73	4.15	3.40	4.01	4.34
6.40	5.77	4.77	2.84	3.25	3.46

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NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR     RALEIGH              NORTH CAROLINA
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.50	43.50	51.50	61.50	69.30	75.90
79.70	78.80	73.20	61.80	52.40	43.80

```
NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
         COEFFICIENTS FOR     RALEIGH              NORTH CAROLINA
           AND STATION LATITUDE  =  35.35 DEGREES
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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.17	171227.125	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	35.134	127536.766	74.48
DRAINAGE COLLECTED FROM LAYER 4	12.0350	43686.902	25.51
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0011		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	0.001	3.365	0.00
SOIL WATER AT START OF YEAR	34.896	126671.383	
SOIL WATER AT END OF YEAR	34.897	126674.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.090	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.69	4.49	3.27	1.63	1.94	6.85
	7.43	7.75	2.56	3.57	0.80	5.19
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00

RUNOFF

TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	1.436	1.926	3.002	2.474	2.867	5.357
	6.192	4.364	2.866	3.385	0.395	0.870
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.6545	0.4259	2.1411	0.6815	0.3048	0.0001
	0.0013	1.8489	1.5869	1.3420	0.6555	1.3924
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0018	0.0005	0.0023	0.0007	0.0003	0.0000
	0.0000	0.0020	0.0017	0.0014	0.0007	0.0015
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.17 (0.000)	171227.1	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	35.134 (0.0000)	127536.77	74.484
LATERAL DRAINAGE COLLECTED FROM LAYER 4	12.03496 (0.00000)	43686.902	25.51401
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.001 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000 (0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.001 (0.0000)	3.36	0.002

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	2.94	10672.200
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 4	0.30165	1094.97546
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 5	0.010	
MAXIMUM HEAD ON TOP OF LAYER 5	0.311	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
SNOW WATER	1.65	5989.4712

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.2708

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1232

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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****

FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	3.7283	0.3107
2	6.9688	0.0726
3	15.5405	0.4317
4	0.0025	0.0100
5	0.0000	0.0000
6	0.1793	0.7470
7	8.2980	0.4610
SNOW WATER	0.000	

****
****

INSERT SECOND HELP MODEL
ALTERNATE LINER SYSTEM (Alt. 2)
PHASE 3 OPEN 5 YEARS w/25 FT. OF SOLID WASTE

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04    (13 MARCH 1995)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\WAYNE1.D4
TEMPERATURE DATA FILE:        C:\HELP3\WAYNE1.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\WAYNE1.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\WAYNE1.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\WAYNE2A.D10
OUTPUT DATA FILE:             C:\HELP3\Wayne2A.OUT
```

TIME: 15:48 DATE: 10/01/2009

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TITLE: Wayne Co. Phase 3 Open 5 Years w/25 ft. of Solid Waste (Alt. 2)

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


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER  12
          THICKNESS                  =    12.00    INCHES
          POROSITY                   =     0.4710 VOL/VOL
          FIELD CAPACITY             =     0.3420 VOL/VOL
          WILTING POINT              =     0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.3109 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  = 0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.20
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	300.00	INCHES
POROSITY	=	0.1680	VOL/VOL
FIELD CAPACITY	=	0.0730	VOL/VOL
WILTING POINT	=	0.0190	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0729	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00	INCHES
POROSITY	=	0.4790	VOL/VOL
FIELD CAPACITY	=	0.3710	VOL/VOL
WILTING POINT	=	0.2510	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4471	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04	CM/SEC

LAYER 4

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	100.0	FEET

LAYER 5

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES

```
POROSITY                      =      0.0000 VOL/VOL
FIELD CAPACITY                =      0.0000 VOL/VOL
WILTING POINT                 =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY           =      4.00   HOLES/ACRE
FML INSTALLATION DEFECTS      =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY         =  3 - GOOD


                        LAYER  6
                        --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER  17
THICKNESS                     =      0.24    INCHES
POROSITY                      =      0.7500 VOL/VOL
FIELD CAPACITY                =      0.7470 VOL/VOL
WILTING POINT                 =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.7470 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.300000003000E-08 CM/SEC


                        LAYER  7
                        --------

                  TYPE 3 - BARRIER SOIL LINER
                  MATERIAL TEXTURE NUMBER  23
THICKNESS                     =     18.00    INCHES
POROSITY                      =      0.4610 VOL/VOL
FIELD CAPACITY                =      0.3600 VOL/VOL
WILTING POINT                 =      0.2030 VOL/VOL
INITIAL SOIL WATER CONTENT    =      0.4610 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =  0.900000032000E-05 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
         AND A SLOPE LENGTH OF  200. FEET.

SCS RUNOFF CURVE NUMBER            =      91.70
FRACTION OF AREA ALLOWING RUNOFF   =      50.0     PERCENT
AREA PROJECTED ON HORIZONTAL PLANE =       1.000   ACRES
EVAPORATIVE ZONE DEPTH             =      22.0     INCHES
INITIAL WATER IN EVAPORATIVE ZONE  =       4.426   INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE =       7.332   INCHES
```

LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.710	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	50.177	INCHES
TOTAL INITIAL WATER	=	50.177	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.00
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.07	3.73	4.15	3.40	4.01	4.34
6.40	5.77	4.77	2.84	3.25	3.46

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.50	43.50	51.50	61.50	69.30	75.90
79.70	78.80	73.20	61.80	52.40	43.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.35 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.17	171227.125	100.00
RUNOFF	2.922	10606.174	6.19
EVAPOTRANSPIRATION	34.737	126096.398	73.64
DRAINAGE COLLECTED FROM LAYER 4	9.5142	34536.723	20.17
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0009		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-0.003	-12.213	-0.01
SOIL WATER AT START OF YEAR	50.356	182791.906	
SOIL WATER AT END OF YEAR	50.353	182779.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.032	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	51.97	188651.125	100.00
RUNOFF	4.642	16851.811	8.93
EVAPOTRANSPIRATION	34.147	123952.344	65.70
DRAINAGE COLLECTED FROM LAYER 4	15.3364	55671.250	29.51
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00

AVG. HEAD ON TOP OF LAYER 5	0.0014		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-2.155	-7824.280	-4.15
SOIL WATER AT START OF YEAR	50.353	182779.687	
SOIL WATER AT END OF YEAR	48.197	174955.406	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	76.47	277586.125	100.00
RUNOFF	11.782	42767.832	15.41
EVAPOTRANSPIRATION	34.491	125200.812	45.10
DRAINAGE COLLECTED FROM LAYER 4	29.9091	108570.094	39.11
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0028		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	0.289	1047.289	0.38
SOIL WATER AT START OF YEAR	48.197	174955.406	
SOIL WATER AT END OF YEAR	48.486	176002.703	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.103	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.20	171335.984	100.00
RUNOFF	3.196	11601.604	6.77
EVAPOTRANSPIRATION	34.319	124578.398	72.71
DRAINAGE COLLECTED FROM LAYER 4	7.5199	27297.229	15.93
PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.003	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0007		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.003	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	2.155	7823.477	4.57
SOIL WATER AT START OF YEAR	48.486	176002.703	
SOIL WATER AT END OF YEAR	50.641	183826.172	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0097	35.277	0.02

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.93	170355.922	100.00
RUNOFF	3.452	12530.854	7.36
EVAPOTRANSPIRATION	33.674	122237.586	71.75
DRAINAGE COLLECTED FROM LAYER 4	10.9622	39792.625	23.36

PERC./LEAKAGE THROUGH LAYER 5	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0010		
PERC./LEAKAGE THROUGH LAYER 7	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
CHANGE IN WATER STORAGE	-1.158	-4205.177	-2.47
SOIL WATER AT START OF YEAR	50.641	183826.172	
SOIL WATER AT END OF YEAR	49.482	179621.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.76	3.07	4.93	3.07	3.87	6.42
	6.67	8.13	4.06	3.91	2.85	3.20
STD. DEVIATIONS	3.40	1.03	1.47	2.21	2.89	2.35
	3.34	7.69	2.46	2.80	1.88	1.41
RUNOFF						
TOTALS	0.360	0.153	0.339	0.124	0.260	0.524
	0.713	1.280	0.619	0.339	0.201	0.287
STD. DEVIATIONS	0.546	0.105	0.233	0.200	0.529	0.341
	0.579	2.090	0.729	0.432	0.206	0.185
EVAPOTRANSPIRATION						
TOTALS	1.479	1.914	2.910	3.429	3.687	4.325
	5.130	3.823	2.363	2.860	1.300	1.054
STD. DEVIATIONS	0.227	0.182	0.070	0.839	1.554	1.287

	1.672	1.212	0.827	0.393	0.540	0.190

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	1.8553	1.8908	1.3673	0.9030	0.6366	0.5916
	0.7168	1.6717	2.2856	0.9645	0.9333	0.8319
STD. DEVIATIONS	0.8598	2.3780	0.7316	0.3213	0.4831	0.9817
	0.8468	2.4984	3.4998	0.2481	0.6791	0.4312

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0020	0.0022	0.0015	0.0010	0.0007	0.0006
	0.0008	0.0018	0.0025	0.0010	0.0010	0.0009
STD. DEVIATIONS	0.0009	0.0028	0.0008	0.0004	0.0005	0.0011
	0.0009	0.0027	0.0039	0.0003	0.0007	0.0005

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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

	INCHES	CU. FEET	PERCENT

PRECIPITATION	53.95	(12.766)	195831.3	100.00
RUNOFF	5.199	(3.7381)	18871.65	9.637
EVAPOTRANSPIRATION	34.274	(0.3993)	124413.12	63.531
LATERAL DRAINAGE COLLECTED FROM LAYER 4	14.64837	(9.00175)	53173.586	27.15276
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 5	0.001	(0.001)		
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000	(0.00000)	0.004	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000	(0.000)		
CHANGE IN WATER STORAGE	-0.175	(1.6251)	-634.18	-0.324

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.78	24611.400
RUNOFF	2.592	9409.1426
DRAINAGE COLLECTED FROM LAYER 4	0.64909	2356.20166
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00004
AVERAGE HEAD ON TOP OF LAYER 5	0.022	
MAXIMUM HEAD ON TOP OF LAYER 5	0.456	
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00004
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
SNOW WATER	1.65	5989.4712

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2728
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1232

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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              FINAL WATER STORAGE AT END OF YEAR     5
      ----------------------------------------------------------------------
                LAYER          (INCHES)          (VOL/VOL)
                -----          --------          ---------
                  1             3.8180            0.3182

                  2            22.8162            0.0761

                  3            14.1874            0.3941

                  4             0.0043            0.0172

                  5             0.0000            0.0000

                  6             0.1793            0.7470

                  7             8.2980            0.4610

              SNOW WATER        0.000

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INSERT FINAL HELP MODEL
ALTERNATE LINER SYSTEM (Alt. 2)
PHASE 3 CLOSED

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\WAYNE1.D4
TEMPERATURE DATA FILE:        C:\HELP3\WAYNE1.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\WAYNE1.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\WAYNE1.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\WAYNECA.D10
OUTPUT DATA FILE:             C:\HELP3\WayneCA.OUT
```

TIME: 15:50 DATE: 10/01/2009

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

   TITLE:  Wayne Co. Phase 3  Closed  (Alt. 2)

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


                                       LAYER  1
                                       --------

                         TYPE 1 - VERTICAL PERCOLATION LAYER
                             MATERIAL TEXTURE NUMBER  12
           THICKNESS                     =     24.00    INCHES
           POROSITY                      =      0.4710 VOL/VOL
           FIELD CAPACITY                =      0.3420 VOL/VOL
           WILTING POINT                 =      0.2100 VOL/VOL
           INITIAL SOIL WATER CONTENT    =      0.3501 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.419999997000E-04 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   4.20
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

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

          TYPE 2 - LATERAL DRAINAGE LAYER
           MATERIAL TEXTURE NUMBER  20
THICKNESS                  =      0.20    INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0281 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =   10.0000000000       CM/SEC
SLOPE                      =      5.00    PERCENT
DRAINAGE LENGTH            =    300.0     FEET


                    LAYER  3
                    --------

          TYPE 4 - FLEXIBLE MEMBRANE LINER
           MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.04    INCHES
POROSITY                   =      0.0000 VOL/VOL
FIELD CAPACITY             =      0.0000 VOL/VOL
WILTING POINT              =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY        =       4.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =       4.00   HOLES/ACRE
FML PLACEMENT QUALITY      =  3 - GOOD


                    LAYER  4
                    --------

          TYPE 3 - BARRIER SOIL LINER
           MATERIAL TEXTURE NUMBER  23
THICKNESS                  =     18.00    INCHES
POROSITY                   =      0.4610 VOL/VOL
FIELD CAPACITY             =      0.3600 VOL/VOL
WILTING POINT              =      0.2030 VOL/VOL
INITIAL SOIL WATER CONTENT =      0.4610 VOL/VOL
EFFECTIVE SAT. HYD. COND.  =  0.900000032000E-05 CM/SEC


                    LAYER  5
                    --------
```

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 12

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4710 VOL/VOL
FIELD CAPACITY	=	0.3420 VOL/VOL
WILTING POINT	=	0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3420 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.419999997000E-04 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	360.00 INCHES
POROSITY	=	0.1680 VOL/VOL
FIELD CAPACITY	=	0.0730 VOL/VOL
WILTING POINT	=	0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0730 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 14

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4790 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3710 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.249999994000E-04 CM/SEC

LAYER 8

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

THICKNESS	=	0.25 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	33.0000000000 CM/SEC
SLOPE	=	2.00 PERCENT
DRAINAGE LENGTH	=	100.0 FEET

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                          LAYER  9
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                     =       0.06    INCHES
POROSITY                      =       0.0000 VOL/VOL
FIELD CAPACITY                =       0.0000 VOL/VOL
WILTING POINT                 =       0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY           =       4.00    HOLES/ACRE
FML INSTALLATION DEFECTS      =       4.00    HOLES/ACRE
FML PLACEMENT QUALITY         =   3 - GOOD


                          LAYER 10
                          --------

              TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER  17
THICKNESS                     =       0.24    INCHES
POROSITY                      =       0.7500 VOL/VOL
FIELD CAPACITY                =       0.7470 VOL/VOL
WILTING POINT                 =       0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.7470 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   0.300000003000E-08 CM/SEC


                          LAYER 11
                          --------

                 TYPE 3 - BARRIER SOIL LINER
                 MATERIAL TEXTURE NUMBER  23
THICKNESS                     =      18.00    INCHES
POROSITY                      =       0.4610 VOL/VOL
FIELD CAPACITY                =       0.3600 VOL/VOL
WILTING POINT                 =       0.2030 VOL/VOL
INITIAL SOIL WATER CONTENT    =       0.4610 VOL/VOL
EFFECTIVE SAT. HYD. COND.     =   0.900000032000E-05 CM/SEC


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

NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
         SOIL DATA BASE USING SOIL TEXTURE #12 WITH A
         POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
```

AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	91.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.638	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.362	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	4.620	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	68.926	INCHES
TOTAL INITIAL WATER	=	68.926	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.00	
START OF GROWING SEASON (JULIAN DATE)	=	86	
END OF GROWING SEASON (JULIAN DATE)	=	310	
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.07	3.73	4.15	3.40	4.01	4.34
6.40	5.77	4.77	2.84	3.25	3.46

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.50	43.50	51.50	61.50	69.30	75.90
79.70	78.80	73.20	61.80	52.40	43.80

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.35 DEGREES

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.17	171227.125	100.00
RUNOFF	6.125	22234.236	12.99
EVAPOTRANSPIRATION	36.551	132681.469	77.49
DRAINAGE COLLECTED FROM LAYER 2	4.4931	16310.127	9.53
PERC./LEAKAGE THROUGH LAYER 4	0.000080	0.290	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0013		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.290	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	0.000	0.942	0.00
SOIL WATER AT START OF YEAR	69.105	250852.687	
SOIL WATER AT END OF YEAR	69.106	250853.625	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.058	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	51.97	188651.125	100.00
RUNOFF	9.594	34826.180	18.46
EVAPOTRANSPIRATION	36.439	132272.812	70.12
DRAINAGE COLLECTED FROM LAYER 2	6.4017	23238.273	12.32
PERC./LEAKAGE THROUGH LAYER 4	0.000118	0.427	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.427	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	-0.465	-1686.497	-0.89
SOIL WATER AT START OF YEAR	69.106	250853.625	
SOIL WATER AT END OF YEAR	68.641	249167.125	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.055	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	76.47	277586.125	100.00
RUNOFF	24.813	90072.242	32.45
EVAPOTRANSPIRATION	34.733	126080.547	45.42
DRAINAGE COLLECTED FROM LAYER 2	16.9111	61387.254	22.11

PERC./LEAKAGE THROUGH LAYER 4	0.000281	1.019	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0049		
DRAINAGE COLLECTED FROM LAYER 8	0.0003	1.018	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.001	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.001	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	0.012	45.087	0.02
SOIL WATER AT START OF YEAR	68.641	249167.125	
SOIL WATER AT END OF YEAR	68.654	249212.219	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.015	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	47.20	171335.984	100.00
RUNOFF	6.647	24127.512	14.08
EVAPOTRANSPIRATION	35.544	129022.984	75.30
DRAINAGE COLLECTED FROM LAYER 2	4.6390	16839.553	9.83
PERC./LEAKAGE THROUGH LAYER 4	0.000082	0.299	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.298	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.000	0.00

AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	0.361	1310.513	0.76
SOIL WATER AT START OF YEAR	68.654	249212.219	
SOIL WATER AT END OF YEAR	69.015	250522.734	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0097	35.128	0.02

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.93	170355.922	100.00
RUNOFF	7.110	25810.369	15.15
EVAPOTRANSPIRATION	35.046	127218.562	74.68
DRAINAGE COLLECTED FROM LAYER 2	4.1297	14990.926	8.80
PERC./LEAKAGE THROUGH LAYER 4	0.000078	0.285	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0012		
DRAINAGE COLLECTED FROM LAYER 8	0.0001	0.285	0.00
PERC./LEAKAGE THROUGH LAYER 9	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
PERC./LEAKAGE THROUGH LAYER 11	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
CHANGE IN WATER STORAGE	0.643	2335.716	1.37
SOIL WATER AT START OF YEAR	69.015	250522.734	
SOIL WATER AT END OF YEAR	69.658	252858.453	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0000	0.056	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.76	3.07	4.93	3.07	3.87	6.42
	6.67	8.13	4.06	3.91	2.85	3.20
STD. DEVIATIONS	3.40	1.03	1.47	2.21	2.89	2.35
	3.34	7.69	2.46	2.80	1.88	1.41
RUNOFF						
TOTALS	0.814	0.356	0.742	0.279	0.534	1.018
	1.400	2.649	1.302	0.706	0.423	0.635
STD. DEVIATIONS	1.230	0.243	0.501	0.453	1.078	0.644
	1.129	4.383	1.531	0.860	0.421	0.396
EVAPOTRANSPIRATION						
TOTALS	1.466	1.903	2.909	3.495	4.562	4.291
	5.374	3.752	2.260	3.116	1.511	1.025
STD. DEVIATIONS	0.213	0.183	0.079	0.773	1.132	1.381
	1.286	1.192	0.758	0.225	0.124	0.176
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	1.2263	0.9087	1.0667	0.5196	0.3049	0.0239
	0.0877	0.7803	0.6148	0.4160	0.4762	0.8897
STD. DEVIATIONS	1.3626	0.9416	0.5818	0.6168	0.4691	0.0518
	0.1635	1.7413	1.1397	0.4136	0.5671	0.4968
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 8

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 11

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0042	0.0034	0.0037	0.0018	0.0010	0.0001
	0.0003	0.0027	0.0022	0.0014	0.0017	0.0030
STD. DEVIATIONS	0.0047	0.0036	0.0020	0.0022	0.0016	0.0002
	0.0006	0.0060	0.0040	0.0014	0.0020	0.0017

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 11

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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

	INCHES	CU. FEET	PERCENT
PRECIPITATION	53.95 (12.766)	195831.3	100.00
RUNOFF	10.858 (7.9140)	39414.11	20.127
EVAPOTRANSPIRATION	35.663 (0.8140)	129455.27	66.106
LATERAL DRAINAGE COLLECTED FROM LAYER 2	7.31494 (5.43573)	26553.227	13.55924
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00013 (0.00009)	0.464	0.00024
AVERAGE HEAD ON TOP OF LAYER 3	0.002 (0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00013 (0.00009)	0.464	0.00024
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000 (0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.00000 (0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 11	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.111 (0.4181)	401.15	0.205

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	6.78	24611.400
RUNOFF	5.257	19083.2070
DRAINAGE COLLECTED FROM LAYER 2	0.63696	2312.15381
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000009	0.03203
AVERAGE HEAD ON TOP OF LAYER 3	0.068	
MAXIMUM HEAD ON TOP OF LAYER 3	2.464	
DRAINAGE COLLECTED FROM LAYER 8	0.00001	0.03202
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.009	
PERCOLATION/LEAKAGE THROUGH LAYER 11	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 11	0.000	
SNOW WATER	1.65	5989.4712
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4265	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100	

*** MAXIMUM HEADS ARE COMPUTED USING THE MOUND EQUATION. ***

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	8.9439	0.3727
2	0.0170	0.0849
3	0.0000	0.0000
4	8.2980	0.4610
5	4.1040	0.3420
6	26.2800	0.0730
7	13.3560	0.3710
8	0.0025	0.0100
9	0.0000	0.0000
10	0.1793	0.7470
11	8.2980	0.4610
SNOW WATER	0.000	

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2.2.4 Leachate Collection System Design Calculations

Initial Calculations

25 yr. 24 hr. Storm = 7.24" (NOAA Website)

Lagoon storage capacity = 1,012,029 gallons

Based on the HELP Model with the conservative waste characteristics (Texture No. 19), the average monthly flows collected from layer 4 for a 5 year period on a per acre basis are as follows:

Sample Calculation = in. from layer 4/12 in./ft. x 43,560 ft.^{2}/acre x 7.48 gals/ft.^{3} = gals./acre

1.	January	=	50,375 gallons/acre
2.	February	=	51,342 gallons/acre
3.	March	=	37,125 gallons/acre
4.	April	=	24,519 gallons/acre
5.	May	=	17,285 gallons/acre
6.	June	=	16,063 gallons/acre
7.	July	=	19,463 gallons/acre
8.	August	=	45,391 gallons/acre
9.	September	=	62,060 gallons/acre
10.	October	=	26,189 gallons/acre
11.	November	=	25,341 gallons/acre
12.	December	=	22,588 gallons/acre
	Total	=	397,741 gallons/acre

Annual Flow based on 20 acres = 7,954,820 gallons

The lagoon holds 1,012,029 gallons of leachate. The HELP Model predicts 7,954,820 gallons of leachate per year for Phase 3 only. Wayne Co. reports that they have pumped 2,985,257 gallons between January 1, 2010 and October 31, 2010 from Phase 1 and 2 which are as large as Phase 3. The annual total would be 3,582,308. The pump station can pump at a minimum 288,000 gallons per day; consequently, the lagoon can be emptied in approximately 3.5 days. The annual total from Phases 1, 2, and 3, including the flow anticipated by the HELP Model, is 11,537,128 gallons or approximately 11.4 lagoons full of leachate. It will take approximately 40 days of pumping to empty the total flow from Phases 1 and 2 and what is anticipated from 3.

It is obvious that the actual flow is much less than the anticipated flow (HELP Model). Phases 1 and 2 combined have generated approximately one half on the leachate that is anticipated from Phase 3 thru the HELP Model. Phases 1 and 2 cover twice the acreage than Phase 3. This is the reason that the leachate lagoon is always virtually empty.

Leachate Collection System Components

Leachate lagoon

Pipe and rock surrounding it

Pumps

Drainage net

System Performance

Assume a annual worst case scenario for lagoon storage of 3,582,308 gals from Phases 1 and 2, the HELP model predicted flow for the entire landfill and one 25 yr. storm over half of the landfill with no waste.

The largest area with no garbage will be approximately 10.0 acres which is approx. ½ of Phase 2..

Q_{25} = (10 ac)(43,560 sq.ft./ac)(7.24"/12")(7.48 gal/cu.ft.) = 1,965,834 gal./day
Q_{25} = 81,910 gal./hr.

Lagoon size without the 2 feet of freeboard = 1,012,029 gallons

The annual worst case scenario for the lagoon is 3,582,308 from Phases 1 & 2, 7,954,820 gallons predicted for Phase 3 and 1,965,834 gallons from a onetime storm event. The total flow into the lagoon for this scenario is 13,502,962 gallons.

∴ Lagoon will hold 1,012,029 and would have to be emptied 13.3 times in the year of the worst case scenario. There is no maximum flow restriction from the Goldsboro WWTP and the pumps from the lagoon to the plant can pump a minimum of 200 gpm. If the pump station was run twenty four hours a day, 7 days a week and 52 weeks a year, it could pump 104,832,000 gallons in one year. Consequently, this system has considerable unused capacity.

Flow Through the Rock in the Leachate trench

Darcy's Law
Q = kiA

Q= flow thru the stone
k = hydraulic conductivity of the stone
i = hydraulic gradient
A = area over which flow occurs

For vertical Flow:
i = (h + D)/D
h = leachate head over stone
D = thickness of the stone

For Horizontal Flow:
i = Diff head/length

25 yr. 24 hr. storm = 7.24"

Assume no evaporation or soil retained water:
- everything is runoff
- assume 7.24" rainfall in 24 hours.

∴ 24.0 acres lined x 43560 ft^2/acres x 7.24"/12"
= 630,749 ft^3 x 7.48 gal/ft^3 = 4,718,003 gpd.
= 3,276 gpm

Vertical Flow in the Rock

What is the required hydraulic conductivity (k) of trench is required to allow the 25 yr. storm to flow through the rock at the surface of the protective cover in 24 hours?

k= Q/iA

Total length of leachate trench available is 8,462 ft. and it is 2 ft. wide.

. Q = 630,749 ft^3/day
A = 8,462 ft. x 2 ft. = 16,924 $ft.^2$
I = (0 + 3)/3 = 1

Required k = 630,749/16,924 = 37.27 ft./day = 0.002 in/sec

Permeability of stone in trench is approximately = 0.04 in/sec

Factor of Safety = 20

Flow (Q) for 8,462 ft. of trench 2 ft. wide with a k = 0.04 in./sec.

Q = 0.04 in,/sec/12in./ft. x 16,924 $ft.^2$ x 1 = 56.41 cfs = 36,458,358 gpd

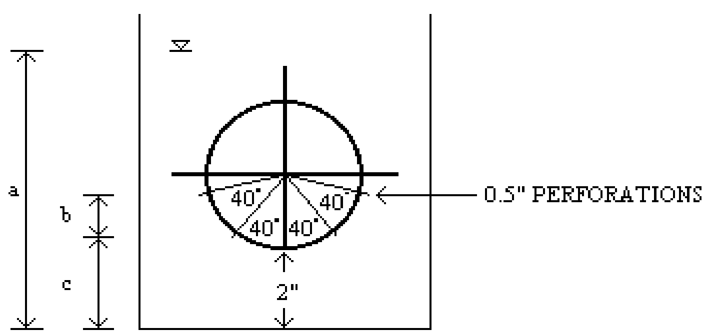
Horizontal Flow in the Rock

Flow thru a leachate trench 2 ft. by 3 ft. with a 2% slope and a k = 0.04 in./sec.

Q= 0.04/12 x 2/100/100 x 6 = 0.04 ft^3./sec = 25,900 gpd

The horizontal flow thru the stone is restrictive; therefore, high flow will flow into the perforations of the pipes to the sump.

Flow in the Pipe



r = Radius, a = 1.0' Head

C = r - rCos40° + 2"

BC = r -rCos80° + 2"

C_6 = 2.70" BC_6 = 4.48"
C_8 = 2.94" BC_8 = 5.31"

∴ Head on the 40° perforation @ 1.0 overall head on liner:

(6") = 12"- 2.70" = 9.30"

(8") = 12" - 2.94" = 9.06"

∴ Head on the 80° perforation @ 1.0 overall head on liner:

(6") = 12"- 4.48" = 7.52"

(8") = 12" - 5.31" = 6.69"

Use the orifice equation to determine the flow into the holes w/ 1.0' of head on the liner.

$Q = CA\sqrt{(2gh)}$ where: $C = 0.95$ $A = 0.0014 ft^2$ $g = 32.2$ ft/sec. H = head (ft.) Q = cfs

$Q_{40°}$

$Q_6 = 0.95(0.0014)\sqrt{(2(32.2)((12-2.70)\div 12)} = 0.0094$ cfs

$Q_8 = 0.95(0.0014)\sqrt{(2(32.2)((12-2.94)\div 12)} = 0.0093$ cfs

$Q_{80°}$

$Q_6 = 0.95(0.0014)\sqrt{(2(32.2)((12-4.48)\div 12)} = 0.0084$ cfs

$Q_8 = 0.95(0.0014)\sqrt{(2(32.2)((12-5.31)\div 12)} = 0.0080$ cfs

Flow per foot of 6" leachate line:

4(0.0094) + 4(0.0084) = .0712 cfs

Flow per foot of 8" leachate line:

4(0.0093) + 4(0.0080) = .0692 cfs

Worst case scenario for entire 20 acres is the 25 year storm with no waste.

The 25 yr. 24 hr storm is 525,624 ft.^{3}/day = 4.29 cfs:

The length of 6 inch line required = 4.29 cfs/0.0712 cfs/ft. = 60 ft.

The length of 8 inch line required = 4.29 cfs/0.0692 cfs/ft. = 62 ft.

It would take 60 ft. of 6 inch line or 62 ft. of 8 in. to empty the landfill from the 25 yr 24 hr. storm in one day. There is a total of 8,462 ft. of perforated pipe in the landfill. This is more than ample pipe to drain all leachate generated.

Assume worst case scenario:

7.24" rain on 10.0 acres and nothing is discharged from the landfill until rain has stopped.

∴ Volume of water retained = 7.24/12 x 10.0 x 43,560

= 262,812 ft^3

= 1,965,833 gallons

The most restrictive component in the system other than the pump is the 8" leachate line at the lowest point which is designed w/ a slope of 2%. Consequently, the maximum water that can be discharged through this pipe is:

Maximum Flow Through 8" pipe @2% (Manning's Equation)

n = 0.009   s = 0.02 ft/ft   A= 0.3110 ft^2 P= 1.9774 ft   R = A/P

$$Q = \frac{1.486\ (AR^{2/3}s^{1/2})}{n}$$

$$Q = \frac{1.486\ (.3110)(.1573)^{2/3}(.02)^{1/2}}{0.009}$$

Q = 2.12 cfs = 950 gpm

Volume to Discharge = 1,965,833 gals.

1,965,833 gals ÷ 950 gpm = 2,069 min. = 34.5 hours

This is an extreme condition that cannot happen because the storm event would be discharged as it was occurring and not after it happened.

Pump Design

Minimum Pump Flow = 75 gpm @ approximately 20 ft. TDH

Worst case scenario is the 25 yr. 24 hr. storm w/ no runoff and no water retained within waste. There are two sumps within the landfill and the most that can affect one pump is 10 acres.

25 yr. 24 hr. storm over 10 acres generates $ft.^3$ = 1,965,834 gals.

It will take the pump 18.2 days to pump the water out from the 25 yr. storm.

It will easily handle the flow predicted by the HELP Model, which is approx. 8,000,000 gals. annually.

Divide the flow into two parts it is 4,000,000 annually = 16 gpm and the pump will remove 75 gpm.

The Peak Daily Flow predicted by the HELP Model for years 1 thru 5 is 0.65 ins./acre.
10 acres x 43,560 $ft.^2$/acre x 0.65 ins/12 ins./ft. x 7.48 gals/$ft.^3$ = 176,491 gals.

The pump station will remove the peak flow predicted by the HELP Model in 16.3 hrs.

Drainage Net and Geotextiles

The non-woven geotextiles that are used in the landfill are there to protect drainage devices such as the stone around the leachate piping from sedimentation. They are not intended to act as any filter under waste because filters will eventually become clogged with whatever they are filtering from the liquid. The fabric around the stone is a light weight fabric with an Apparent Opening Size (AOS) of 70 mm. that will allow water to pass thru it but filter out sediment that is carried by the runoff within the landfill prior to waste being place over the trench. The fabric is folded back so that waste is indirect contact with the stone in the trench and/or sump. Leachate that would flow thru the protective cover will not be carrying sediments because it will not have the scouring velocity to do so; consequently, this liquid can pass thru either the side of the leachate trench geotextile or the drainage net on the bottom of the landfill.

The drainage net is a minimum of 250 mil. The Peak daily Value of maximum head on the liner for years 1 thru 5 as predicted by the HELP Model is 0.456 inches. The maximum allowable head is 1.0 ft. The minimum transmissivity of the composite geonet is 3.0 x 10^{-5} m^2/sec and using Darcy's Law:

Transmissivity (θ) = permeability (k) x saturated thickness (t)

Darcy's Law

Q= k I A
A = t x 1 ft. unit width

Q = θ/t x i x t

Q = θ x i

Q = 0.00003 $m^{2/}$sec x 10.764 ft^2/m^2 x 2ft./100.ft./100 ft.(2% slope for 100 ft.)
= 0.0006 $ft.^3$/sec./ft.

Peak daily Flow from HELP Model = 47,190 ft^3

Drainage net 1 ft. wide 100 ft. long on a slope of 2% will take 78,650,000 seconds = 910 days to drain the Peak Day. The entire landfill of 20 acres is covered with the composite drainage net, which is more than adequate to drain the peak flow predicted by the HELP Model. It would take just over 910 ft. of the drainage net to handle the peak daily flow in less than a day. The only liquid that will reach the drainage net has to permeate thru the soil cover. The other areas the liquid will flow in other parts of the leachate collection system. They are adequate to handle a 25 yr. 24 hr. storm event.

2.2.5 Strength of Pipe

Rinker Materials PolyPipe Division Design and Engineering Guide for Polyethylene Piping

PolyPipe®

C Earthloading Critical Buckling

$$P_t = P_b + P_L + P_s$$

$$P_{CB} = \frac{1}{SF}\sqrt{\frac{2.67 \times B \times RW \times \Sigma_s \times \Sigma}{SDR^3}}$$

$$P_{CB} \geq P_t$$

See Page C-5 Thru C-8

09/17/2009

Rho	60	lbs/ft³
H	200	ft
PL	21	psi
PS	0	psi
HW	5	ft
SF	2	
DR	17	
E	30000	psi
Es	3000	psi
Pt	104.33	psi
Pcb	110.12	

Variable descriptions

Note: If Pcb is less than Pt, critical buckling of the pipe may occur.
DR = standard dimension ratio
Pcb = critical buckling stress
SF = safety factor (recommend SF = 2)
Rw = water buoyancy factor
' Rw = (1-(0.33*hw/h))
' Note: hw must be less than h
H = height of soil cover above pipe
Hw = height of water table above pipe
B = empirical coefficient of elastic support
e = 2.718
Es = soil modulus (see table C-4)
E = pipe modulus of elasticity
Ps = surface load exerted by a permanent structure in close proximity to buried pipe. See page C-6 for value calculation
PL = live load exerted by heavy equipment on surface above the pipe. See page C-7 for table of values. If depth of bury is greater than 4ft. then H20 load is 3psi and E80 load is 21psi. For depth of bury greater than 10ft. E80 load is 9psi.
Rho = Density of backfill meterial

Using this CD for Design Purposes

Due to wide variations in service conditions, quality of installation, etc., no warranty or guarantee, expressed or implied, is given in conjunction with the use of the calculations and analytical solutions

Select the appropriate soil modulus Es (psi). For crushed rock bedding use 3000 psi.

PolyPipe®

C Earthloading % Deflection

$$\% \text{ Deflection} = \frac{\Delta x}{D} \times 100$$

$$\text{where } \Delta x = \frac{DI \times K \times W}{\frac{2E}{3 \times SDR^3} + 0.61 \times E_s}$$

$$\text{where } W = \frac{C_d \times \rho \times B_d \times D}{144}$$

See Page C-4

09/17/2009

CD	3.0	
Rho	60	lbs/ft³
Bd	2	ft
D	6.625	in
DR	17	
H	200	ft
DI	1.50	
K	0.1	
E	30000	psi
Es	3000	psi
W	16.563	psi
delta X	0.013546	
% deflection	0.20446	

Variable descriptions

W = earthload
Cd = trench coefficient (See figure 15)
Rho = soil density
D = outside diameter of pipe
DR = Standard Dimension Ratio
Bd = trench width at top of pipe
H = height of backfill above top of pipe
delta x = vertical defection of pipe
DI = deflection lag factor (1.50)
K = bending constant (0.10)
E = modulus of pipe elasticity
Es = soil modulus

Using this CD for Design Purposes

Due to wide variations in service conditions, quality of installation, etc., no warranty or guarantee, expressed or implied, is given in conjunction with the use of the calculations and analytical solutions. PolyPipe® has checked the calculations in this CD and to the best of our knowledge these calculations are accurate. However, users of this CD assume all responsibility for the accuracy of the analytical solutions. In all cases, third party verification or a licensed professional engineer should be consulted prior to any actual selection of product or material specification or use.

Contact our Technical Services Group at (800) 433-5632 for further assistance.

Maximum allowable safe deflection for flexible polyethylene pipe w/DR 17 is 5%.

PolyPipe®

C Earthloading % Deflection

$$\% \text{ Deflection} = \frac{\Delta x}{D} \times 100$$

$$\text{where } \Delta x = \frac{DI \times K \times W}{\frac{2E}{3 \times SDR^3} + 0.61 \times E_s}$$

$$\text{where } W = \frac{C_d \times \rho \times B_d \times D}{144}$$

See Page C-4

09/17/2009

CD	3.0	
Rho	60	lbs/ft³
Bd	2	ft
D	8.625	in
DR	17	
H	200	ft
DI	1.50	
K	0.1	
E	30000	psi
Es	3000	psi
W	21.563	psi
delta X	0.017635	
% deflection	0.20446	

Variable descriptions

W = earthload
Cd = trench coefficient (See figure 15)
Rho = soil density
D = outside diameter of pipe
DR = Standard Dimension Ratio
Bd = trench width at top of pipe
H = height of backfill above top of pipe
delta x = vertical defection of pipe
DI = deflection lag factor (1.50)
K = bending constant (0.10)
E = modulus of pipe elasticity
Es = soil modulus

Using this CD for Design Purposes

Due to wide variations in service conditions, quality of installation, etc., no warranty or guarantee, expressed or implied, is given in conjunction with the use of the calculations and analytical solutions. PolyPipe® has checked the calculations in this CD and to the best of our knowledge these calculations are accurate. However, users of this CD assume all responsibility for the accuracy of the analytical solutions. In all cases, third party verification or a licensed professional engineer should be consulted prior to any actual selection of product or material specification or use.

Contact our Technical Services Group at (800) 433-5632 for further assistance.

Maximum allowable safe deflection for flexible polyethylene pipe w/DR 17 is 5%.

C Earthloading % Deflection

$$\% \text{ Deflection} = \frac{\Delta x}{D} \times 100$$

$$\text{where } \Delta x = \frac{Dl \times K \times W}{\frac{2E}{3 \times SDR^3} + 0.61 \times E_s}$$

$$\text{where } W = \frac{C_d \times \rho \times B_d \times D}{144}$$

See Page C-4

09/17/2009

CD	3.0	
Rho	60	lbs/ft³
Bd	2	ft
D	10.75	in
DR	17	
H	200	ft
DI	1.50	
K	0.1	
E	30000	psi
Es	3000	psi
W	26.875	psi
delta X	0.02198	
% deflection	0.20446	

Variable descriptions

W = earthload
Cd = trench coefficient (See figure 15)
Rho = soil density
D = outside diameter of pipe
DR = Standard Dimension Ratio
Bd = trench width at top of pipe
H = height of backfill above top of pipe
delta x = vertical defection of pipe
DI = deflection lag factor (1.50)
K = bending constant (0.10)
E = modulus of pipe elasticity
Es = soil modulus

Using this CD for Design Purposes

Due to wide variations in service conditions, quality of installation, etc., no warranty or guarantee, expressed or implied, is given in conjunction with the use of the calculations and analytical solutions. PolyPipe® has checked the calculations in this CD and to the best of our knowledge these calculations are accurate. However, users of this CD assume all responsibility for the accuracy of the analytical solutions. In all cases, third party verification or a licensed professional engineer should be consulted prior to any actual selection of product or material specification or use.

Contact our Technical Services Group at (800) 433-5632 for further assistance.

Maximum allowable safe deflection for flexible polyethylene pipe w/DR 17 is 5%.

2.2.6 Base Liner Calculations

Reference: Designing w/ Geosynthetics Robert M. Koerner

T_{allow} = $F_u + F_L + 2F_{at}$
T_{allow} = $\sigma_{allow}\ t$
σ_{allow} = the mobilized allowable geomembrane stress = $\sigma_{ult} \div FS$
FS = Factor of Safety
t = Geomembrane Thickness
F_u = the friction force above geomembrane(assumed to be negligible, since the cover soil probably moves along with the liner as it deforms)
q = the surcharge pressure = $d_{cs}\gamma_{cs}$
d_{cs} = the depth of cover soil
γ_{cs} = the unit weight of cover soil
δ = the friction angle between geomembrane and soil or geomembrane and drainage net
L_{RO} = length of runout
F_{AT} = $(\sigma_h)_{ave} \tan \delta(d_{at})$
σ_h = the average horizontal stress in anchor trench = $K_0\sigma_v$
σ_v = γH_{ave}
γ = the unit weight of backfill soil
H_{ave} = the average depth of anchor trench (requires an estimate)
K_0 = $1-\sin\phi$
ϕ = the angle of shearing resistance of backfill soil
d_{at} = the (unknown) depth of anchor trench

Allowable Stress in Liner

T_{allow} = $\sigma_{allow}t$
σ_{allow} = σ_{ult}/FS
σ_{ult} = 2,100 psi (from N.S.F. 54)

σ_{allow} = $\sigma_{ult} \div FS$ = 2,100 psi ÷ 1.0
$\therefore T_{allow}$ = 2,100 psi x 0.06 in.
= 126 lbs/in.
= 1,512 lbs/ft.

Compute Forces below Liner (F_L)

F_L = $q\tan\delta(L_{ro})$
L_{ro} = 3.0 ft.
d_{cs} = 3.0 ft.
γ_{cs} = 110 pcf
δ = 25° textured liner

q = $d_{cs}\gamma_{cs}$
= (3.0)(110)
= 330 lbs/ft^2

$\therefore F_L$ = (330)tan 25° (3.0)
= 461.64 lbs/ft.

Compute Forces Due to Anchor Trench (F_{at})

F_{at} = $(\sigma_h)_{ave}$ tan δ (d_{at})
= (1-sinϕ)(γ)(H_{ave})tan δ (d_{at})
ϕ = 30°
γ = 110 lbs/ft^3
H_{ave} = 5 ft.
δ = 25°

$\therefore F_{at}$ = (1-sin30°)(110 lbs/ft^3)(5ft)(tan25°)(d_{at})
= 128.23d_{at}

Compute Required Anchor Trench Depth for FML

T_{allow} = $F_u + F_c + 2F_{at}$

1512 lbs/ft = 0 + 461.64 lbs/ft. + 2(128.23 d_{at})
$\therefore d_{at}$ = (1512.00-461.64)÷256.46
= 4.10ft provide maximum 4.0 ft. deep anchor trench because the liner will fail before pull out if it exceeds 4.10 ft.

Check Anchor Trench for Drainage Net

T_{allow} = 75 lbs/in tensile strength per SKAPS Industries Transnet 270-2-7.1 F.S. = 1.3
= 75 lbs./in /1.3 = 58 lbs/in
= 696 lbs/ft.

Compute Forces Below Drainage Net (F_L)

F_L = q tan δ(L_{ro})
δ = 24° Friction angle between textured liner and double bonded geonet.
q = dγ = 3'(110lbs/ft^3)
= (3.0)(110)(tan24°)(3.0)
= 440.78 lbs/ft.

Compute Forces Due to Anchor Trench

F_{at} = (1-sin30°)(110)(5)(tan24°)(d_{at})
= 122.44 d_{at}

Compute Required Anchor Trench

696 lbs./ft. = 0 + 440.78 lbs./ft. +122.24d_{at}
$\therefore d_{at}$ = 2.09 ft.

Note: The drainage net will be anchored in F.M.L. anchor trench @ 4.00 ft.

Check Sliding Forces of Soil Cover

F.S. = (tanδ)÷(tanβ)
δ = Friction Angle = 26° for soil to double bonded geonet
β = Slope Angle = 3:1 slope = 18.418°

F.S. = (tanδ)÷(tanβ)
= (tan 26°)÷(tan18.418°)
= 1.46 > 1 $\therefore$ O.K.

<u>**Check Stress Due to Placement of Protective Cover**</u>

Ref: Giroud and Beech (1989)

$T = (\gamma_p Z^2_p \div \sin 2\beta)[((2H_p\cos\beta \div Z_p)-1)((\sin(\beta-\phi_{cm})\div\cos\phi_{cm})-(\sin\phi_{pm}\div\cos(\beta+\phi_{pm}))]$

T	= Tension generated by placement of Cover (lbs/in width)
γ_p	= unit weight of protective cover (lbs/in^3)
Z_p	= thickness of protective cover (in.)
β	= Slope angle of the liner (degrees)
H_p	= Vertical height of protective cover (in.)
ϕ_{cm}	= Critical mobilized interface friction angle of liner (degrees) = 26°
ϕ_{pm}	= mobilized internal friction angle of protective cover (degs.) = 30°

Assume worst case of 50 ft deep on a 3:1 slope with a factor of safety of 1.3

ϕ_{cm}	= ϕ_c÷F.S. = 26°÷1.3 = 20°
ϕ_{pm}	= ϕ_p÷F.S. = 30°÷1.3 = 23.1°
γ_p	= 0.0637 lbs/in^3.
Z_p	= 36 in.
β	= 18.418° (for 3:1 slope)
H_p	= 600 in.

$T = (0.0637\text{x}36^2) \div \sin (2)18.418°)[((2\text{x}600\cos18.418°\div36)-1)((\sin(18.418°-20.0°)\div\cos20.0°)-(\sin23.1°\div\cos(18.418°+23.1°))]$

T = 137.70[(30.63)(-0.03)-0.52]
= 137.70(-092) - 0.52
= -127.20 lb/in. < T_{allow} 50 ft. 3:1 Embankment O.K.

Conclusion: Highest and steepest slope can have protective cover installed during the construction of the cell. Therefore, any of the other slopes will be o.k.

Self-Weight Stress during Construction

Tensile stress due to self-weight of the Smooth 60mil HDPE liner

$T = \gamma \times H \times L \times (\sin\beta - \cos\beta\tan\delta)$

T = Tension due to self-weight (lbs/in.)
H = thickness of liner system component (in.)
L = length of liner system component (in.)
β = Slope angle of the liner (degrees)
δ = critical interface friction angle of liner system
γ = unit weight of liner system component (lbs/in^3)
W = weight per square area of membrane (lbs/in^2)

Assume worst condition:
The length of the liner on a 3:1 slope that would induce failure in the liner.

$T = F_p = 126$ lbs/in

Solve for L (Length)

$L = T \div (\gamma \times H \times (\sin\beta - \cos\beta\tan\delta))$
γ = W x .06 in = 0.00012 lbs/in^3
H = 0.06 in. (60mil Smooth HDPE)
β = 18.418° (for 3:1 slope)
δ = 17°

$L = 126 \div ((0.00012 \times 0.06(\sin 18.418° - \cos 18.418° \tan 17°))$

= 67,628 in.

= 5,636ft. far exceeds any requirement

∴Self Weight stress is O.K.

Thermal Stress during Construction

$\varepsilon = \Delta L \div L$ = Strain
ε = Strain in the liner system (percent)
ΔL = Change in length of liner due to change in temperature
L = Length of liner before temperature change
$\Delta L = (\alpha)L(\Delta T)$
α = Coefficient of liner thermal expansion (°F^{-1})
ΔL = Change in length of liner due to change in temperature
ΔT = Change in Temperature (°F°)

Assume:

α = Coefficient of liner thermal expansion (°F^{-1}) = 6.7×10^{-5} °F^{-1}
ΔT = 100°F Conservative assumption
L = 1 ft.
$\varepsilon = \alpha L \Delta T \div L$
$= \alpha\Delta T$
= 0.0067 ft. or 0.67%

Allowable elongation @ yield = 13%
∴allowable > design thermal stress o.k.

2.2.7 Alternate Base Liner Calculations

Geosynthetic Clay Liner (GCL) Calculations
Ref: CETCO Design Manual Technical Notes 5 and 6

FS = factor of safety
T = the allowable long-term tensile strength in the layer above the critical surface being analyzed.
L = the slope length.
S = the shear strength along the surface being analyzed.
β = slope angle (degrees).
γ = the unit weight of cover soil
z = the thickness of the cover soil layer.
ϕ = the internal or interface friction angle along the surface being analyzed.
C = the apparent cohesion along the surface being analyzed.

$$FS = \frac{[(T \div L) + S]}{[(z)(\gamma)(\sin \beta)]} \qquad S = (\gamma)(z)(\cos \beta)(\tan \phi) + C$$

Check interface between cohesive soil liner and Bentomat (Reinforced GCL):

$\phi = 13.5°$
$\gamma = 110$ lbs./ft^3
z = 3 ft.
$\beta = 18.4°$ (3:1 slopes)
C = 500 lbs./ft^2
T = 90 lbs./ft.
L = 150 ft.

$\therefore S = (110)(3)(0.9489)(0.2401) + 500$
$S = 575.18$ lbs/ft^2

$$\therefore FS = \frac{(90 \div 150) + 575.18}{(3)(110)(\sin 18.4°)}$$

FS = 5.53 OK

Check interface between Bentomat (Reinforced GCL) and 60 mil Textured HDPE Liner:

$$FS = \frac{[(T \div L) + S]}{[(z)(\gamma)(\sin \beta)]} \qquad S = (\gamma)(z)(\cos \beta)(\tan \phi) + C$$

$\phi = 13°$
$\gamma = 110$ lbs./ft^3
z = 3 ft.
$\beta = 18.4°$ (3:1 slopes)
C = 200 lbs./ft^2
T = 1,512 lbs./ft.
L = 150 ft.

$\therefore S = (110)(3)(0.9489)(0.2309) + 200$
$S = 272.29$ lbs/ft^2

$$\therefore FS = \frac{(1{,}512 \div 150) + 272.29}{(3)(110)(\sin 18.4°)}$$

FS = 2.71 OK

2.2.8 Foundation, Settlement, and Slope Stability Analysis

ECS CAROLINAS, LLP "Setting the Standard for Service"
CAROLINAS Geotechnical • Construction Materials • Environmental • Facilities NC Registered Engineering Firm F-1078

January 19, 2011

Mr. Wayne Sullivan
Municipal Engineering Services Co. PA
PO Box 97
Garner, NC 27529

RE: Report of Geotechnical Services – Settlement Analysis
Wayne County Landfill, Phase 3
460 S. Landfill Road
Dudley, North Carolina
ECS Project No. 06:16642-A

Dear Mr. Sullivan:

ECS Carolinas, LLP (ECS) has completed the settlement analysis for the proposed Phase 3 of the Wayne County Landfill as requested by Municipal Engineering Services Company, PA (MESCO). ECS previously analyzed the proposed project and presented our findings in a report dated November 5, 2010 under ECS Project No. 16642-A. This analysis is based on a maximum height of waste of 150 feet instead of the 115 feet previously analyzed.

Project Information

The Wayne County Landfill is located at 460 South Landfill Road in Dudley, North Carolina. Based on information and the facility plan dated April 27, 2009 for the landfill prepared and provided by MESCO, the proposed approximately 20-acre Phase 3 of the landfill will be located north-northeast of and adjacent to the existing Phases 1 and 2. Based on the proposed finished cap grades for Phase 3 provided by MESCO, we understand that the maximum waste height will be approximately 150 feet.

Soil borings in the Phase 3 area were conducted by Derry's Well Drilling under subcontract to MESCO. ECS has been provided with the boring logs. The Wayne County Landfill lies in the Coastal Plains Province, and consists of sands overlaying Black Creek Formations Clay. The soils encountered on the site generally consist of loose to medium dense Silty SANDS, with a layer of Sandy, Silty CLAY located near the ground surface in many borings near the perimeter of the proposed phase 3 landfill areas. Groundwater was encountered within most of the borings ranging from approximately 1 to 8 feet below the prevailing ground surface.

Engineering Analyses

Analyses were performed on Phase 3 to determine settlement of the subgrade soils. The analysis was based on information provided by MESCO. Compressibility of the soil was estimated based on the soil descriptions on the provided boring logs and our previous experience.

The approximately 150-foot maximum height of proposed waste, the liner system and cap, will apply a foundation load of approximately 10,635 psf or 5.3 tsf. The maximum fill height was determined to be in the vicinity of boring P3-8 where the proposed final fill elevations are approximately 150 feet higher than proposed subgrade elevations. An average in-place moist density of the compacted waste and daily cover of 70 pounds per cubic foot was assumed based on the typical values published by National Solid Wasted Management Association and several studies consulted by this office. Based on our experience with similar soil conditions, the silty sands at the proposed subgrade elevations are suitable for support of the applied loads.

The total and differential settlement of the foundation soils from the applied solid waste loads were estimated using an elastic analysis and estimated compressibility based on the Standard Penetration Test N-values obtained form the Boring Logs provided to us. The borings performed within the proposed landfill area were advanced to depths ranging from approximately 15 to 54 feet below the prevailing ground surface.

The thickness of the soil profile underlying the waste and clay liner is approximately 18 feet of fill material, assumed to be onsite silty sand borrow material, and 36 feet of natural silty sands in the vicinity of P3-8. The applied load is approximately 10,635 psf, resulting in estimated settlements on the order of 24 inches.

Based on the provided boring results, the soil conditions across the site are reasonably uniform. Settlement will typically be proportional to the waste and embankment height, with little abrupt differential movements.

This report has been prepared in order to aid in the evaluation of this property and to assist the architect and/or engineer in the design of this project. The scope is limited to the specific project and locations described herein and our description of the project represents our understanding of the significant aspects relative to soil and foundation characteristics. In the event that any changes in the nature or location of the proposed construction outlined in this report are planned, we should be informed so that the changes can be reviewed and the conclusions of this report modified or approved in writing by the geotechnical engineer. It is recommended that all construction operations dealing with earthwork and foundations be reviewed by an experienced geotechnical engineer to provide information as to whether the design requirements are fulfilled in the actual construction. If you wish, we would welcome the opportunity to provide field construction services for you during construction.

The data submitted in this report are based upon the information obtained from the soil borings and tests performed by others at the locations as indicated on the information referenced in this report. This report does not reflect any variations which may occur between the borings. In the performance of the subsurface exploration, specific information is obtained at specific locations at specific times. However, it is a well known fact that variations in soil conditions exist on most sites between boring locations and also such situations as groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction. If site conditions vary from those identified during the explorations, the recommendations contained in this report may require revision.

Thank you for the opportunity to work with you on this project. Should you have any questions or if we could be of further assistance, please do not hesitate to contact us.

Respectfully,
ECS CAROLINAS, LLP represented by;
Firm License Number: F-1078

NORTH CAROLINA
PROFESSIONAL
SEAL
036537
1/19/11
ENGINEER
MATTHEW B. OLSEN

Matthew B. Olsen, PE	C. (Nathan) Nallainathan, PE
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Geotechnical • Construction Materials • Environmental • Facilities NC Registered Engineering Firm F-1078

November 5, 2010

Mr. Wayne Sullivan
Municipal Engineering Services Co. PA
PO Box 97
Garner, NC 27529

RE: Report of Geotechnical Services
Wayne County Landfill, Phase 3
460 S. Landfill Road
Dudley, North Carolina
ECS Project No. 06:16642-A

Dear Mr. Sullivan:

ECS Carolinas, LLP (ECS) has completed the revised geotechnical analysis for the proposed Phase 3 of the Wayne County Landfill as requested by Municipal Engineering Services Company, PA (MESCO). ECS previously analyzed the proposed project and presented our findings in a report dated October 8, 2009 under ECS Project No. 16642. The revised analysis includes a change in the liner modeling in the slope stability analysis to better represent the planned system and an increase in the final slope to 3 horizontal to 1 vertical.

Project Information

The Wayne County Landfill is located at 460 South Landfill Road in Dudley, North Carolina. Based on information and the facility plan dated April 27, 2009 for the landfill prepared and provided by MESCO, the proposed approximately 20-acre Phase 3 of the landfill will be located north-northeast of and adjacent to the existing Phases 1 and 2. Based on the information provided to us, two possible liner systems are being considered. The first system is a standard systeme consisting of a 2 foot thick conventional clay liner overlain by a 60 mil thick HDPE flexible membrane liner (FML), a 250 mil thick drainage net, and a 3 foot thick layer of protective cover soil. The second system consists of an 1.5 foot thick alternate clay liner overlain by a 0.24 inch thick geosynthetic clay liner (GCL), a 60 mil thick HDPE flexible membrane liner (FML), a 250 mil thick drainage net, and a 3 foot thick layer of protective cover soil. In both cases the landfill will be capped with an 18 inch thick clay liner, a 40 mil thick LLDPE flexible membrane liner and a 2-foot thick cap of protective soil.

Based on the proposed finished cap grades for Phase 3 from the facility plan, we understand that the maximum waste height will be approximately 115 feet. The permanent side slopes for the cap will have an inclination of 4H:1V (horizontal to vertical).). For the purpose of this analysis, we have been asked to assume maximum slopes of 3H:1V in case additional storage capacity is desired. Based on available drawings, the subgrades for the Phase 3 have been previously prepared.

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Soil borings in the Phase 3 area were conducted by Derry's Well Drilling under subcontract to MESCO. ECS has been provided with the boring logs (the Boring Logs and the Exploration Location Diagram are presented in Appendix A). The Wayne County Landfill lies in the Coastal Plains Province, and consists of sands overlaying Black Creek Formations Clay. The soils encountered on the site generally consist of loose to medium dense Silty SANDS, with a layer of Sandy, Silty CLAY located near the ground surface in many borings near the perimeter of the proposed phase 3 landfill areas. Groundwater was encountered within most of the borings ranging from approximately 1 to 8 feet below the prevailing ground surface.

Engineering Analyses

Analyses were performed on Phase 3 to determine settlement of the subgrade soils and local slope stability of the proposed embankment and global slope stability of the landfill. These analyses were based on the design drawings provided by MESCO. Shear strength and compressibility of the soil were estimated based on the soil descriptions on the provided boring logs and our previous experience. The analyses were performed by engineers specializing in geotechnical engineering and copies of the slope stability analyses are attached in Appendix B.

The approximately 115-foot maximum height of proposed waste, the liner system and cap, will apply a foundation load of approximately 8,185 psf or 4.1 tsf. The maximum fill height was determined to be in the vicinity of boring P3-8 where the proposed final fill elevations are approximately 115 feet higher than proposed subgrade elevations. An average in-place moist density of the compacted waste and daily cover of 70 pounds per cubic foot was assumed based on the typical values published by National Solid Wasted Management Association and several studies consulted by this office. Based on our experience with similar soil conditions, the silty sands at the proposed subgrade elevations are suitable for support of the applied loads.

The total and differential settlement of the foundation soils from the applied solid waste loads were estimated using an elastic analysis and estimated compressibility based on the Standard Penetration Test N-values obtained form the Boring Logs provided to us. The borings performed within the proposed landfill area were advanced to depths ranging from approximately 15 to 54 feet below the prevailing ground surface.

Based on available boring information provided by MESCO, settlements were estimated for locations along section B-B' shown on Figure 1 included in the Appendix to this report. The maximum waste fill height occurred in the vicinity of boring P3-8 along section B-B'. The thickness of the soil profile underlying the waste and clay liner is approximately 18 feet of fill material, assumed to be onsite silty sand borrow material, and 36 feet of natural silty sands in the vicinity of P3-8. The applied load is approximately 8,185 psf, resulting in estimated settlements on the order of 18 inches.

Based on the provided boring results, the soil conditions across the site are reasonably uniform. Settlement will typically be proportional to the waste and embankment height, with little abrupt differential movements.

The waste fill and perimeter embankment were evaluated for slope stability analysis using circular potential failure mechanism. Three sections were selected for the stability analysis, which is considered representative of the most unfavorable conditions. The locations of the analyzed sections are shown on the Exploration Location Diagram in Appendix A. Each section was analyzed using the two liner options. The slope stability analysis was performed using the proprietary Slide 5.0 computer program. The modeled slope configuration was generally based on the topographic information and site grading plan provided to us by the client with the face slopes steepened to 3H:1V, while the soil strata information, index properties and engineering properties used in these analyses were estimated based on the soil descriptions on the provided boring logs and our previous experience.

The factors of safety were determined for both static and seismic loading, using the pseudo-static method. For the pseudostatic analysis of the slope, we used an earthquake ground motion having a 2-percent probability of exceedance within a 50-year period (2,475 year return period). According to the USGS Map, October 2002, the seismic acceleration at the bedrock level based on the probabilistic earthquake (2,475 year return period) for this site is 0.08g. The seismic coefficient, k_s, for the site is 0.04g.

The resulting minimum factors of safety were computed to be 1.5 for permanent slopes under static loading conditions and 1.3 for seismic conditions. The failure planes with the lowest factors of safety were through the waste material and the type of liner system did not affect the results of the analysis. Analyses that forced the failure plane through the liner system calculated higher factors of safety. The results of the slope stability analysis are presented in Appendix B.

In conclusion, the results of the geotechnical analysis indicate that permanent slope configurations of 3H:1V or flatter and the proposed configuration of perimeter embankment fill slopes will be stable and provide an appropriate factor of safety.

Construction Considerations

Based on the provided boring logs and the design drawings, we expect that dewatering will be necessary during any excavation into natural site soils. If groundwater is encountered during construction, it probably can be controlled through the use of ditches, sumps, and pumps. If water is encountered that cannot be controlled by such procedures, ECS should be further consulted. Earthwork and trench excavation in saturated materials may require sheeting and shoring, slope flattening, or benching to control sloughing of soils. Seasonal variations in groundwater levels should be anticipated due to precipitation changes, evaporation, surface water runoff, and other factors.

The soils encountered within the test borings should generally be able to be excavated with conventional earth moving equipment such as pans/scrapers, loaders, bulldozers, rubber tired backhoes, etc. On-site soils used as earth fill should have a well-graded grain size distribution with rock and soil particles ranging from clay or silt size particles to a maximum size of 6 inches in diameter. Particles larger than this should be broken by mechanical compaction equipment to achieve the desired grain size distribution, and the samples shall have a minimum of 20 percent passing the No. 200 sieve and 50 percent passing the No. 40 sieve. Variations from these requirements shall be approved by the geotechnical engineer in the field at the time the samples are prepared.

This report has been prepared in order to aid in the evaluation of this property and to assist the architect and/or engineer in the design of this project. The scope is limited to the specific project and locations described herein and our description of the project represents our understanding of the significant aspects relative to soil and foundation characteristics. In the event that any changes in the nature or location of the proposed construction outlined in this report are planned, we should be informed so that the changes can be reviewed and the conclusions of this report modified or approved in writing by the geotechnical engineer. It is recommended that all construction operations dealing with earthwork and foundations be reviewed by an experienced geotechnical engineer to provide information as to whether the design requirements are fulfilled in the actual construction. If you wish, we would welcome the opportunity to provide field construction services for you during construction.

The data submitted in this report are based upon the information obtained from the soil borings and tests performed by others at the locations as indicated on the information referenced in this report. This report does not reflect any variations which may occur between the borings. In the performance of the subsurface exploration, specific information is obtained at specific locations at specific times. However, it is a well known fact that variations in soil conditions exist on most sites between boring locations and also such situations as groundwater levels vary from time to time. The nature and extent of variations may not become evident until the course of construction. If site conditions vary from those identified during the explorations, the recommendations contained in this report may require revision.

Thank you for the opportunity to work with you on this project. Should you have any questions or if we could be of further assistance, please do not hesitate to contact us.

Respectfully,
ECS CAROLINAS, LLP represented by;
Firm License Number: F-1078

NORTH CAROLINA PROFESSIONAL SEAL 036537 ENGINEER MATTHEW B. OLSEN
11/5/10

Matthew B. Olsen, PE
Manager of Engineering Services
NC PE License No. 036537

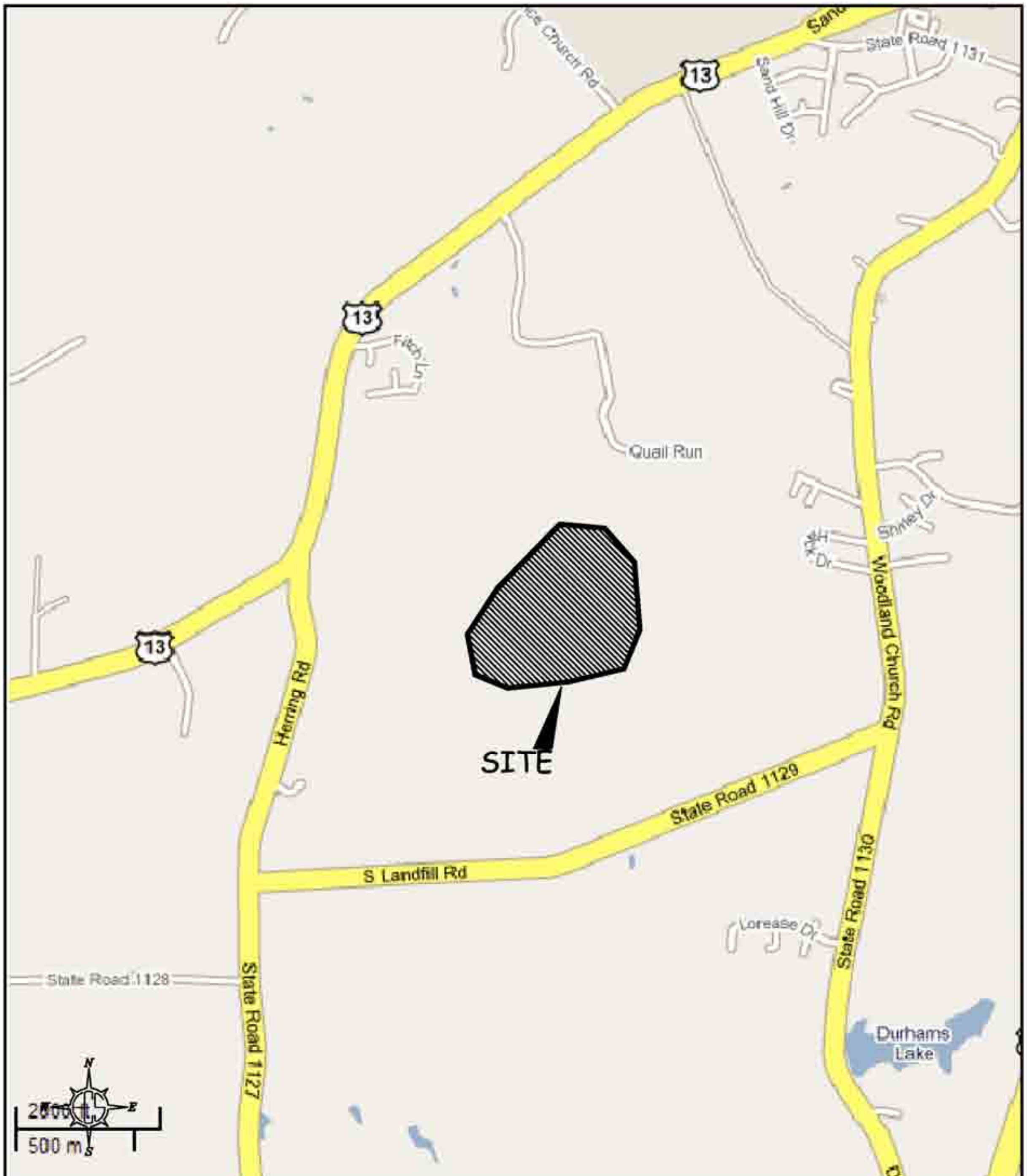
C. (Nathan) Nallainathan, PE
Principal Engineer
NC PE License No. 019937

APPENDICES

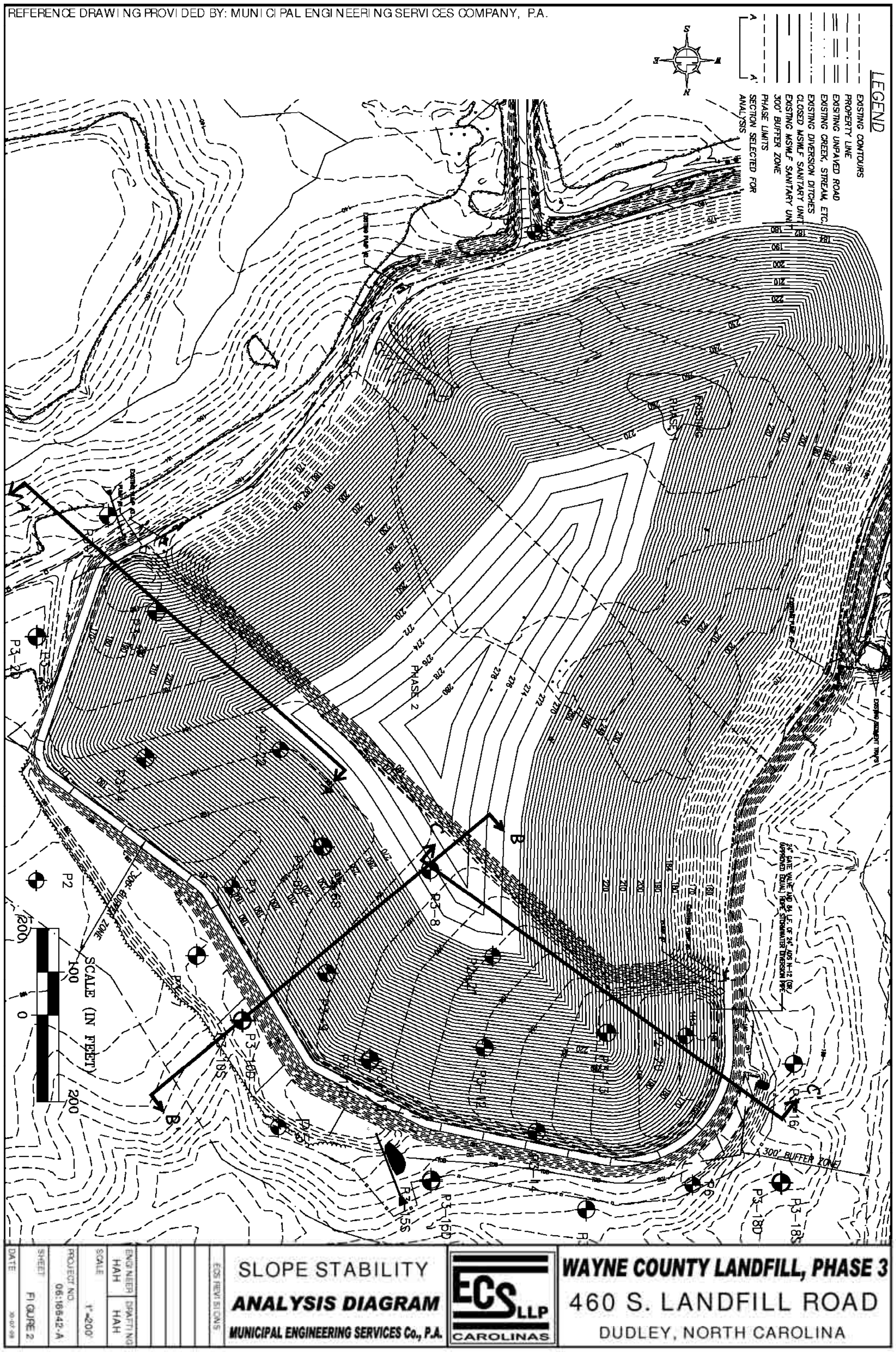
APPENDIX A

EXPLORATION LOCATION DIAGRAM

SELECTED BORING LOGS



VICINITY MAP DIAGRAM	ECS LLP CAROLINAS SETTING THE STANDARD FOR SERVICE	**WAYNE COUNTY LANDFILL, PHASE 3**	ENGINEER HAH	SCALE NTS
		460 S. LANDFILL ROAD	DRAFTSMAN HAH	PROJECT NO. 06:16642-A
			REVISIONS	SHEET FIGURE 1
MUNICIPAL ENGINEERING SERVICES Co., P.A.		**DUDLEY, NORTH CAROLINA**		DATE 10-07-10


REFERENCE DRAWING PROVIDED BY: MUNICIPAL ENGINEERING SERVICES COMPANY, P.A.
LEGEND
EXISTING CONTOURS
PROPERTY LINE
EXISTING UNPAVED ROAD
EXISTING CREEK, STREAM, ETC.
EXISTING DIVERSION DITCHES
CLOSED MSWLF SANITARY UNIT
EXISTING MSWLF SANITARY UNIT
300' BUFFER ZONE
PHASE LIMITS
SECTION SELECTED FOR ANALYSIS
PHASE 2
300' BUFFER ZONE
SCALE (IN FEET)
200
100
0
200
P3-8
P3-16D
P3-16S
P3-15S
P3-16D
P3-18S
P3-18D
P2
B
B'
C'
SLOPE STABILITY
ANALYSIS DIAGRAM
MUNICIPAL ENGINEERING SERVICES Co., P.A.
ECS LLP
CAROLINAS
WAYNE COUNTY LANDFILL, PHASE 3
460 S. LANDFILL ROAD
DUDLEY, NORTH CAROLINA
ECS REVISIONS
ENGINEER HAH
DRAFTING HAH
SCALE 1"=200'
PROJECT NO. 06:18642-A
SHEET FIGURE 2
DATE

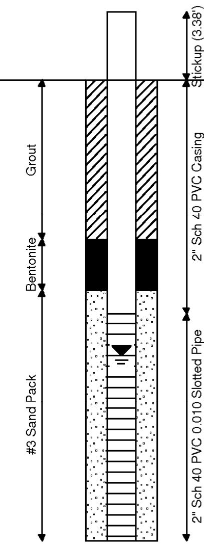
LOG OF BORING: P3-1

Wayne County Landfill, Phase 3 — **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/14/2006	Surface elevation:	157.82 ft (MSL)
Drill rig & method:	8.5" O.D. HSA w/ S.S	Date ended:	9/14/2006	Top of pipe elevation:	161.20 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	20.28 ft	Depth to water (TOB):	10.00 ft
		Stickup height:	3.38 ft	Depth to water (24hrs):	12.13 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	8			Silty Clay with Sand; pale yellow brown, mottled with black top soil, fine root debris, moist
	25			Silty Clay with Sand; pale yellow brown, mottled, relict structure, root debris
5				Clay
	24			Clay; dark brown, light grey, mottled, cohesive, moist
10				
	6			Silty Sand; very light grey to white, fine grained, wet
15				
	7			Silty Sand; same as above, saturated
20				Boring terminated at 20.3 feet
25				
30				
35				
40				
45				

Well Diagram



Municipal Engineering Services Company, P.A.

Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies

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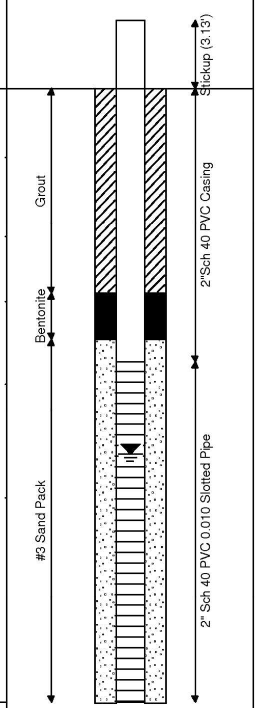
LOG OF BORING: P3-2S

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor: Derry's Well Drilling	Date started: 9/14/2006	Surface elevation: 165.45 ft (MSL)
Drill rig & method: 8.5" OD HSA	Date ended: 9/14/2006	Top of pipe elevation: 168.58 ft (MSL)
Logged by: J. Pfohl	Completion depth: 27.00 ft	Depth to water (TOB): 17.00 ft
	Stickup height: 3.13 ft	Depth to water (24hrs): 16.06 ft

Depth (ft)	SPT (bpf)	Description of Material & Remarks
0	13	Sandy Clay; moderate yellow brown clay with medium grained pale brown and grey orange sand, mottled, damp
3	6	Sand; grey orange, medium grained, damp
6.5	28	Silty Clay with Sand; light grey with yellow red mottles, very fine sand, cohesive, moist
9.5		Clay
13	28	Silty Clay with Sand; light grey with yellow red mottles, very fine grained sand, cohesive, moist
18	5	Silty Sand; very light grey to white, fine grained, wet
23	6	Silty Sand; same as above
27		Boring terminated at 27.0 feet

Well Diagram



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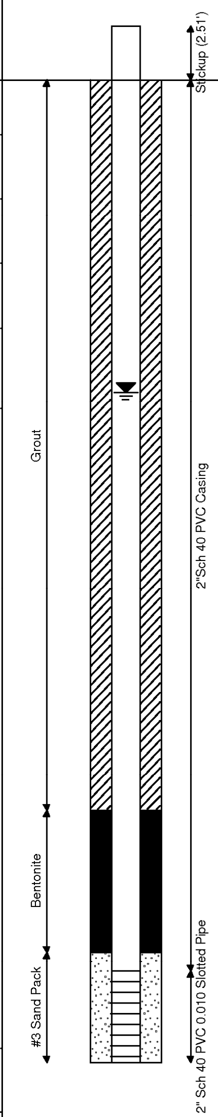
LOG OF BORING: P3-2D

Wayne County Landfill, Phase 3 **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/29/2006
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/29/2006
Logged by:	J. Pfohl	Completion depth:	53.80 ft
		Stickup height:	2.51 ft
Surface elevation:	165.43 ft (MSL)		
Top of pipe elevation:	167.94 ft (MSL)		
Depth to water (TOB):	17.00 ft		
Depth to water (24hrs):	17.07 ft		

SPT (bpf)	Description of Material & Remarks
13	Sandy Clay; moderate yellow brown clay with medium grained pale brown and grey orange sand, mottled, damp
6	Sand; grey orange, medium grained, damp
28	Silty Clay with Sand; light grey with yellow red mottles, very fine sand, cohesive, moist
	Fat Clay (CH) Gravel = 0.0%, Sand = 4.63%, Silt & Clay = 95.37%, LL=64, PL=23, PI=41
28	Silty Clay with Sand; light grey with yellow red mottles, very fine grained sand, cohesive, moist
5	Silty Sand; very light grey to white, fine grained, wet
6	Silty Sand; same as above
6	Silty Sand; same as above
4	Silty Sand; very light grey to white, fine grained, trace clay nodules, wet
6	Silty Sand; very light grey to white, fine grained, saturated
8	Silty Sand; same as above
10	Silty Sand; same as above
	Silty Sand; grey
	Sandy Clay; dark grey, cohesive, fine to medium grained, bottom is black, confining layer, Black Creek Formation
	Boring terminated at 53.8 feet

Well Diagram



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LOG OF BORING: P3-3

Wayne County Landfill, Phase 3 **Project No. G06096.6**

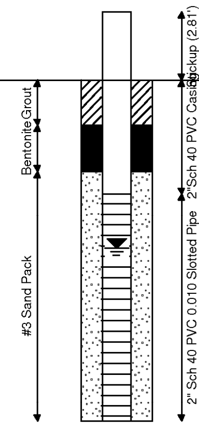
Drilling contractor: Derry's Well Drilling
Drill rig & method: 8.5" OD HSA w/ S.S.
Logged by: J. Pfohl

Date started: 9/17/2006
Date ended: 9/17/2006
Completion depth: 14.99 ft
Stickup height: 2.81 ft

Surface elevation: 154.06 ft (MSL)
Top of pipe elevation: 156.87 ft (MSL)
Depth to water (TOB): 6.50 ft
Depth to water (24hrs): 7.37 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
0	3		X	Silty Sand; brown, medium grained sand with some clay, fine root debris, moist
3	11		X	Clayey Sand; dark yellow orange, poorly sorted, fine to medium grained, trace light grey nodules, slightly plastic, moist
8	13		X	Silty Sand; pale yellow orange, poorly graded fine to medium grained, wet
13	4		X	Silty Sand; very pale orange, fine grained, saturated
15				Boring terminated at 15.0 feet

Well Diagram



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LOG OF BORING: P3-4

Wayne County Landfill, Phase 3 — **Project No. G06096.6**

Drilling contractor: Derry's Well Drilling
Drill rig & method: 8.5" O.D. HSA w/ S.S
Logged by: J. Pfohl

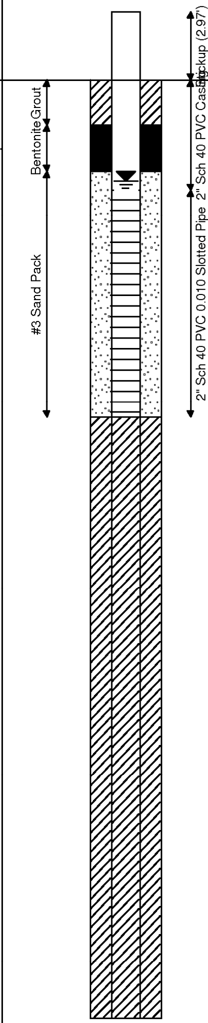
Date started: 9/15/2006
Date ended: 9/15/2006
Completion depth: 41.30 ft
Stickup height: 2.97 ft

Surface elevation: 152.88 ft (MSL)
Top of pipe elevation: 155.85 ft (MSL)
Depth to water (TOB): 4.00 ft
Depth to water (24hrs): 4.41 ft

SPT (bpf)	Description of Material & Remarks
3	Clayey Sand; grey orange with dark yellow orange and grey mottles, poorly sorted, fine to medium grained, cohesive, moist, root debris,
12	Silty Sand; grey orange, with grey and dark yellow mottles, trace clay nodules, fine grained, moist
15	Silty Sand; light brown
	Silty Sand (SM) Gravel = 0.0%, Sand = 77.62%, Silt & Clay = 22.38%, Non-Plastic
4	Silty Sand; very pale orange, fine grained, poorly sorted, saturated
5	Silty Sand; same as above
6	Silty Sand; very pale orange to white, fine grained, poorly sorted, saturated
5	Silty Sand; same as above
4	Silty Sand; same as above
16	Silty Sand with Clay; medium to light grey, black clay nodules, moist
	Black clay confining layer "black creek formation"
	Boring terminated at 41.3 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



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LOG OF BORING: P3-5

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor: Derry's Well Drilling
Drill rig & method: 8.5" OD HSA
Logged by: J. Pfohl

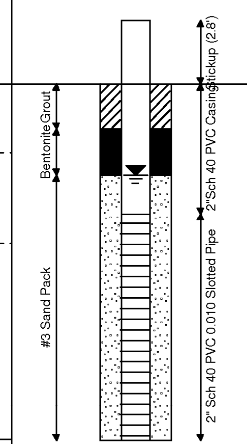
Date started: 10/1/2006
Date ended: 10/1/2006
Completion depth: 15.70 ft
Stickup height: 2.80 ft

Surface elevation: 151.51 ft (MSL)
Top of pipe elevation: 154.31 ft (MSL)
Depth to water (TOB): 4.00 ft
Depth to water (24hrs): 4.01 ft

Depth (ft)	SPT (bpf)	Description of Material & Remarks
0–3	16	Sand; tan, moist, medium dense with silt, fine grained, trace coarse
3–7	28	Clayey Sand; tan, mottled orange, wet, medium dense, trace silt, fine grained
7–13	32	Sandy Clay; gray and red, moist, hard, fine grained, trace silt
13–15.7	34	Sandy Clay; same as above, wet
15.7		Boring terminated at 15.7 feet

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



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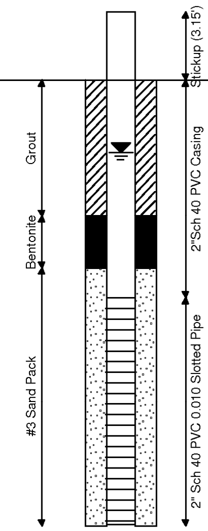
LOG OF BORING: P3-6S

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/18/2006	Surface elevation:	149.16 ft (MSL)
Drill rig & method:	8.5" OD HSA	Date ended:	9/18/2006	Top of pipe elevation:	152.31 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	19.59 ft	Depth to water (TOB):	3.50 ft
		Stickup height:	3.15 ft	Depth to water (24hrs):	3.16 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	15		X	Clayey Sand; light brown, medium grained sand interlayerd with grey orange cohesive clay, root debris, slightly micaceous, moist
	9		X	Silty Sand with Clay; moderate orange pink, fine grained sand with grey orange mottled clay, moist
5				
	6		X	Silty Sand; very light grey to white, poorly sorted, few mottled clay nodules, wet
10				
	16		X	Silty Sand; grey orange, fine grained, relict structure, slightly micaceous, moist
15				
	5		X	Silty Sand; grey orange, fine grained, slightly micaceous, saturated
20				Boring terminated at 19.6 feet
25				
30				
35				
40				
45				

Well Diagram



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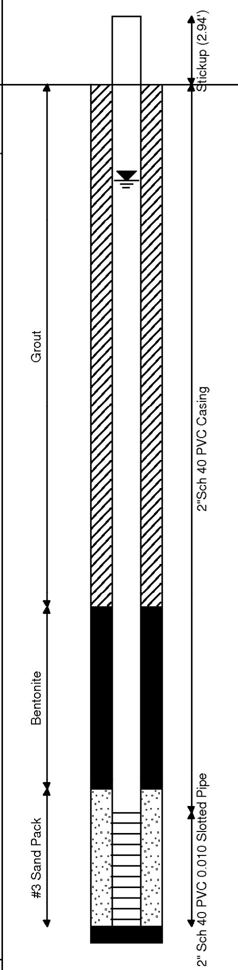
LOG OF BORING: P3-6D

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/27/2006	Surface elevation:	149.24 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/27/2006	Top of pipe elevation:	152.18 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	37.75 ft	Depth to water (TOB):	3.50 ft
		Stickup height:	2.94 ft	Depth to water (24hrs):	4.19 ft

Depth (ft)	SPT (bpf)	Description of Material & Remarks
	15	Clayey Sand; light brown, medium grained sand interlayerd with grey orange cohesive clay, root debris, slightly micaceous, moist
	9	Silty Sand with Clay; moderate orange pink, fine grained sand with grey orange mottled clay, moist
5		
	6	Silty Sand; very light grey to white, poorly sorted, few mottled clay nodules, wet
10		
	16	Silty Sand; grey orange, fine grained, relict structure, slightly micaceous, moist
15		
	5	Silty Sand; grey orange, fine grained, slightly micaceous, saturated
20		
	8	Silty Sand; same as above
25		
	8	Silty Sand; grey orange, fine grained sand with very pale orange silt interlayered, slightly micaceous, saturated
30		
	6	Silty Sand; same as above
35		Silty Sand with Clay; medium to light grey, black clay nodules
		hard black clay confining layer "black creek formation"
		Boring terminated at 37.8 feet
40		
45		

Well Diagram



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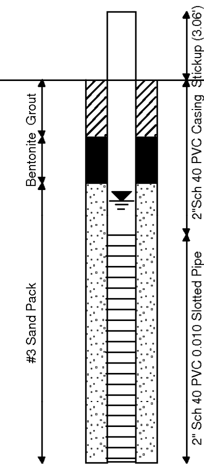
LOG OF BORING: P3-7

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/19/2006	Surface elevation:	153.80 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/19/2006	Top of pipe elevation:	156.86 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	16.83 ft	Depth to water (TOB):	5.00 ft
		Stickup height:	3.06 ft	Depth to water (24hrs):	5.30 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	10		X	Sandy Clay; moderate yellow brown and very pale orange mottled clay with fine to medium grained sand, few fine root fragments, cohesive, moist
	8		X	Sandy Silt; grey orange silt interlayered with fine grained very pale orange sand, few mottled clay nodules, moist
5				
	6		X	Silty Sand; very light grey to white, poorly graded, wet
10				
	6		X	Silty Sand; same as above, saturated
15				
				Boring terminated at 16.8 feet
20				
25				
30				
35				
40				
45				

Well Diagram



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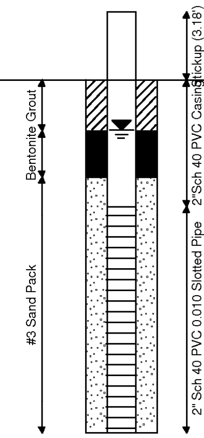
LOG OF BORING: P3-8

Wayne County Landfill, Phase 3 **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/18/2006	Surface elevation:	146.54 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/18/2006	Top of pipe elevation:	149.72 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	15.54 ft	Depth to water (TOB):	2.00 ft
		Stickup height:	3.18 ft	Depth to water (24hrs):	2.21 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	2			Silty Sand; moderate yellow brown, medium grained, trace dark grey organic top soil with roots, few cohesive clay nodules, moist
	12			Silty Sand; moderate red orange, interlayered with fine grained yellow orange, trace mottled cohesive clay nodules, wet
5				
	3			Silty Sand; grey orange, fine to medium grained, saturated
10				
	3			Silty Sand; very pale orange, fine to medium grained, saturated
15				
				Boring terminated at 15.5 feet
20				
25				
30				
35				
40				
45				

Well Diagram



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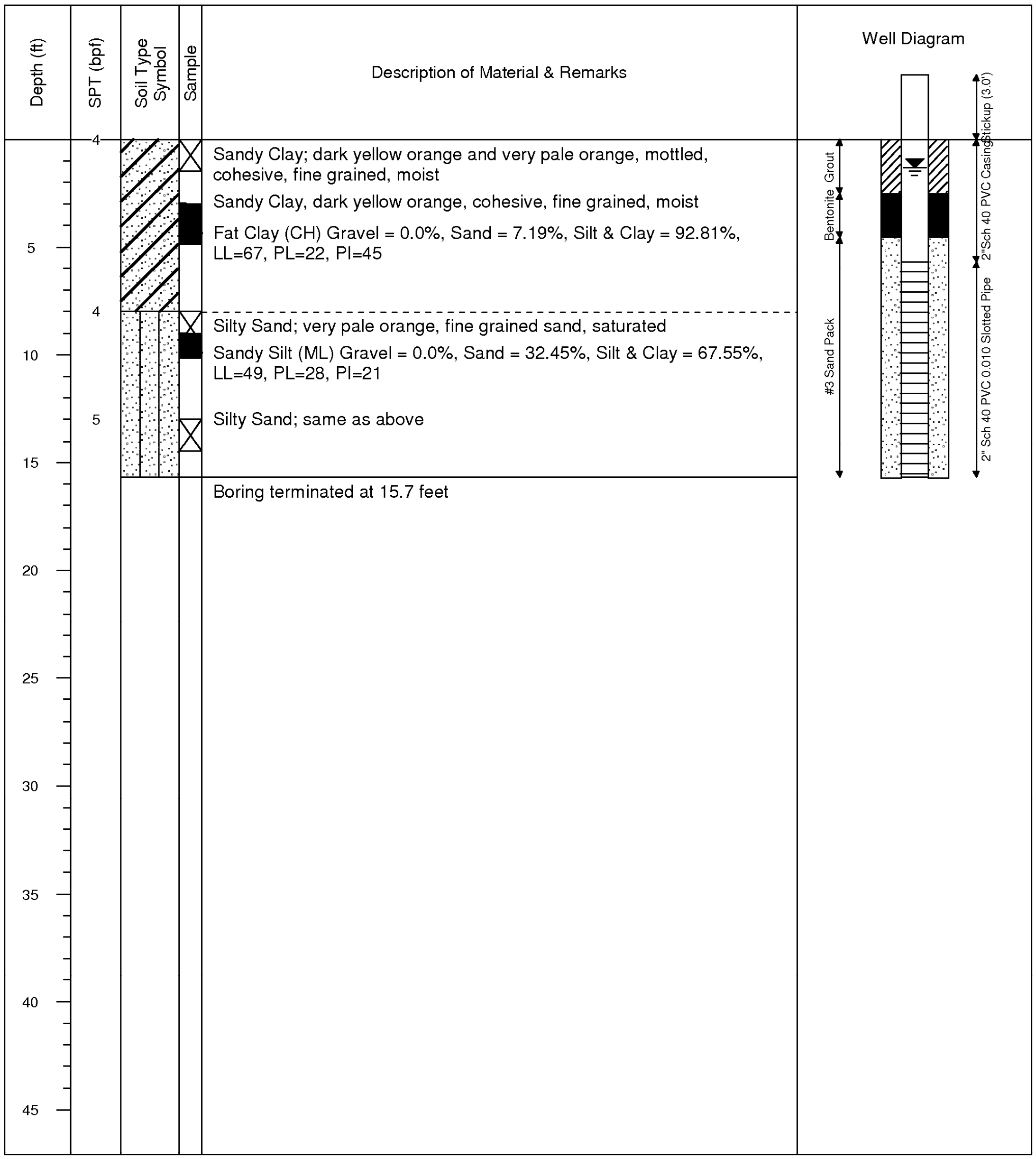
LOG OF BORING: P3-9

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor: Derry's Well Drilling
Drill rig & method: 8.5" OD HSA w/ S.S.
Logged by: J. Pfohl

Date started: 9/18/2006
Date ended: 9/18/2006
Completion depth: 15.67 ft
Stickup height: 3.08 ft

Surface elevation: 147.01 ft (MSL)
Top of pipe elevation: 150.09 ft (MSL)
Depth to water (TOB): 1.00 ft
Depth to water (24hrs): 1.30 ft



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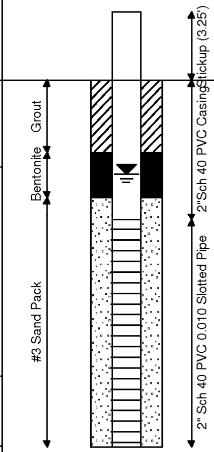
LOG OF BORING: P3-10S

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/11/2006	Surface elevation:	151.23 ft (MSL)
Drill rig & method:	8.5" OD HSA	Date ended:	9/11/2006	Top of pipe elevation:	154.48 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	16.12 ft	Depth to water (TOB):	4.00 ft
		Stickup height:	3.25 ft	Depth to water (24hrs):	4.12 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	3		X	Clayey Sand; moderately yellow brown, medium grained sand with pale yellow brown and light brown mottled clay nodules, few fine roots, relict structure, moist
5	4		X	Sandy Clay; moderately yellow brown and very pale orange, mottled, cohesive, fine grained, few root fragments, moist
10	8		X	Sandy Clay; moderately yellow brown and very pale orange, mottled, very cohesive, sand fine grained, moist
15	7		X	Silty Sand; very pale orange, fine grained, wet
20				Boring terminated at 16.1 feet
25				
30				
35				
40				
45				

Well Diagram



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LOG OF BORING: P3-10D

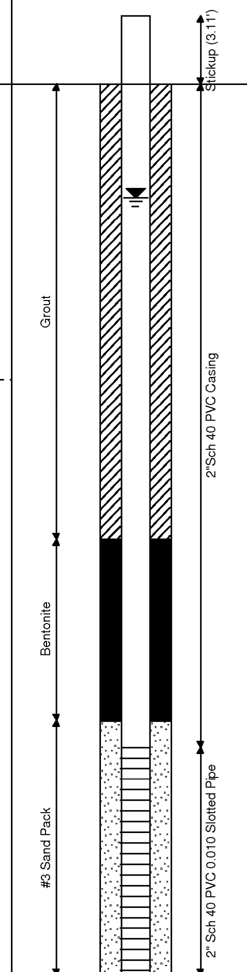
Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/27/2006	Surface elevation:	150.96 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/27/2006	Top of pipe elevation:	154.07 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	39.19 ft	Depth to water (TOB):	4.00 ft
		Stickup height:	3.11 ft	Depth to water (24hrs):	5.00 ft

SPT (bpf)	Description of Material & Remarks
3	Clayey Sand; moderately yellow brown, medium grained sand with pale yellow brown and light brown mottled clay nodules, few fine roots, relict structure, moist
4	Sandy Clay; moderately yellow brown and very pale orange, mottled, cohesive, fine grained, few root fragments, moist
8	Sandy Clay; moderately yellow brown and very pale orange, mottled, very cohesive, fine grained, moist
7	Silty Sand; very pale orange, fine grained, wet
5	Silty Sand with Clay; very pale orange, fine grained sand with moderate yellow brown and very pale orange morttled clay nodules, wet
12	Silty Sand; very pale orange, fine grained, saturaed
13	Silty Sand; same as above
11	Silty Sand; same as above
	Silty Sand with Clay; medium light grey, black clay nodules
	hard black clay confining layer "black creek formation"
	Boring terminated at 39.2 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



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LOG OF BORING: P3-11S

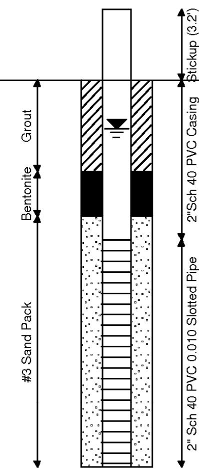
Wayne County Landfill, Phase 3 — **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/25/2006	Surface elevation:	146.53 ft (MSL)
Drill rig & method:	8.5" OD HSA	Date ended:	9/25/2006	Top of pipe elevation:	149.73 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	17.03 ft	Depth to water (TOB):	2.00 ft
		Stickup height:	3.20 ft	Depth to water (24hrs):	2.13 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
0	5		X	Silty Sand; dark yellow orange, trace clay, moist
3	4		X	Silty Sand; same as above
8	12		X	Silty Sand; grey orange, fine to medium grained, moist
13	7		X	Silty Sand; same as above
17				Boring terminated at 17.0 feet

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



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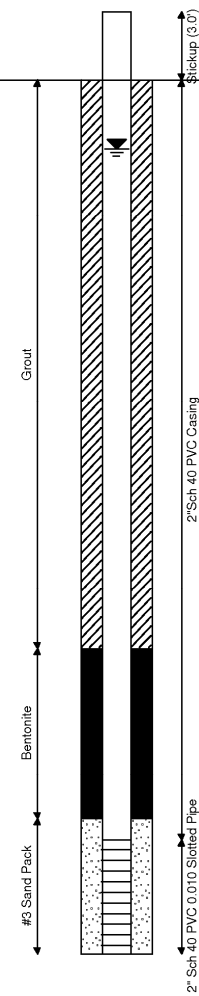
LOG OF BORING: P3-11D

Wayne County Landfill, Phase 3 — **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/11/2006	Surface elevation:	146.58 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/11/2006	Top of pipe elevation:	149.59 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	38.42 ft	Depth to water (TOB):	2.00 ft
		Stickup height:	3.01 ft	Depth to water (24hrs):	3.00 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	5		X	Silty Sand; dark yellow orange, trace clay, moist
	4		X	Silty Sand; same as above
5				
	12		X	Silty Sand; grey orange, fine to medium grained,moist
10				
	7		X	Silty Sand; same as above
15				
	7		X	Silty Sand; same as above, saturated
20				
	3		X	Silty Sand; grey orange, fine to medium grained, saturated
25				
	11		X	Silty Sand; grey orange, fine to medium grained, saturated
30				Silty Sand with Clay; grey to white, hard
	26		X	Silty Sand with Clay; moderate light grey, black clay nodules, moist
35				hard black clay confining layer "black creek formation"
				Boring terminated at 38.4 feet
40				
45				

Well Diagram



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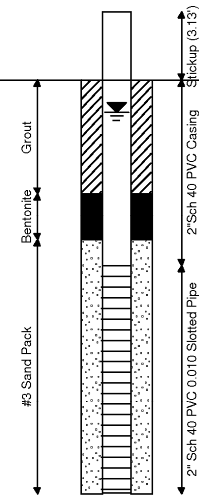
LOG OF BORING: P3-12

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/27/2006	Surface elevation:	143.46 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/27/2006	Top of pipe elevation:	146.59 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	18.18 ft	Depth to water (TOB):	1.00 ft
		Stickup height:	3.13 ft	Depth to water (24hrs):	1.40 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	6		X	Silty Sand; grey orange, poorly graded, fine to medium grained, trace root fragments, moist
	15		X	Silty Sand; moderate brown, medium grained, few round gravel size rock fragments, moist
5				
	7		X	Silty Sand; grey orange, fine grained sand with laminated very pale orange silt, wet
10				
	3		X	Silty Sand; very light grey to white, poorly graded, fine grained, saturated
15				
				Boring terminated at 18.2 feet
20				
25				
30				
35				
40				
45				

Well Diagram



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LOG OF BORING: P3-13

Wayne County Landfill, Phase 3 — **Project No. G06096.6**

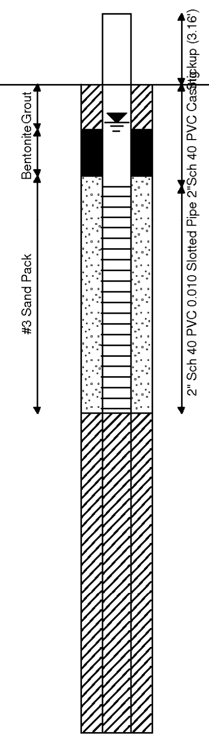
Drilling contractor:	Derry's Well Drilling	Date started:	9/26/2006	Surface elevation:	139.88 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/26/2006	Top of pipe elevation:	143.04 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	28.50 ft	Depth to water (TOB):	1.00 ft
		Stickup height:	3.16 ft	Depth to water (24hrs):	1.67 ft

SPT (bpf)	Description of Material & Remarks
8	Silty Sand; brown grey orange, fine to medium grained, trace root fragments, trace black organic silt partings, poorly graded, moist
7	Silty Sand; same as above
3	Silty Sand; grey orange, fine grained, poorly graded, wet
3	Silty Sand; very light grey to white, fine grained, poorly sorted, saturated
2	Silty Sand; no recovery, samples too saturated
5	Silty Sand; grey blue green, poorly graded, fine to medium grained, saturated Silty Sand with Clay
	Silty Sand; dark grey, confining layer Black Creek Formation
	Silty Sand (SM) Gravel = 2.36%, Sand = 79.12%, Silty & Clay = 18.52%, LL=40, PL=27, PI=13
	Boring terminated at 28.5 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Soil Type Symbol / Sample

Well Diagram



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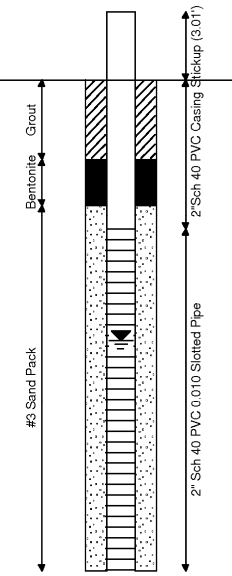
LOG OF BORING: P3-14

Wayne County Landfill, Phase 3 — **Project No. G06096.6**

Drilling contractor: Derry's Well Drilling	Date started: 9/19/2006	Surface elevation: 151.16 ft (MSL)
Drill rig & method: 8.5" OD HSA w/ S.S.	Date ended: 9/19/2006	Top of pipe elevation: 154.17 ft (MSL)
Logged by: J. Pfohl	Completion depth: 21.56 ft	Depth to water (TOB): 11.50 ft
	Stickup height: 3.01 ft	Depth to water (24hrs): 11.44 ft

Depth (ft)	SPT (bpf)	Description of Material & Remarks
0	7	Sandy Clay; light brown with dark yellow orange mottles, trace fine grained sand, very cohesive, root debris, moist
	29	Sandy Clay; light brown, trace fine grained sand, cohesive, moist
	11	Silty Sand; grey orange, fine grained sand, laminated with very pale orange silt, trace clay, moist
	10	Silty Sand; same as above without clay
	6	Silty Sand; grey orange, fine grained sand laminated with very pale orange silt, saturated
		Boring terminated at 21.6 feet

Well Diagram



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LOG OF BORING: P3-15S

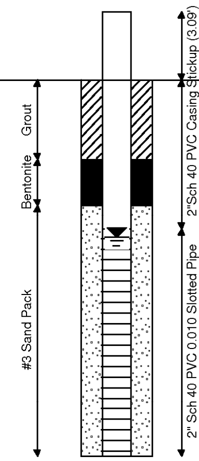
Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/21/2006	Surface elevation:	149.14 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/21/2006	Top of pipe elevation:	152.23 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	16.53 ft	Depth to water (TOB):	7.00 ft
		Stickup height:	3.09 ft	Depth to water (24hrs):	6.92 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
0	6		X	Silty Sand with Clay; dusky yellow brown, medium grained sand with organic top soil, root debris, trace grey orange clay, moist
3	24		X	Sandy Clay; moderate yellow brown, medium grained sand laminated with cohesive clay, moist
8	22		X	Silty Sand; grey orange, medium to coarse grained, micaceous, moist
13	6		X	Silty Sand; very light grey to white, fine to medium grained, moist
16.5				Boring terminated at 16.5 feet

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



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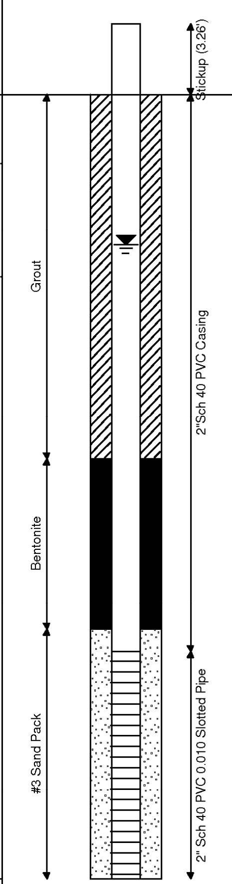
LOG OF BORING: P3-15D

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/22/2006	Surface elevation:	148.98 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/22/2006	Top of pipe elevation:	152.24 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	34.49 ft	Depth to water (TOB):	7.00 ft
		Stickup height:	3.26 ft	Depth to water (24hrs):	6.60 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	6		X	Silty Sand with Clay; dusky yellow brown, medium grained sand with organic top soil, root debris, trace grey orange clay, moist
5	24		X	Sandy Clay; moderate yellow brown, medium grained sand laminated with cohesive clay, moist
10	22		X	Silty Sand; grey orange, medium to coarse grained, micaceous, moist
15	6		X	Silty Sand; very light grey to white, fine to medium grained, moist
20	5		X	Silty Sand; same as above
25	3		X	Silty Sand; very light grey to white, fine grained, saturated
30	4		X	Silty Sand; same as above
35	25		X	Silty Sand with Clay; moderately light grey, black clay nodules, moist
40				Boring terminated at 34.5 feet
45				

Well Diagram



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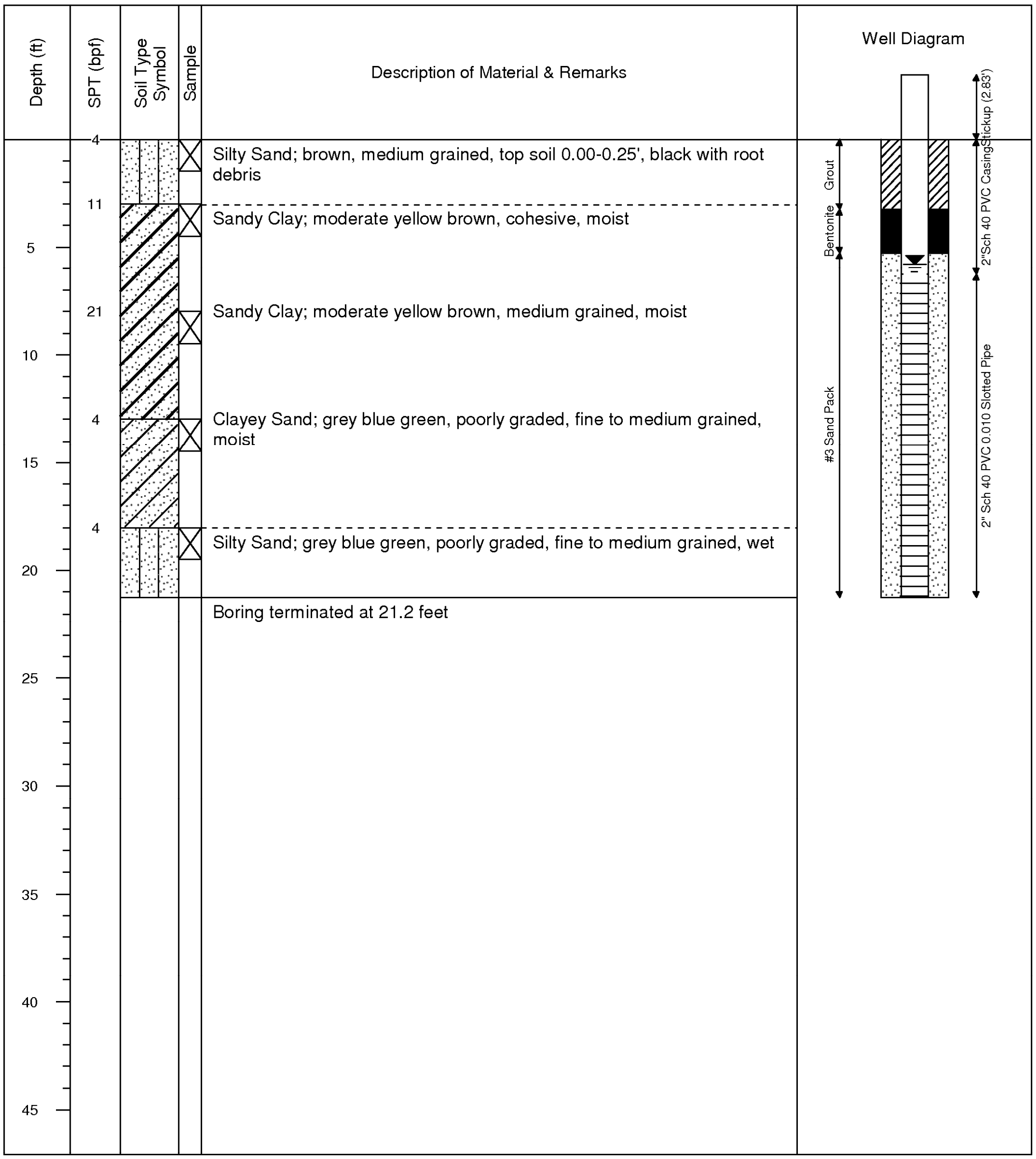
LOG OF BORING: P3-16

Wayne County Landfill, Phase 3 | **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/21/2006	Surface elevation:	134.68 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/21/2006	Top of pipe elevation:	137.51 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	21.24 ft	Depth to water (TOB):	8.50 ft
		Stickup height:	2.83 ft	Depth to water (24hrs):	5.78 ft

Depth (ft)	SPT (bpf)	Description of Material & Remarks
0	4	Silty Sand; brown, medium grained, top soil 0.00-0.25', black with root debris
	11	Sandy Clay; moderate yellow brown, cohesive, moist
	21	Sandy Clay; moderate yellow brown, medium grained, moist
	4	Clayey Sand; grey blue green, poorly graded, fine to medium grained, moist
	4	Silty Sand; grey blue green, poorly graded, fine to medium grained, wet
21.2		Boring terminated at 21.2 feet



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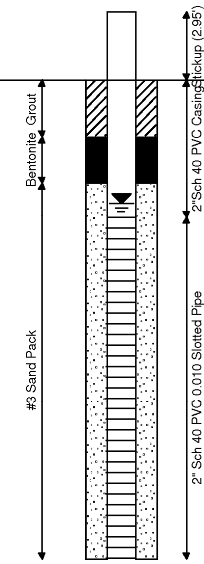
LOG OF BORING: P3-17

Wayne County Landfill, Phase 3 — **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/25/2006	Surface elevation:	140.37 ft (MSL)
Drill rig & method:	8.5" OD HSA w/ S.S.	Date ended:	9/25/2006	Top of pipe elevation:	143.32 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	21.05 ft	Depth to water (TOB):	10.00 ft
		Stickup height:	2.95 ft	Depth to water (24hrs):	5.43 ft

Depth (ft)	SPT (bpf)	Description of Material & Remarks
0	7	Sandy Clay; light brown with dark yellow orange, mottles, fine grained, cohesive, root debris, moist
	8	Sandy Clay; same as above without roots
5		
	12	Silty Sand; grey orange, fine grained sand laminated with very pale orange silt, trace clay, moist
10		
	10	Silty Sand; same as above but lacks clay
15		
	3	Silty Sand; very light grey to white, fine to medium grained, saturated
20		
		Boring terminated at 21.1 feet
25		
30		
35		
40		
45		

Well Diagram



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LOG OF BORING: P3-18S

Wayne County Landfill, Phase 3 **Project No. G06096.6**

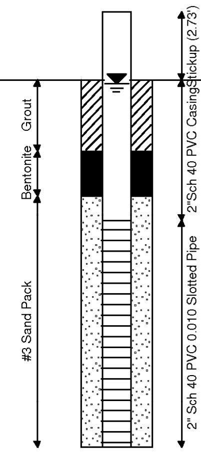
Drilling contractor: Derry's Well Drilling
Drill rig & method: 8.5" OD HSA w/ S.S.
Logged by: J. Pfohl

Date started: 9/26/2006
Date ended: 9/26/2006
Completion depth: 16.17 ft
Stickup height: 2.73 ft

Surface elevation: 129.01 ft (MSL)
Top of pipe elevation: 131.74 ft (MSL)
Depth to water (TOB): 0.50 ft
Depth to water (24hrs): 0.17 ft

Depth (ft)	SPT (bpf)	Soil Type Symbol	Sample	Description of Material & Remarks
	6			Top Soil; black organic soil, root debris, "creek mud", wet
	27			Silty Sand; grey green, medium grained, wet
5				
	7			Silty Sand; very light grey to white, fine grained, saturated
10				
	3			Silty Sand; same as above, saturated
15				
				Boring terminated at 16.2 feet
20				
25				
30				
35				
40				
45				

Well Diagram



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LOG OF BORING: P3-18D

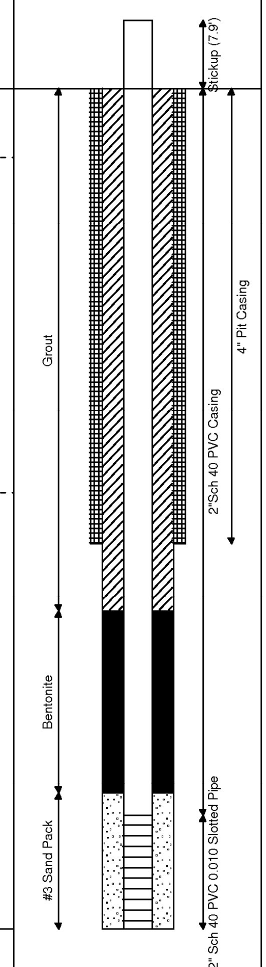
Wayne County Landfill, Phase 3 — **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/28/2006
Drill rig & method:	8.5"OD HSA w/S.S.,3 7/8"mud tricone	Date ended:	9/28/2006
Logged by:	J. Pfohl	Completion depth:	36.98 ft
		Stickup height:	7.90 ft

Surface elevation:	128.89 ft (MSL)
Top of pipe elevation:	136.79 ft (MSL)
Depth to water (TOB):	0.50 ft
Depth to water (24hrs):	-

SPT (bpf)	Description of Material & Remarks
6	Top Soil; black organic soil, root debris, "creek mud", wet
27	Silty Sand; grey green, medium grained, wet
7	Silty Sand; very light grey to white, fine grained, saturated
3	Silty Sand; same as above, saturated
85	Clay with Sand; black, very cohesive, abundant lignitic wood, very stiff, "black creek formation"
	extremely hard, black clay
	softer drilling with depth, more grey sand and less clay
	Boring terminated at 37.0 feet

Well Diagram



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LOG OF BORING: P3-19

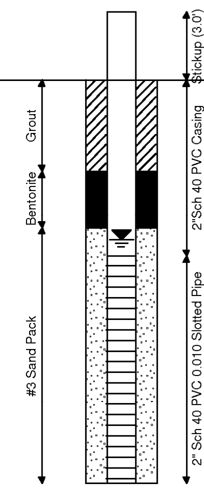
Wayne County Landfill, Phase 3 **Project No. G06096.6**

Drilling contractor:	Derry's Well Drilling	Date started:	9/30/2006	Surface elevation:	141.13 ft (MSL)
Drill rig & method:	8.5" OD HSA	Date ended:	9/30/2006	Top of pipe elevation:	144.13 ft (MSL)
Logged by:	J. Pfohl	Completion depth:	17.74 ft	Depth to water (TOB):	7.00 ft
		Stickup height:	3.00 ft	Depth to water (24hrs):	7.01 ft

SPT (bpf)	Description of Material & Remarks
13	Clayey Sand; orange, moist, medium dense with silt, fine grained
31	Clayey Sand; grades dense, increasing sand
10	Sand; tan and white, saturated, fine grained
28	Sand; grades orange, moderately dense, increasing silt
	Boring terminated at 17.7 feet

Depth (ft): 5, 10, 15, 20, 25, 30, 35, 40, 45

Well Diagram



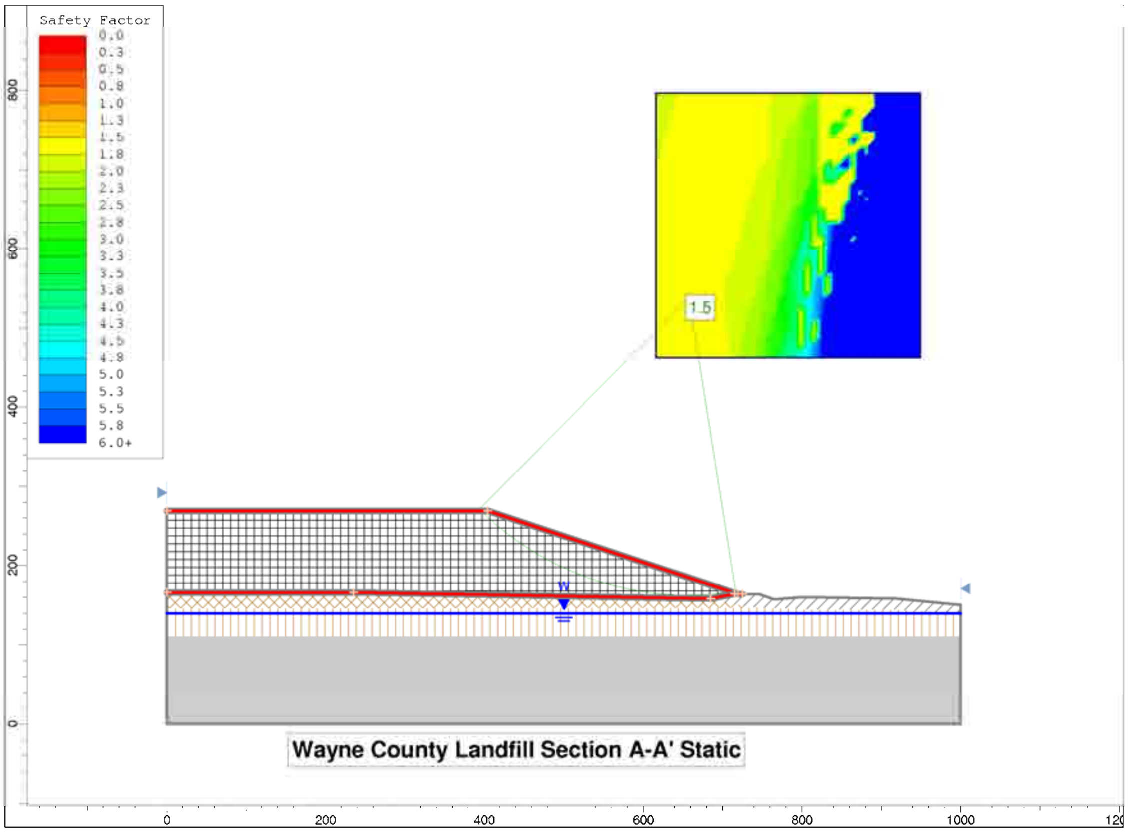
Municipal Engineering Services Company, P.A.
Operation/Construction Managers Civil/Sanitary Engineers Environmental Studies
PO Box 97, Garner, North Carolina 27529 (919) 772-5393 PO Box 349, Boone, North Carolina 28607 (828) 262-1767

APPENDIX B

SLOPE STABILITY ANALYSES RESULTS

Material Property Legend

Soil Layer/Material	Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)
Waste	70	20	200
Protective Soil	125	30	0
Clay Liner	125	20	400
Fill: Silty Sand	130	34	150
Sandy to Silty CLAY	115	20	400
Silty SAND	125	32	150
Black Creek Clay	130	20	800
HDPE Liner, LLDPE Liner, & Drainage Net	-	26	0
Geosynthetic Clay Liner	-	21	0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4.8
5.0
5.3
5.5
5.8
6.0+
1.5
W
Wayne County Landfill Section A-A' Static
0
200
400
600
800
1000

Slide Analysis Information

Document Name

File Name: Section A-A' Static.sli

Project Settings

Project Title: Wayne County Landfill Section A-A' Static
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: Waste
Strength Type: Mohr-Coulomb
Unit Weight: 70 lb/ft3
Cohesion: 200 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay Liner
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 400 psf

Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 0

Material: Fill: Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 130 lb/ft3
Cohesion: 150 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unit Weight: 115 lb/ft3
Cohesion: 400 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Black Creek Clay
Strength Type: Mohr-Coulomb
Unit Weight: 130 lb/ft3
Cohesion: 800 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Protective
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1

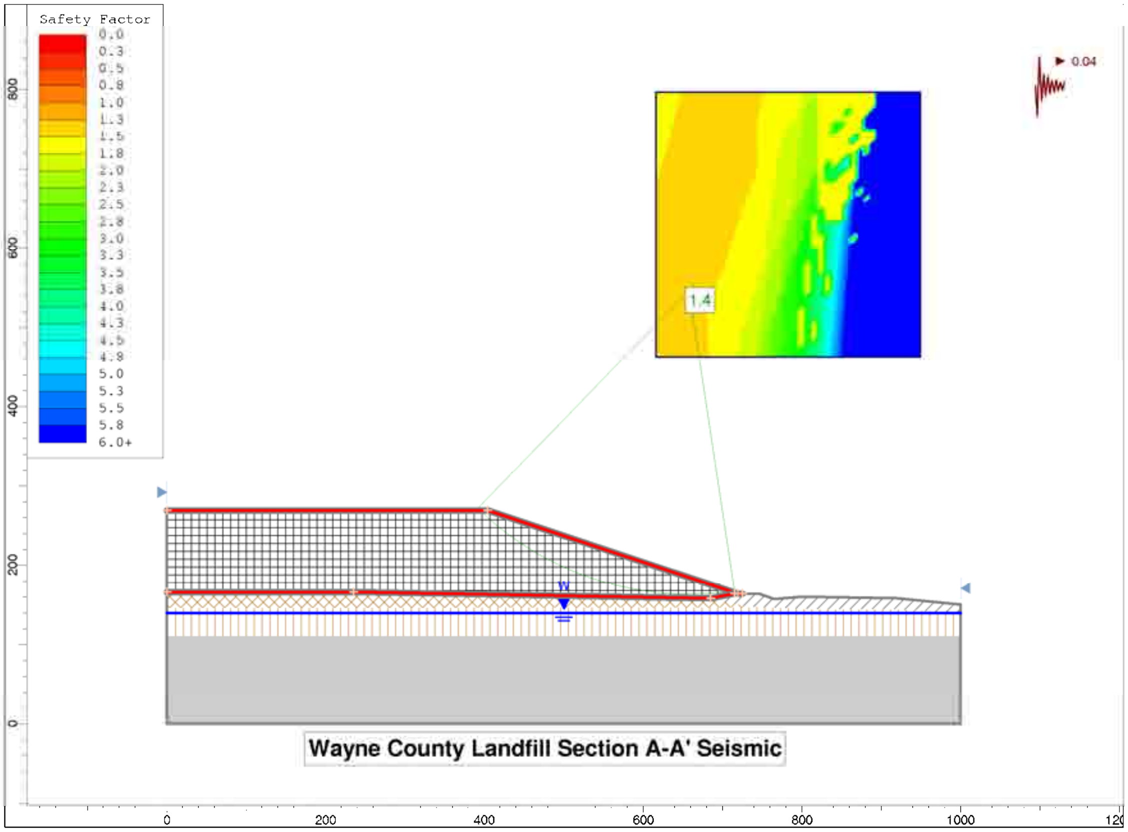
Support Properties

Support: Liner and Drainage Net (Frict Angle = 26)
Liner and Drainage Net (Frict Angle = 26)
Support Type: GeoTextile
Force Application: Passive
Force Orientation: Bisector of Parallel and Tangent
Anchorage: None
Shear Strength Model: Linear
Strip Coverage: 100 percent
Tensile Strength: 0 lb/ft
Pullout Strength Adhesion: 0 lb/ft2

Pullout Strength Friction Angle: 26 degrees

Global Minimums

Method: bishop simplified
FS: 1.539300
Center: 657.682, 537.565
Radius: 375.425
Left Slip Surface Endpoint: 393.321, 271.000
Right Slip Surface Endpoint: 716.615, 166.795
Resisting Moment=1.26393e+008 lb-ft
Driving Moment=8.21108e+007 lb-ft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5.3
5.5
5.8
6.0+
0.04
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600
800
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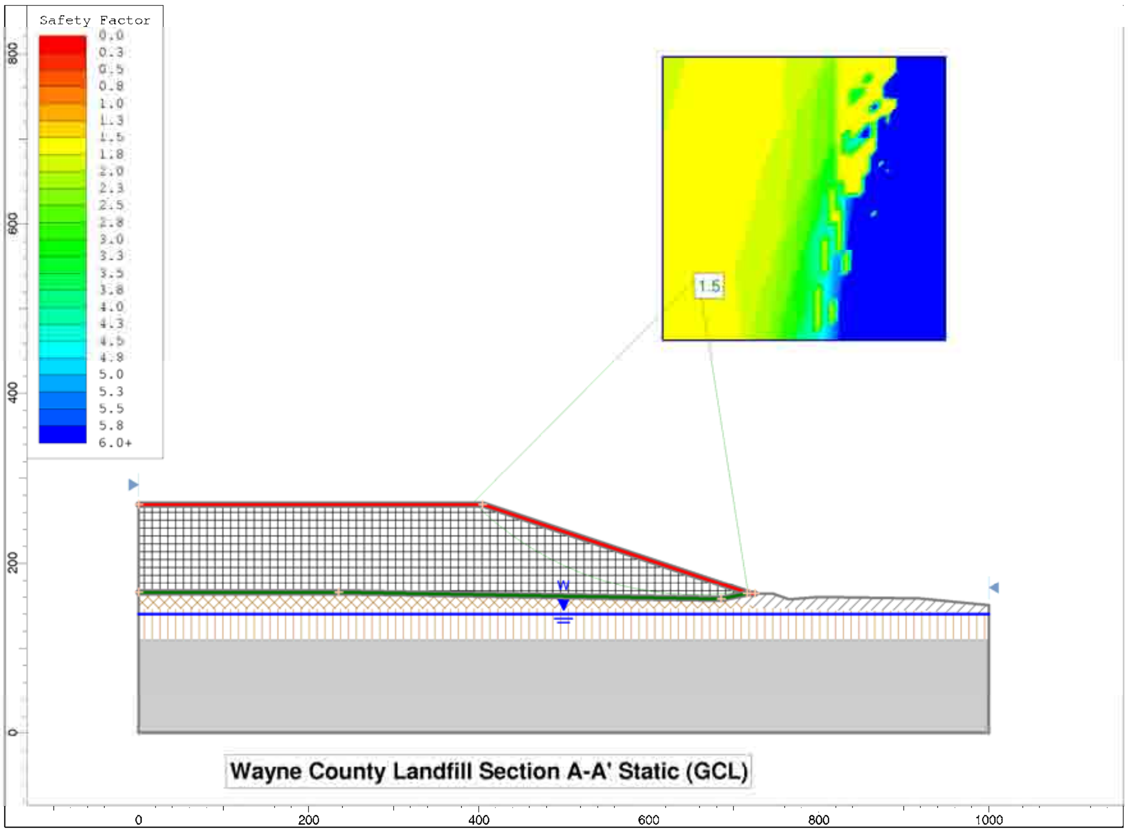
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4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+
1.5
W
Wayne County Landfill Section A-A' Static (GCL)
0
200
400
600
800
1000

Slide Analysis Information

Document Name

File Name: Section A-A' Static GCL.sli

Project Settings

Project Title: Wayne County Landfill Section A-A' Static (GCL)
Failure Direction: Left to Right
Units of Measurement: Imperial Units
Pore Fluid Unit Weight: 62.4 lb/ft3
Groundwater Method: Water Surfaces
Data Output: Standard
Calculate Excess Pore Pressure: Off
Allow Ru with Water Surfaces or Grids: Off
Random Numbers: Pseudo-random Seed
Random Number Seed: 10116
Random Number Generation Method: Park and Miller v.3

Analysis Methods

Analysis Methods used:
Bishop simplified

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Grid Search
Radius increment: 10
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Material: Waste
Strength Type: Mohr-Coulomb
Unit Weight: 70 lb/ft3
Cohesion: 200 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay Liner
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3

Cohesion: 400 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 0

Material: Fill: Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 130 lb/ft3
Cohesion: 150 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Clay
Strength Type: Mohr-Coulomb
Unit Weight: 115 lb/ft3
Cohesion: 400 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 150 psf
Friction Angle: 32 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Black Creek Clay
Strength Type: Mohr-Coulomb
Unit Weight: 130 lb/ft3
Cohesion: 800 psf
Friction Angle: 20 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Protective
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 30 degrees
Water Surface: Water Table
Custom Hu value: 1

Support Properties

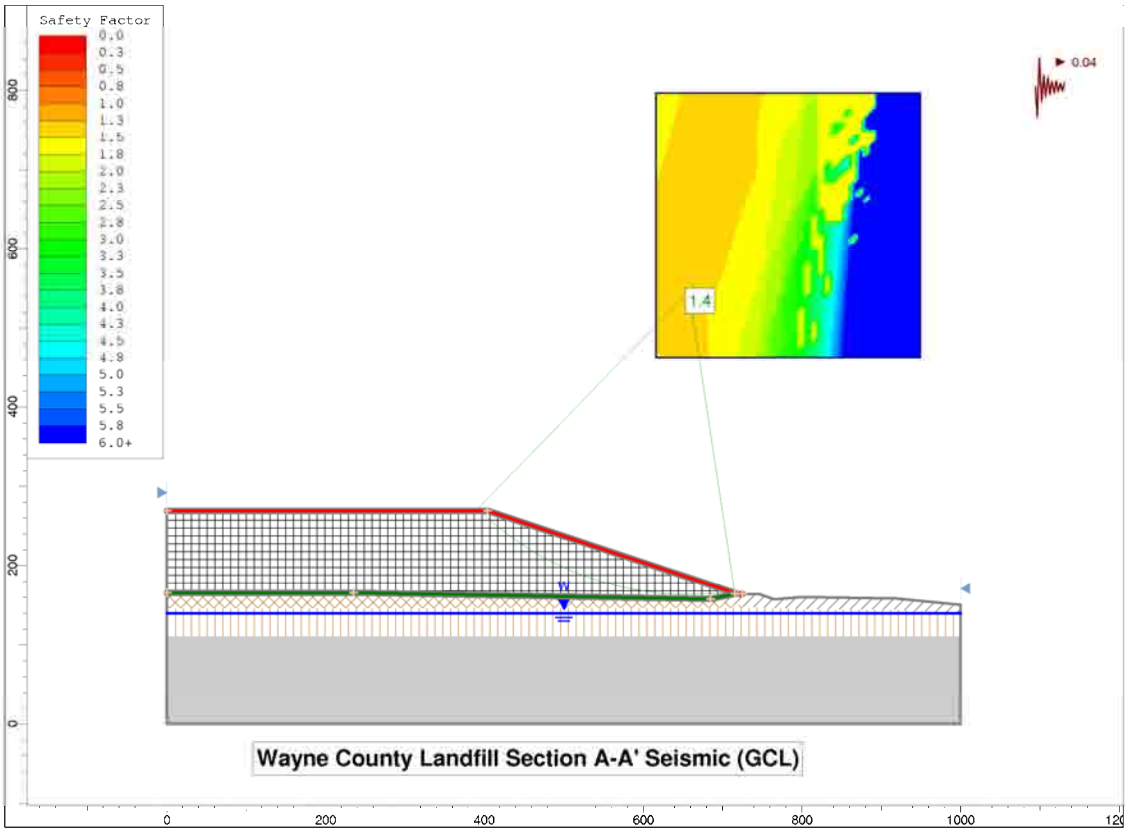
Support: Liner and Drainage Net (Frict Angle = 26)
Liner and Drainage Net (Frict Angle = 26)
Support Type: GeoTextile
Force Application: Passive
Force Orientation: Bisector of Parallel and Tangent
Anchorage: None
Shear Strength Model: Linear
Strip Coverage: 100 percent
Tensile Strength: 0 lb/ft

Pullout Strength Adhesion: 0 lb/ft2
Pullout Strength Friction Angle: 26 degrees

Support: GCL (Frict Angle = 21)
GCL (Frict Angle = 21)
Support Type: GeoTextile
Force Application: Passive
Force Orientation: Bisector of Parallel and Tangent
Anchorage: None
Shear Strength Model: Linear
Strip Coverage: 100 percent
Tensile Strength: 0 lb/ft
Pullout Strength Adhesion: 0 lb/ft2
Pullout Strength Friction Angle: 21 degrees

Global Minimums

Method: bishop simplified
FS: 1.539300
Center: 657.682, 537.565
Radius: 375.425
Left Slip Surface Endpoint: 393.321, 271.000
Right Slip Surface Endpoint: 716.615, 166.795
Resisting Moment=1.26393e+008 lb-ft
Driving Moment=8.21108e+007 lb-ft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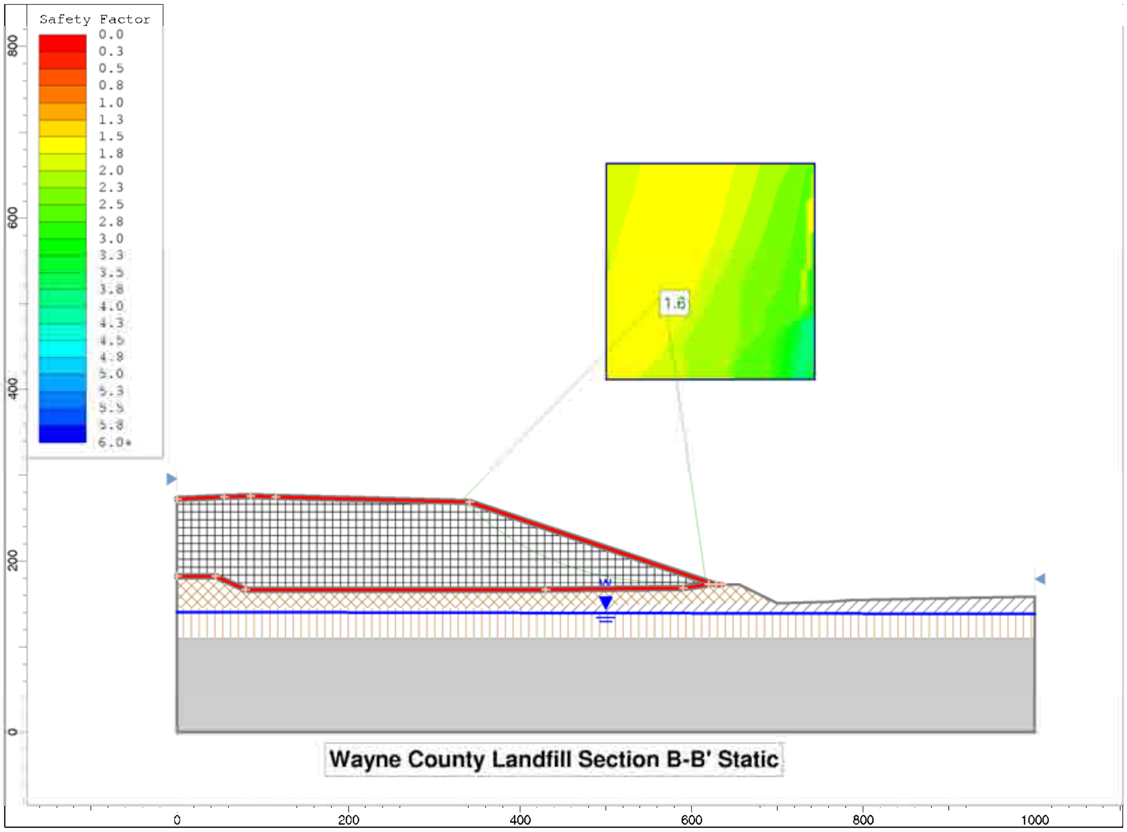
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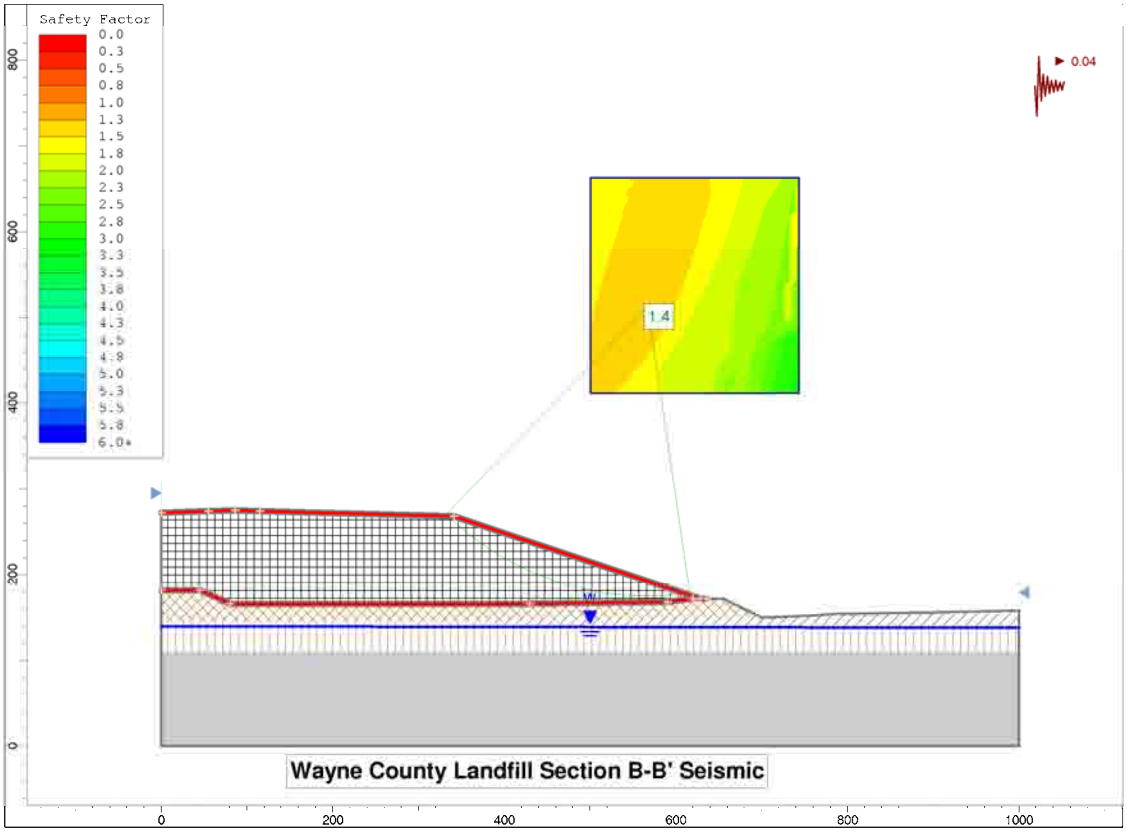
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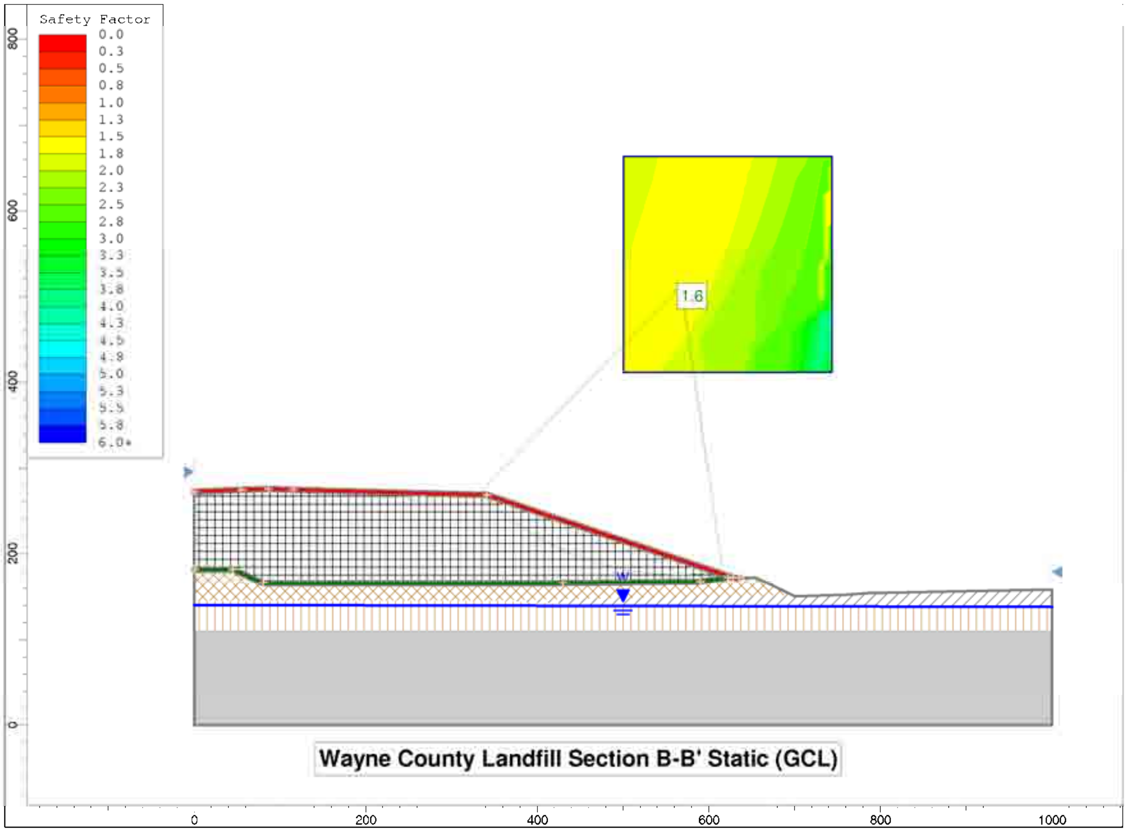
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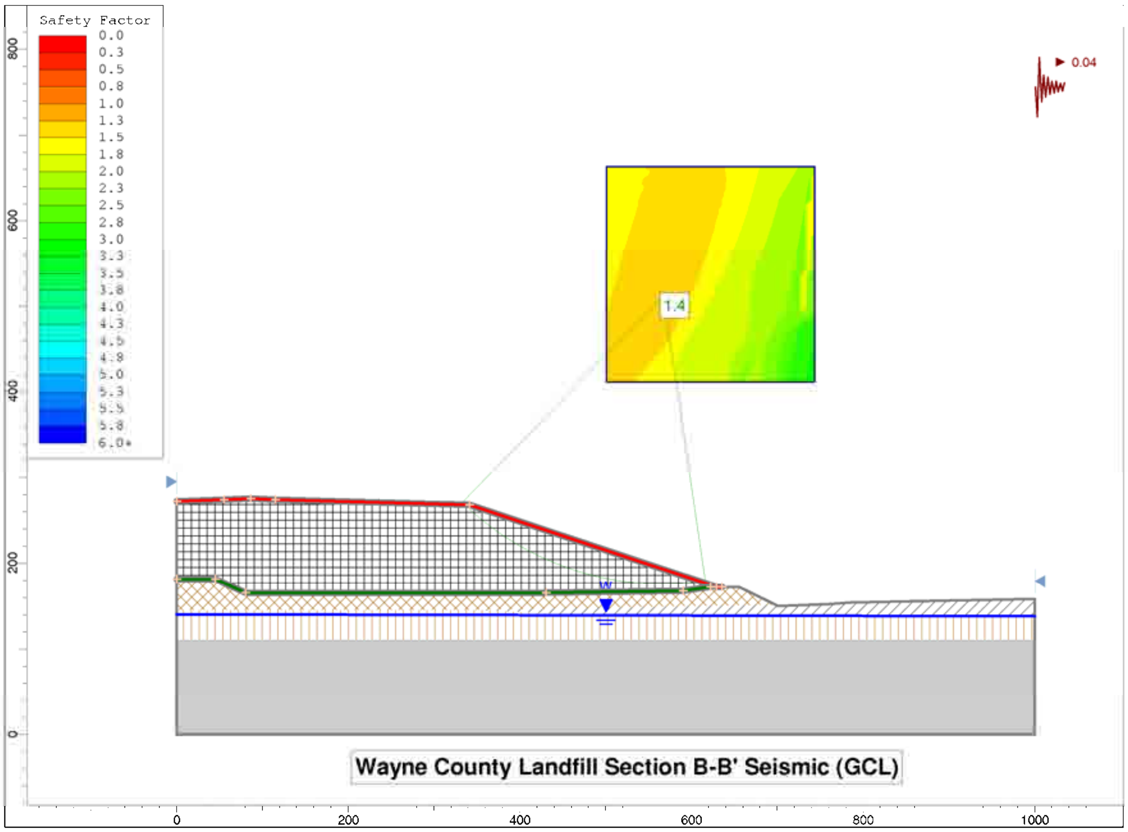
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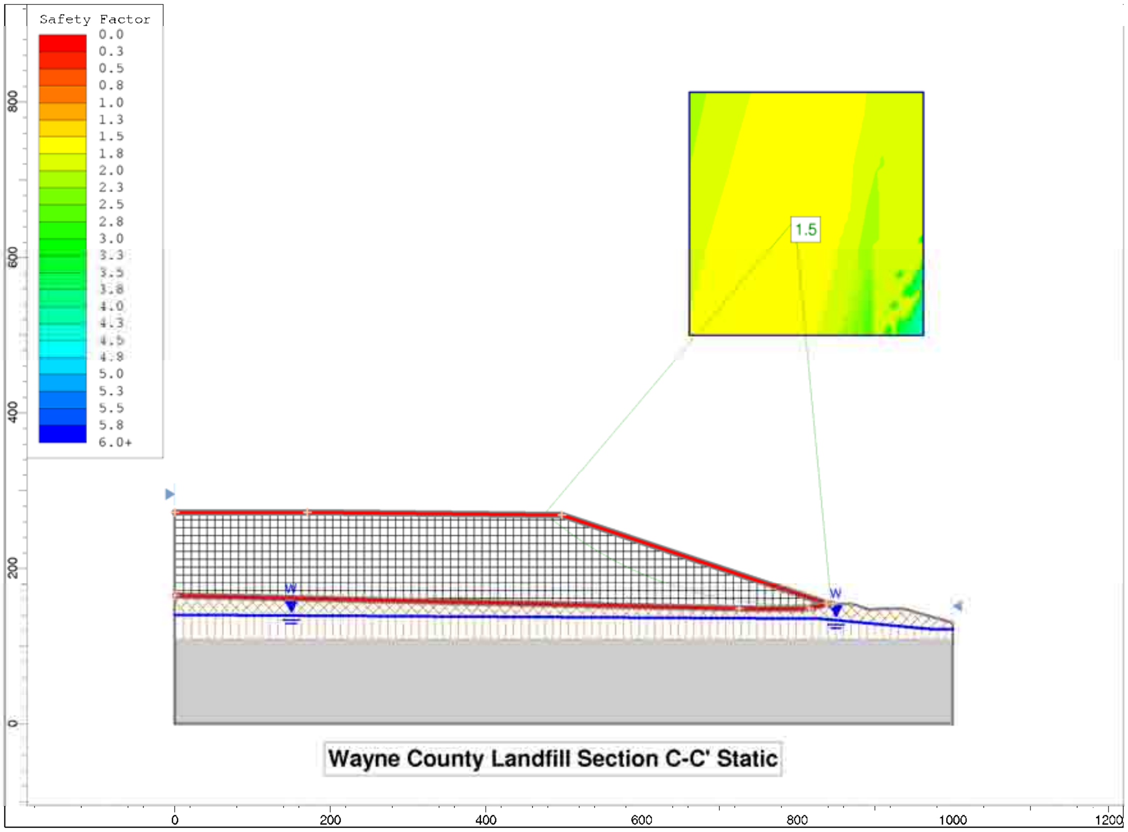
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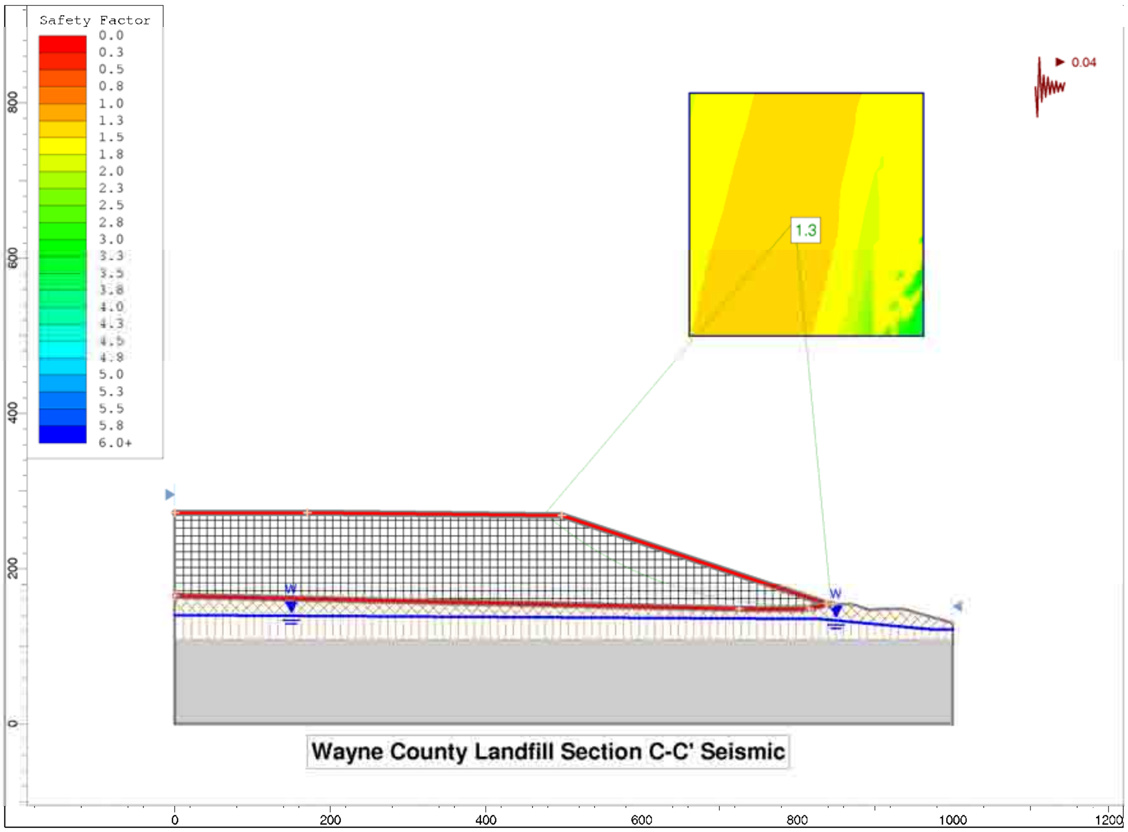
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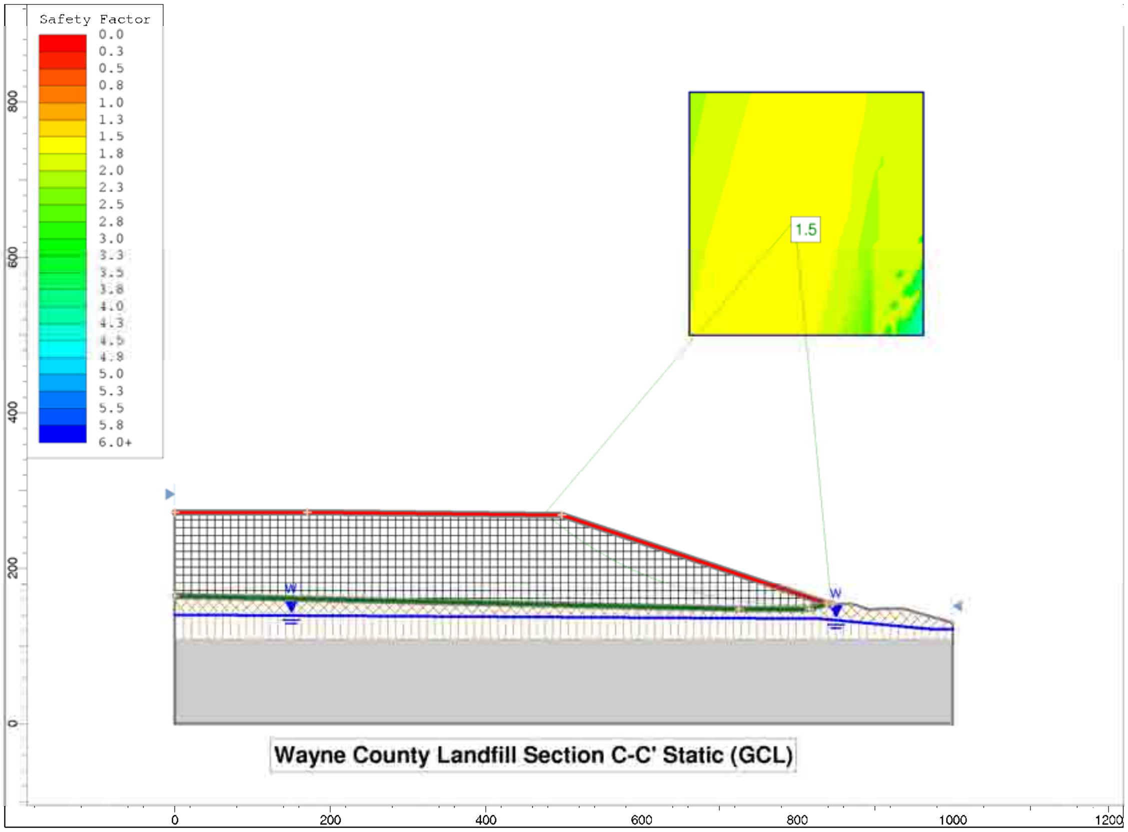
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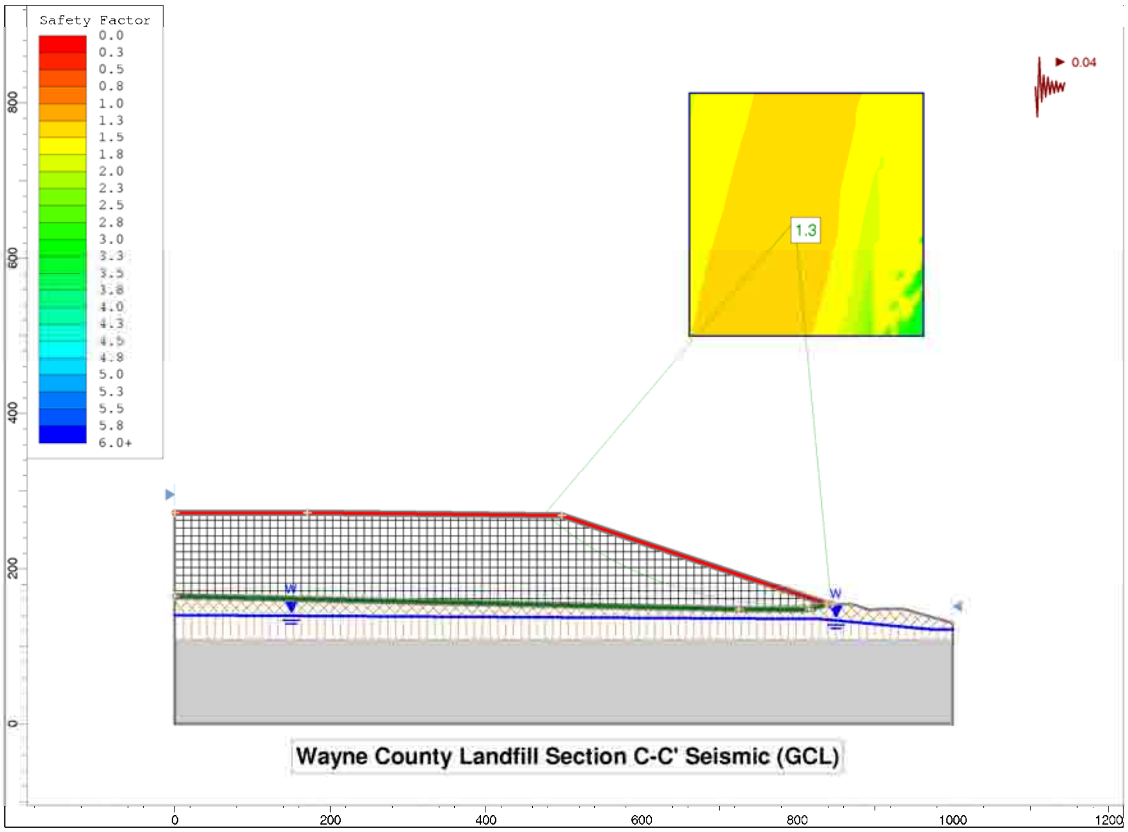
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W
Wayne County Landfill Section C-C' Seismic (GCL)
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200
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2.2.9 Capping Materials

Geosynthetic capping materials consist of textured 40 mil. LLDPE liner and 250 mil. double bonded drainage net.

Check Sliding Forces of Soil Cover and Geonet

F.S. = $(\tan\delta)\div(\tan\beta)$
δ = Friction Angle = 26° for soil to double bonded geonet
= 24° for double bonded geonet to textured liner
β = Slope Angle = 4:1 slope = 14.036°

F.S. = $(\tan\delta)\div(\tan\beta)$ (Soil and Geonet)
= (tan 26°)÷(tan18.418°)
= 1.95 > 1 ∴ O.K.

F.S. = $(\tan\delta)\div(\tan\beta)$ (Geonet and Liner)
= (tan 24°)÷(tan18.418°)
= 1.78 > 1 ∴ O.K.

Transmissivity of Drainage Net

Transmissivity (θ) = permeability (k) x saturated thickness (t)

Darcy's Law

Q= k I A
A = t x 1 ft. unit width

Q = θ/t x i x t

Q = θ x i

Q = 0.00001 $m^{2/}$sec x 10.764 ft^2/m^2 x 5ft./100.ft./100 ft.(5% slope for 100 ft.)
= 0.0005 $ft.^3$/sec./ft.

Peak daily drainage from HELP Model for 5 years thru drainage net (layer 2) is 2,323 $ft.^3$/acre
Total area of the capped landfill is approximately 60 acres = 2,613,600 $ft.^2$
Total Peak Daily Flow = 139,380 $ft.^3$

100 $ft.^2$ of drainage net = 0.0005 $ft.^3$/sec.
2,613,600 $ft.^2$/100 $ft.^2$ x 0.0005 $ft.^3$/sec.= 13.1 $ft.^3$/sec.
Drainage net at minimum slope of 5% over the entire foot print will drain the Peak Daily Volume in less than 3 hrs..

139,380 $ft.^3$/13.1 $ft.^3$/sec = 10,640 sec. = 177 mins. = 3hrs.

Creep in the geonet composite is not considered because there is only two feet of soil over the geonet.

2.2.10 Technical References

1. "Lining of Waste Impoundment and Disposal Facilities", (U.S.) Environmental Protection Agency, March 1983.

2. "NSF International (NSF) Standard 54 Flexible Membrane Liner", The NSF Joint Committee on Flexible Membrane Liners, 1991.

3. "Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments", S & M E Inc. for the USEPA, December 1987, pgs EPA III-21 to EPA III-49.

4. James K. Mitchell, Raymond B. Seed, and H. Bolton Seed, "Kettleman Hill Waste Landfill Slope Failure I: Liner-System Properties" in Journal of Geotechnical Engineering, April 1 1990, pgs 647-668.

5. Design, Construction and Monitoring of Landfills, Second Edition, Amalendu Bagchi, Wisconsin Department of Natural Resources, Pages 178- 238.

2.2.11 Applicable Location Restriction Demonstrations

All location restrictions, if any, were handled in the site study with the exception of the seismic impact zone. See map in this section.

The County Landfill is located in a seismic impact zone, all safety factors have been applied to insure site stability.

There are no other features that impact the site.

2.3 Engineering Drawings

2.3.1 Title Sheet
2.3.2 Index and Vicinity Map
2.3.3 Existing Conditions
2.3.4 Stage 1 Erosion Control Plan
2.3.5 Stage 2 Erosion Control Plan
2.3.6 Erosion Control Details
2.3.7 Erosion Control Details
2.3.8 Proposed Subgrade
2.3.9 Top of Cohesive Soil Liner
2.3.10 Top of Protective Cover
2.3.11 Leachate Collection System
2.3.12 Initial Placement of Waste
2.3.13 Final Fill and Methane Venting System
2.3.14 Operation Details
2.3.15 Baseline Profile and Cross Sections
2.3.16 Construction Details
2.3.17 Sump, Pump, Riser, Pad and Details

WAYNE COUNTY
MUNICIPAL SOLID WASTE
LANDFILL FACILITY

ENGINEERING PLAN - PHASE 3

Permit Number: 96-06

Site Location: 460 B South Landfill Road
Dudley, NC 28333

Applicant: Wayne County

Applicant's Address: 224 E. Walnut St., 3rd Floor
Goldsboro, NC 27530

BOARD OF COMMISSIONERS

C. Munroe "Jack" Best, Jr - Chairman
J.D. Evans - Vice-Chairman
Roland M. "Bud" Gray
Wilbur E. "Andy" Anderson
John M. Bell
Steve Keen
Dr. Sandra McCullen

COUNTY MANAGER

William "Lee" Smith, III

SOLID WASTE DIRECTOR

Tim Rogers

Engineer

Municipal Engineering Services Company, P.A.
Garner, NC - Morehead City, NC - Boone, NC

NORTH CAROLINA PROFESSIONAL SEAL 5282 ENGINEER JIMMY D. WOODIE
9/1/2011

by ______________________
Professional Engineer
(Garner Office)

LICENSE NUMBER: C-0281
Municipal Services Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

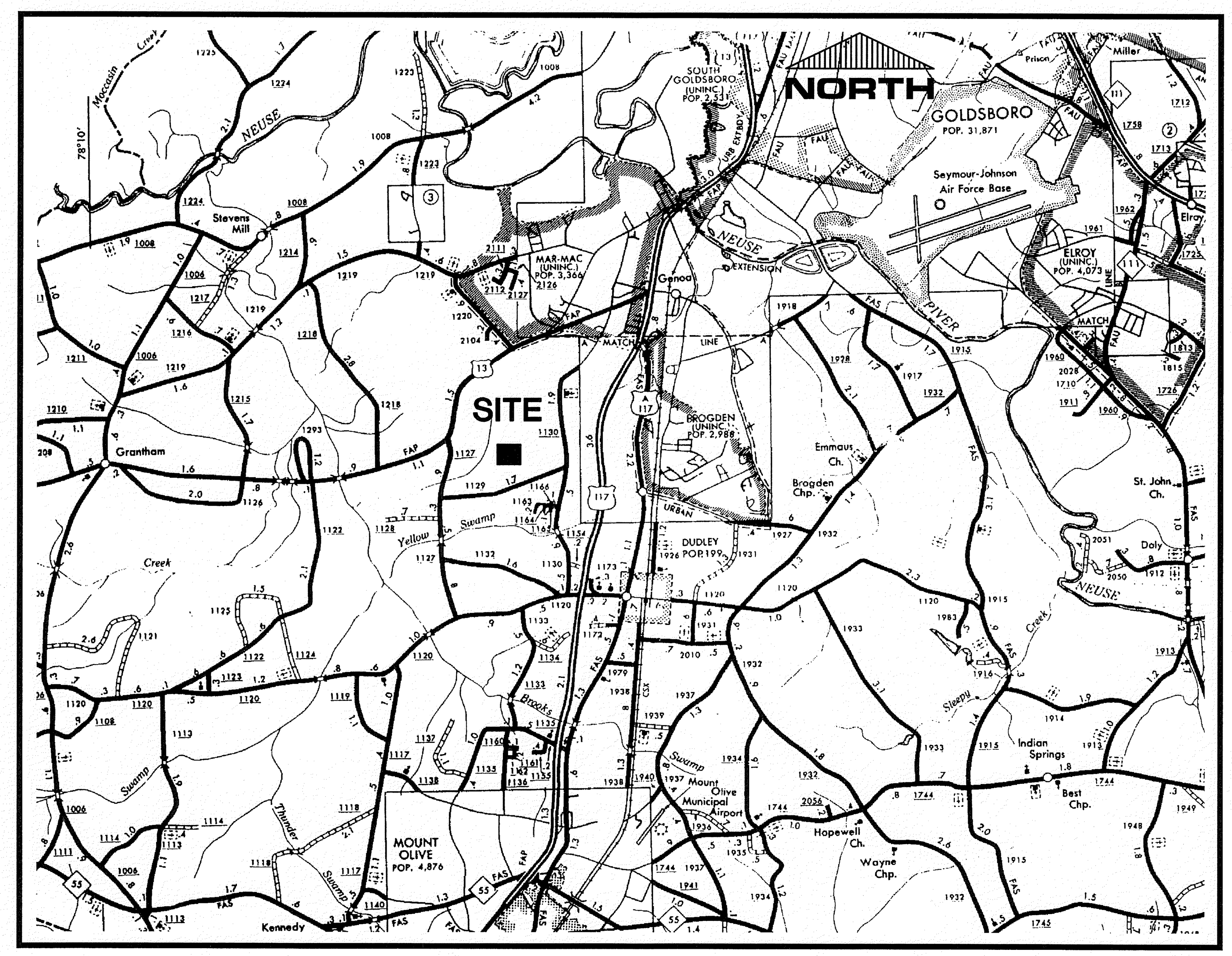
DATE	BY	REV.	DESCRIPTION
1/12/2011	LHC	1	NO REVISIONS TO THIS SHEET
3/17/2011	LHC	2	NO REVISIONS TO THIS SHEET

SCALE: 1:1
DATE: 3/11/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER: G06096
DRAWING NO.: T1
SHEET NO.: 1 OF 17

P:\SolidWaste\G06096 – Wayne Co. PTC Ph.3\dwg\engineering\G6096E-01.dwg, 4/1/2011 8:35:19 AM, lch,lch

INDEX

SHEET NO.	DRAWING NO.	DESCRIPTION
1	T1	TITLE SHEET
2	T2	INDEX AND VICINITY MAP
3	E1	EXISTING CONDITIONS
4	E2	STAGE 1 EROSION CONTROL PLAN (CLEARING AND GRUBBING)
5	E3	STAGE 2 EROSION CONTROL PLAN (LANDFILL CONSTRUCTION)
6	E4	EROSION CONTROL DETAILS
7	E5	EROSION CONTROL DETAILS
8	E6	PROPOSED SUBGRADE
9	E7	TOP OF COHESIVE SOIL LINER
10	E8	TOP OF PROTECTIVE COVER
11	E9	LEACHATE COLLECTION SYSTEM
12	E10	INITAL PLACEMENT OF WASTE AND STORMWATER DIVERSION
13	E11	FINAL FILL WITH EXIST. AND PROP. GAS COLLECTION WELLS
14	E12	OPERATION DETAILS
15	E13	BASELINE PROFILE AND CROSS SECTIONS
16	E14	CONSTRUCTION DETAILS
17	E15	SUMP, PUMP, RISER, PAD AND DETAILS



VICINITY MAP

LICENSE NUMBER: C-0281

Municipal Services Engineering Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393

P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	NO REVISIONS TO THIS SHEET
1/12/2011	LCH	2	NO REVISIONS TO THIS SHEET
11/1/2010	LCH	1	REVISED INDEX

ENGINEERING PLAN - PHASE 3
INDEX AND VICINITY MAP

SCALE: 1:1
DATE: 3/11/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE

PROJECT NUMBER: G06096

DRAWING NO.: T2
SHEET NO.: 2 OF 17

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 8282 JIMMY D. WOODIE

4/1/2011

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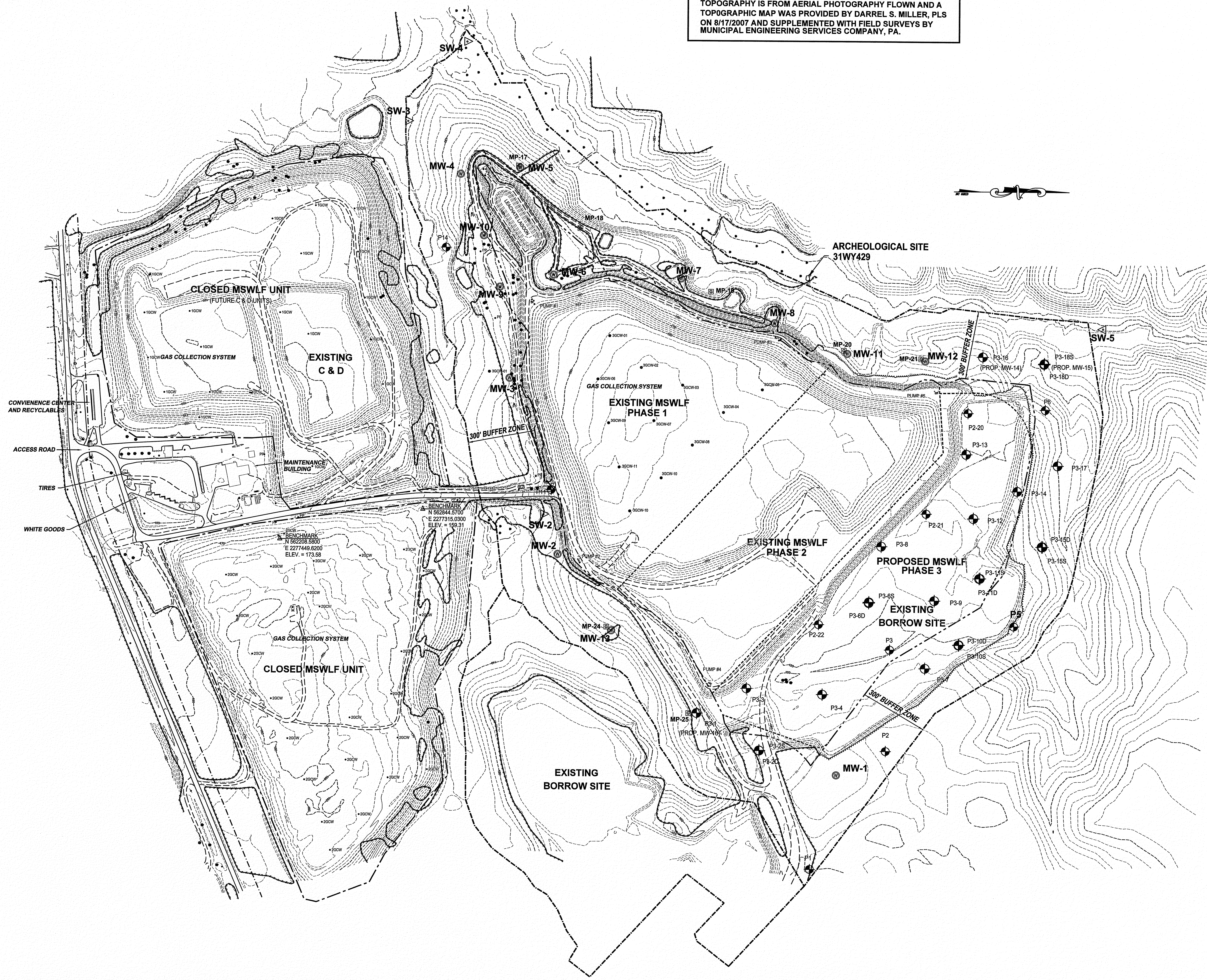
TOPOGRAPHY IS FROM AERIAL PHOTOGRAPHY FLOWN AND A TOPOGRAPHIC MAP WAS PROVIDED BY DARREL S. MILLER, PLS ON 8/17/2007 AND SUPPLEMENTED WITH FIELD SURVEYS BY MUNICIPAL ENGINEERING SERVICES COMPANY, PA.



LEGEND

- - - - - -	EXISTING CONTOURS
— - — - —	PROPERTY LINE
= = = = = =	EXISTING UNPAVED ROAD
— · — · —	EXISTING CREEK, STREAM, ETC.
— · · — · ·	EXISTING DIVERSION DITCHES
— - - —	CLOSED MSWLF SANITARY UNIT
— — —	300' BUFFER ZONE
- - - -	MSWLF PHASE LIMITS
—x—x—	EXISTING CHAINLINK FENCE
	TREE LINE (AERIAL MAPPING)
	TREE LINE (SURVEYED)
	TREES/SHRUBS
• 3GCW-04	EXISTING GAS COLLECTION WELL
• PP	POWER POLE
MP-11	EXISTING METHANE MONITORING PROBE
P3-17	EXISTING PIEZOMETERS
P3-17 (PROP. MW-14)	PROPOSED MONITORING WELL LOCATION
MW-12	EXISTING MONITORING WELL LOCATION
SW-4	SURFACE WATER SAMPLING POINT

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
5/19/2011	LHC	4	REVISED EXIST. METHANE PROBE LOCATIONS
3/17/2011	LHC	3	NO REVISIONS TO THIS SHEET
1/12/2011	LHC	2	ADDED EXISITNG AND PROPOSED MONITORING WELLS
11/1/2010	LCH	1	REVISED GAS COLLECTION WELLS

ENGINEERING PLAN – PHASE 3 EXISTING CONDITIONS

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

5/19/2011

SCALE:	1" = 200'
DATE:	12/16/08
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. E1	SHEET NO. 3 OF 17

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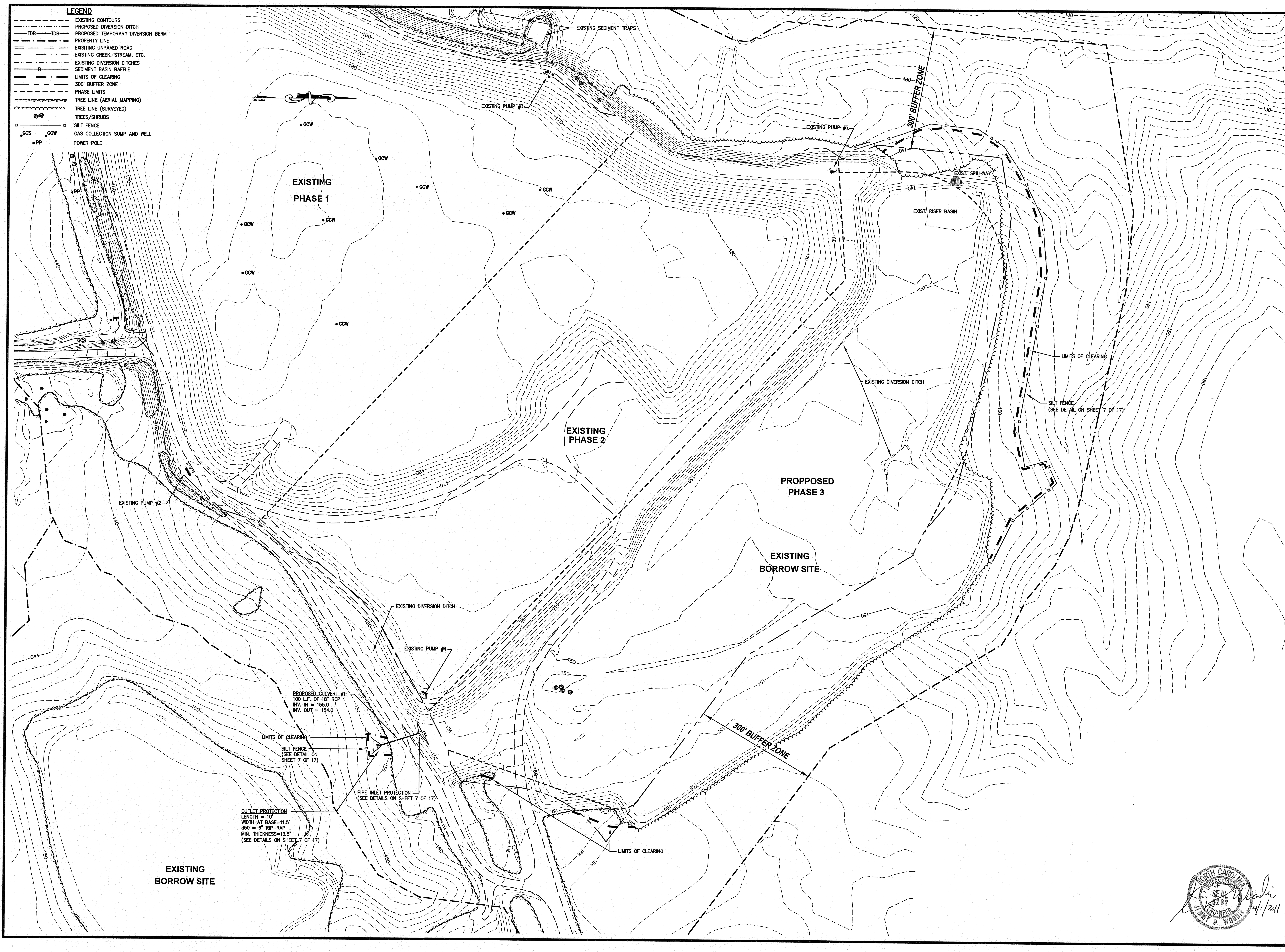

LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	REVISED SILT FENCE SHEET REFERENCE
1/12/2011	LHC	1	REVISED SHEET REFERENCES

ENGINEERING PLAN - PHASE 3
EROSION CONTROL PLAN
STAGE 1 (CLEARING AND GRUBBING)

SCALE: 1" = 100'
DATE: 3/12/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER: G06096
DRAWING NO.: E2
SHEET NO.: 4 OF 17

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 8282 JIMMY D. WOODIE
4/1/2011

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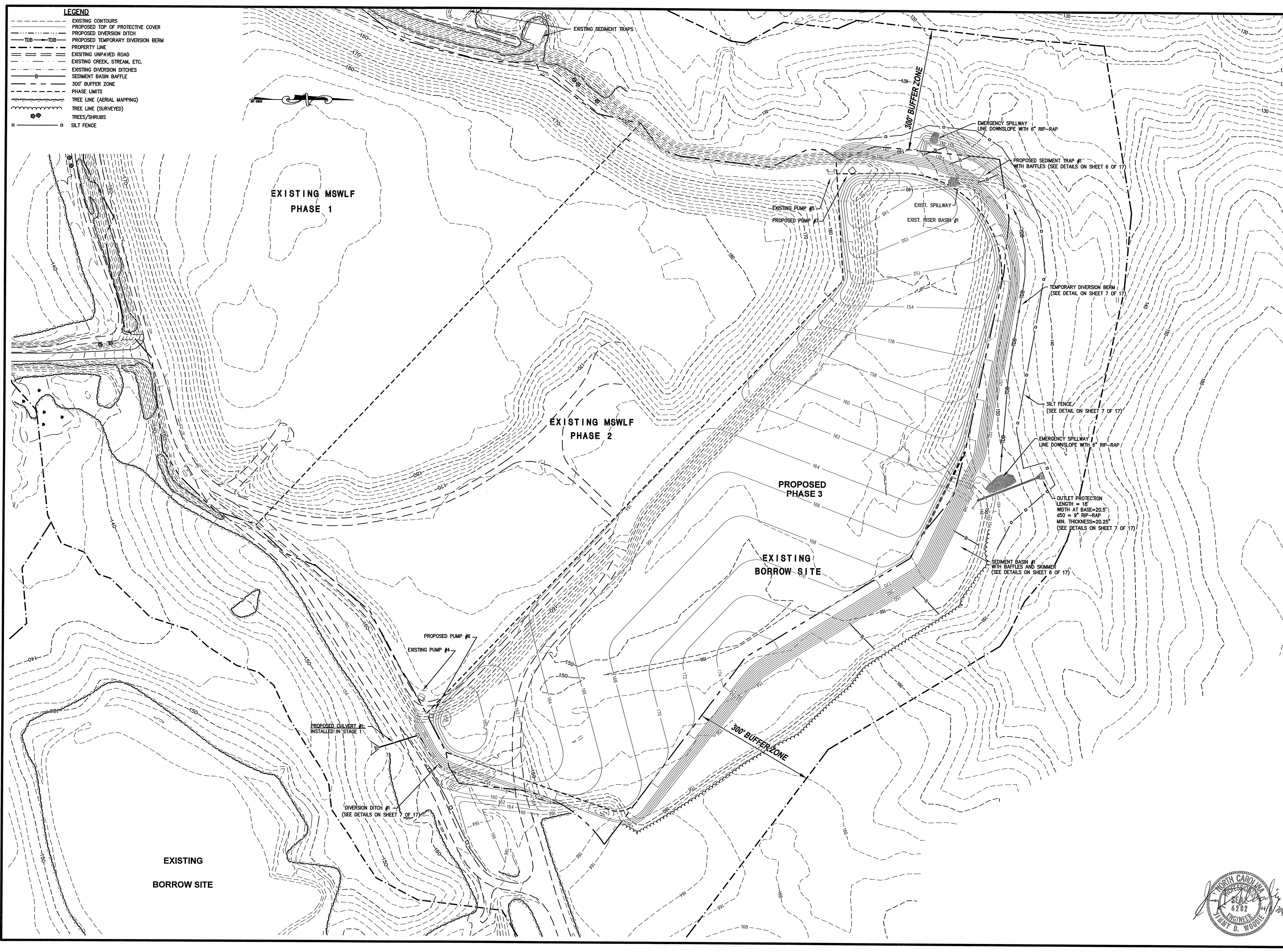

LICENSE NUMBER: C-0281

Municipal Services **Engineering Company, P.A.**

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED SHEET REFERENCES AND SUBGRADE
1/12/2011	LHC	2	REVISED EASTERN SUMP ELEVATION
11/1/2010	LCH	1	REVISED GRADING AT PROPOSED PUMP #7

ENGINEERING PLAN – PHASE 3 EROSION CONTROL PLAN STAGE 2 (LANDFILL CONSTRUCTION)

SCALE:	1" = 100'
DATE:	3/12/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	E3
SHEET NO.	5 OF 17

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SEEDBED PREPARATION (SP)

SP-1 FILL SLOPES 3:1 OR STEEPER TO BE SEEDE BY A HYDRAULIC SEEDER (PERMANENT SEEDING)

1) Leave the last 4-6 inches of fill loose and uncompacted, allowing rocks, roots, large clods and other debris to remain on the slope.
2) Roughen slope faces by making grooves 2-3 inches deep, perpendicular to the slope.
3) Spread lime evenly over slopes at rates recommended by soil tests.

SP-2 Fill slopes 3:1 or steeper (temporary seedings)

1) Leave a loose, uncompacted surface. Remove large clods, rocks, and debris which might hold netting above the surface.
2) Spread lime and fertilizer evenly at rates recommended by soil tests.
3) Break up large clods and rake into a loose, uniform seedbed.
4) Rake to loosen surface just prior to applying seed.

SP-4 Gentle or flat slopes where topsoil is not used.

1) Remove rocks and debris.
2) Apply lime and fertilizer at rates recommended by soil tests; spread evenly and incorporate into the top 6" with a disk, chisel plow, or rotary tiller.
3) Break up large clods and rake into a loose, uniform seedbed.
4) Rake to loosen surface just prior to applying seed.

SEEDING METHODS (SM)

SM-1 Fill slopes steeper than 3:1 (permanent seeding)

Use hydraulic seeding equipment to apply seed and fertilizer, a wood fiber mulch at 45 lb./1,000 s.f., and mulch tackifer.

SM-2 Gentle to flat slopes or temporary seedings

1) Broadcast seed at the recommended rate with a cyclone seeder, drop spreader, or cultipacker seeder.
2) Rake seed into the soil and lightly pack to establish good contact.

MULCH (MU)

MU-1 Steep slopes (3:1 or greater)

In mid-summer, late fall or winter, apply 100 lb./1,000 s.f. grain straw, cover with netting and staple to the slope. In spring or early fall use 45lb. / 1,000 s.f. wood fiber in a hydroseeder slurry.

MU-2 High-maintenance vegetation and temporary seedings

Apply 90 lb./1,000 s.f. (4000 lb./acre) grain straw and tack with 0.1 gal./s.y. asphalt (11 gal./1,000 s.f.).

MU-3 Grass-lined channels

Install excelsior mat in the channel, extend up the channel banks to the highest calculated depth of flow, and secure according to manufactur's specifications.
On channel shoulders, apply 100 lb./1,000 s.f. grain straw and anchor with 0.1 gal./s.y. (11 gal./1,000 s.f.) asphalt.

MAINTENANCE (MA)

MA-1 Refertilize in late winter or early spring the following year. Mow as desired.

MA-3 Inspect and repair mulch and lining. Refertilize in late winter of the following year with 150 lb./acre 10-10-10 (3.5 lb./1,000 s.f.). Mow regularly to a height of 3-4 inches.

MA-4 Topdress with 10-10-10 fertilizer if growth is not fully adequate.

MA-5 Topdress with 50 lb./acre (1 lb./1,000 s.f.) nitrogen in March. If cover is needed through the following summer, overseed with 50 lb./acre Kobe lespedeza.

PERMANENT SEEDING REQUIREMENTS (N.C. NO. 1CP)

SEEDING MIXTURE

Species	Rate (lb./acre)
Tall fescue	80
Pensacola Bahiagrass	50
Sericea lespedeza	30
Kobe lespedeza	10

SEEDING NOTES

1. From Sept.1-Mar.1, use unscarified sericea seed.
2. On poorly drained sites omit sericea and increase Kobe to 30 lb/acre.
3. Where a neat appearance is desired, omit sericea and increase Kobe to 40 lb/acre.

NURSE PLANTS

Between Apr.15 and Aug.15, add 10lb/acre German millet or 15 lb/acre Sudangrass. Prior to May1 or after Aug.15, add 25 lb/acre rye (grain).

SEEDING DATES

	BEST	POSSIBLE
Early spring:	Aug.25-Sept.15	Aug.20-Oct.25
Fall:	Sept. 1-Sept.30	Sept. 1-Oct.31

SOIL AMENDMENTS

Apply lime and fertilizer according to soil tests, or apply 3000-5000 lb/acre ground agricultural limestone (use the lower rate on sandy soils) and 1,000 lb/acre 10-10-10 fertilizer.

MULCH

Apply 4,000 lb./acre small grain straw or equivalent cover of another suitable mulch. Anchor straw by tacking with asphalt, netting, or roving or by crimping with a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.

MAINTENANCE

If growth is less than fully adequate, refertilize in the second year, according to soil tests or topdress with 500 lb/acre 10-10-10 fertilizer. Mow as needed when sericea is omitted from the mixture. Reseed, fertilize and mulch damaged areas immediately.

TEMPORARY SEEDING SPECIFICATIONS

TEMPORARY SEEDING RECOMMENDATIONS FOR LATE WINTER AND EARLY SPRING

Seeding Mixture

species	Rate(lb./acre)
Rye (grain)	120
Annual lespedza (Kobe in Piedmont and Coastal Plain,Korean in Mountains)	50

Omit annual lespedeza when duration of temporary cover is not to extend beyond June.

SEEDING DATES

Mountains-Above 2500ft.:Feb. 15 - May 15
Below 2500ft.:Feb. 1 - May 1
Piedmont-Jan. 1 - May 1
Coastal Plain-Dec. 1 - Apr. 15

SOIL AMENDMENTS
Follow recommendations of soil tests or apply 2,000 lb./acre ground agricultural limestone and 750 lb./acre 10-10-10 fertilizer.

MULCH
Apply 4,000 lb./acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulching tool.

MAINTENANCE
Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

TEMPORARY SEEDING RECOMMENDATIONS FOR SUMMER

Seeding Mixture

species	Rate(lb./acre)
German millet	40

In the Piedmont and Mountains, a small-stemmed Sudangrass may be substituted at a rate of 50 lb./acre.

SEEDING DATES
Mountains-May 15 - Aug.15
Piedmont-May 1 - Aug. 15
Coastal Plain-Apr. 15 - Aug. 15

SOIL AMENDMENTS
Follow recommendations of soil tests or apply 2,000 lb./acre ground agricultural limestone and 750 lb./acre 10-10-10 fertilizer.

MULCH
Apply 4,000 lb./acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulching tool.

MAINTENANCE
Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

TEMPORARY SEEDING RECOMMENDATIONS FOR FALL

Seeding Mixture

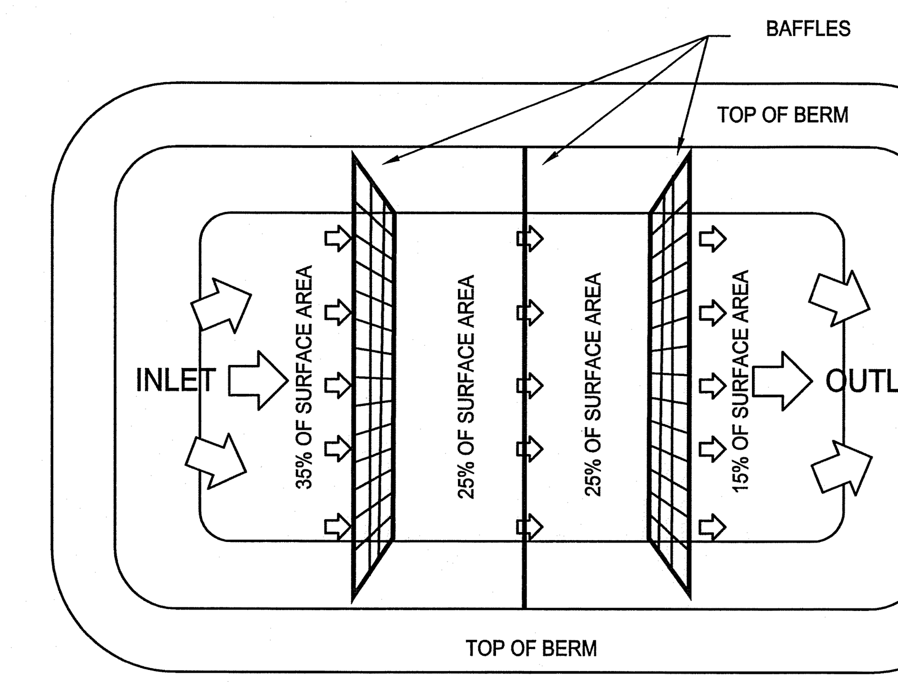
species	Rate(lb./acre)
Rye (grain)	120

SEEDING DATES
Mountains-Aug.15 - Dec. 15
Coastal Plain and Piedmont-Aug. 15 - Dec. 30

SOIL AMENDMENTS
Follow recommendations of soil tests or apply 2,000 lb./acre ground agricultural limestone and 1,000 lb./acre 10-10-10 fertilizer.

MULCH
Apply 4,000 lb./acre straw. Anchor straw by tacking with asphalt, straight can be used as a mulching tool.

MAINTENANCE
Repair and refertilize damaged areas immediately. Topdress with netting, or a mulch anchoring tool. A disk with blades set nearly 50 lb./acre of nitrogen in March. If it is necessary to extend temporary cover beyond June 15, overseed with 50 lb./acre Kobe (Piedmont and Coastal Plain) or Korean (Mountains)lespedeza in late February or early March.

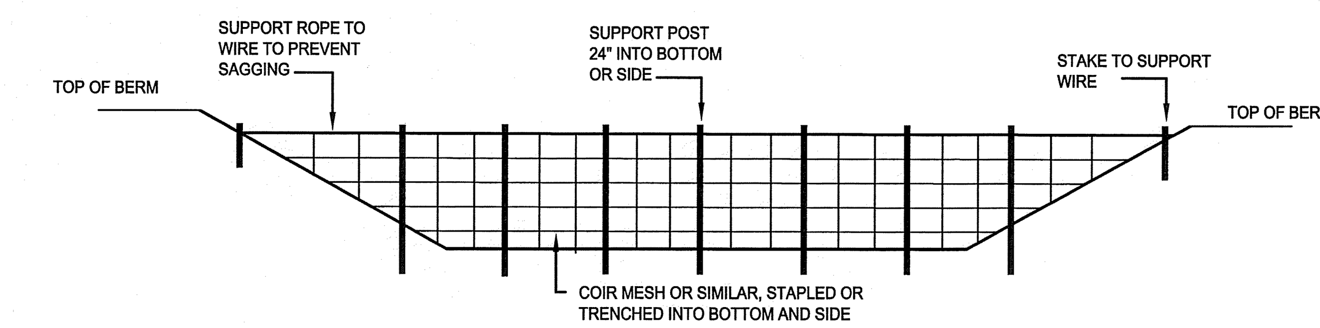


NOTE: BAFFLES NEED TO BE INSTALLED CORRECTLY IN ORDER TO FULLY PROVIDE THEIR BENEFITS.

REFER TO CROSS-SECTION BELOW AND THE FOLLOWING KEY POINTS:

THE BAFFLE MATERIAL NEEDS TO BE SECURED AT THE BOTTOM AND SIDES USING STAPLES OR BY TRENCHING AS FOR SILT FENCE.

MOST OF THE SEDIMENT WILL ACCUMULATE IN THE FIRST BAY, SO THIS SHOULD BE READILY ACCESSIBLE FOR MAINTENANCE.

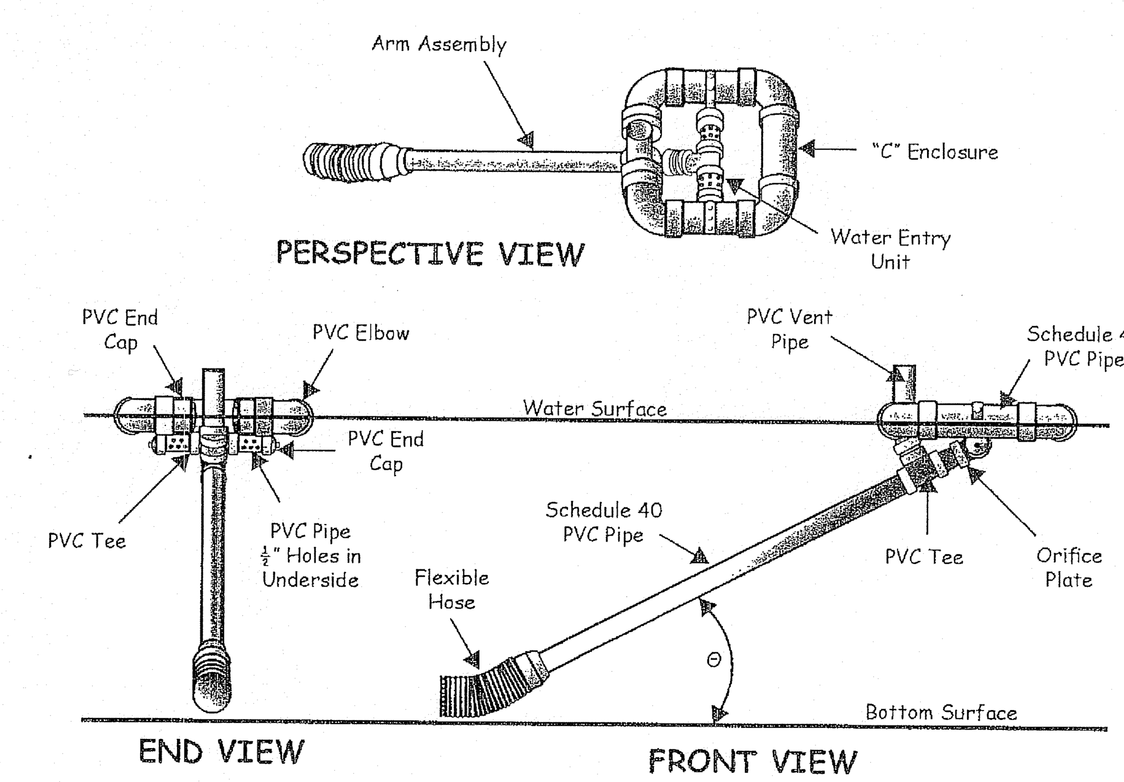


CROSS-SECTION OF A POROUS BAFFLE IN A SEDIMENT BASIN.

NOTE: DETAIL TAKEN FROM NC EROSION CONTROL MANUAL FIGURE 6.65a AND 6.65b

RISER BASIN BAFFLE DETAIL

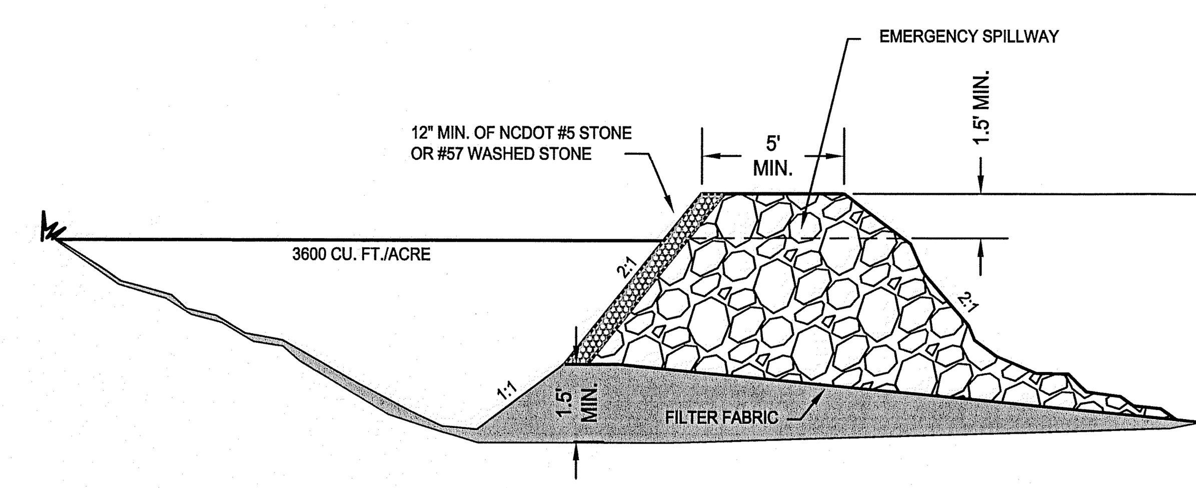
NOT TO SCALE



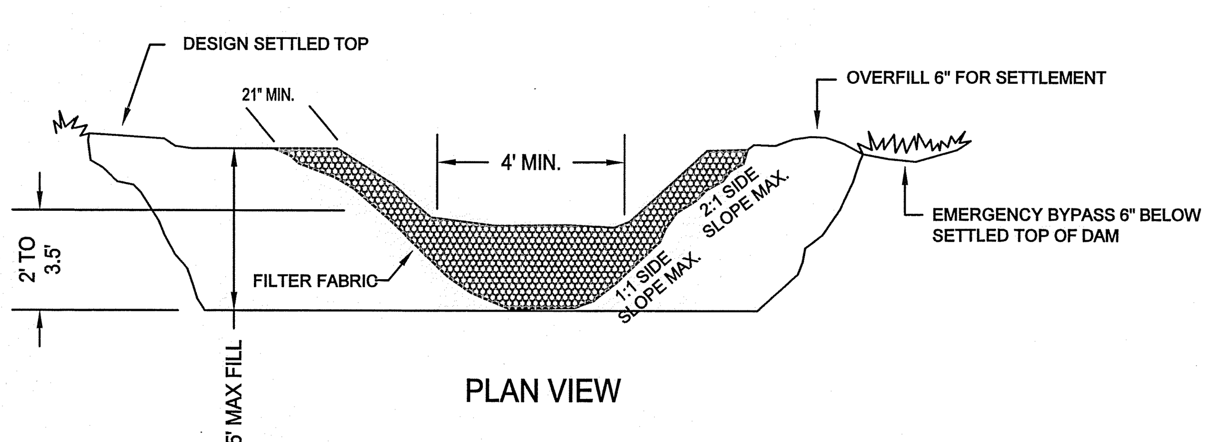
NOTE: DETAIL TAKEN FROM NC EROSION CONTROL MANUAL FIGURE 6.64a

SKIMMER DEWATERING DEVICE DETAIL

NOT TO SCALE



CROSS SECTION



PLAN VIEW

NOTE: DETAIL TAKEN FROM NC EROSION CONTROL MANUAL FIGURE 6.60a

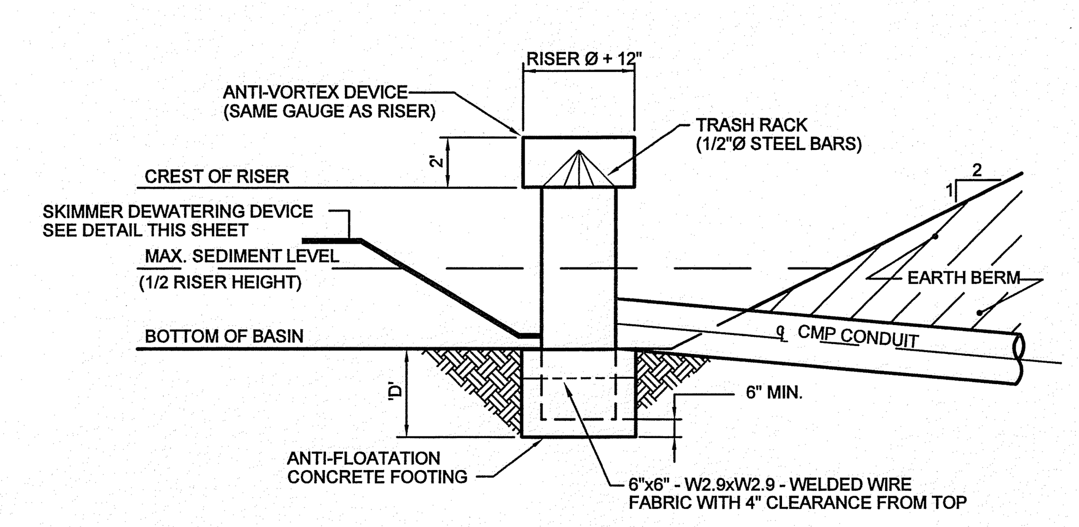
SEDIMENT TRAP SCHEDULE

NOTES:
1. TRAP SHALL BE CLEANED OUT AT 12 MONTH INTERVALS OR WHEN MAX. SEDIMENT LEVEL IS REACHED. REPLACE FILTER AS REQUIRED.
2. SOIL SHALL BE COMPACTED TO 95% STD. PROCTOR MAX. DENSITY.
3. ESTABLISH VEGETATION ON BERMS.

TRAP NO.	BOTTOM			SPILLWAY		BERM ELEV.	BAFFLES REQUIRED
	LEN.	WIDTH	ELEV.	WIDTH	ELEV.		
1	SEE PLAN		138.5'	6.0'	140.0'	142.0'	3

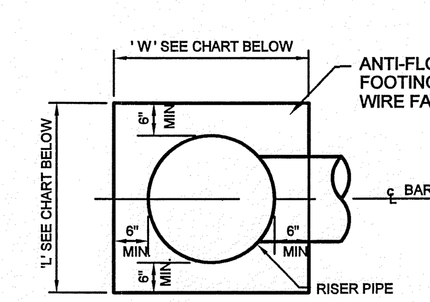
SEDIMENT TRAP DETAIL

NOT TO SCALE



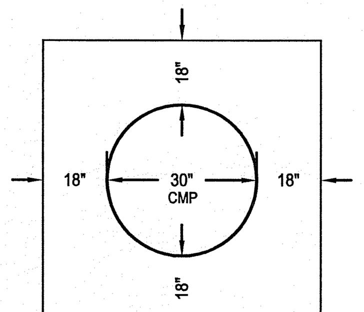
RISER PIPE DETAIL

NOT TO SCALE



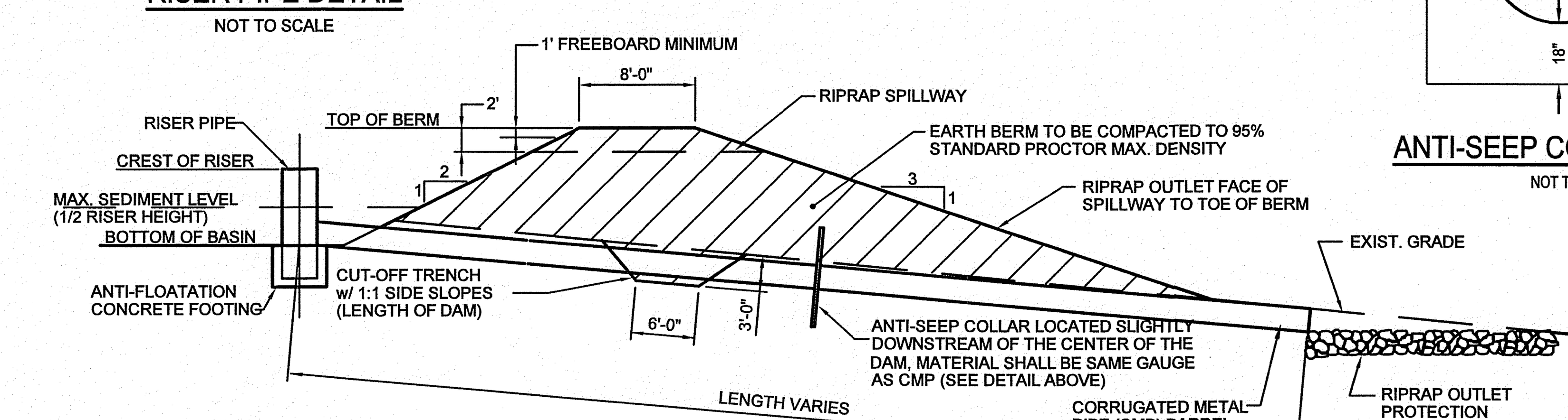
RISER FOOTING DETAIL

NOT TO SCALE



ANTI-SEEP COLLAR DETAIL

NOT TO SCALE



DAM - SECTION

BASIN NO.	BOTTOM		SPILLWAY		BERM EL.	RISER		BARREL			FOOTING FOR RISER PIPE				BARREL OUTLET PROTECTION					SKIMMER DEWATERING DEVICE			BAFFLES
	SIZE	EL.	WIDTH	EL.		DIA.	INV. IN	DIA.	LENGTH	INV.IN	TOP EL.	'L'	'W'	'D'	'L'	'W'	d_{50}	THICK.	EL.	BASIN VOLUME (CU. FT.)	ORIFICE DIA.SIZE	DEWATERING TIME (DAYS)	NUMBER REQUIRED
#1	SEE PLAN	148.0'	12'	152.0'	154.0'	48"	151.5'	30"	155'	148.0'	151.5'	5'	5'	1'	18'	20.5'	9"	20.25"MIN.	147.5'	19,584	3"	1	3

SEDIMENT BASIN DETAIL

NOT TO SCALE

LICENSE NUMBER: C-0281
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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	NO REVISIONS THIS SHEET
1/12/2011	LHC	1	NO REVISIONS THIS SHEET

ENGINEERING PLAN - PHASE 3
EROSION CONTROL DETAILS

SCALE:	NOT TO SCALE
DATE:	3/25/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	E4
SHEET NO.	6 OF 17

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 028282 JIMMY D. WOODIE
4/1/2011

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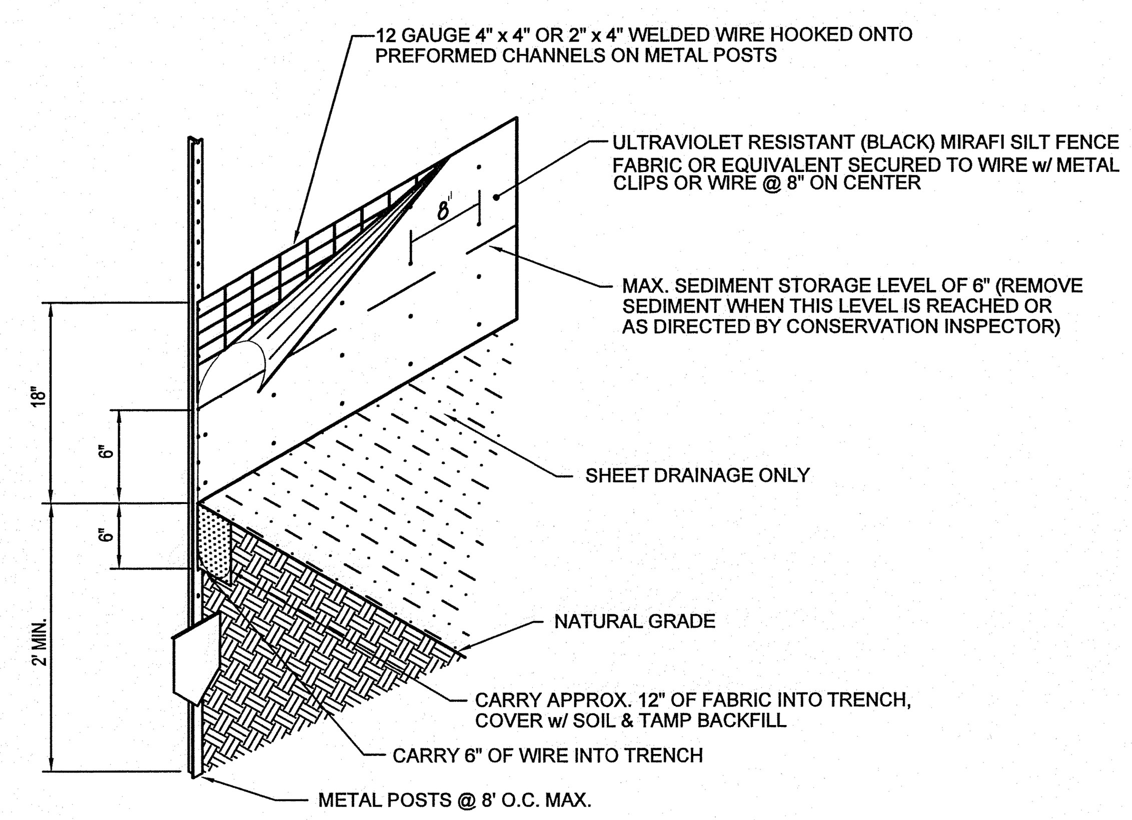
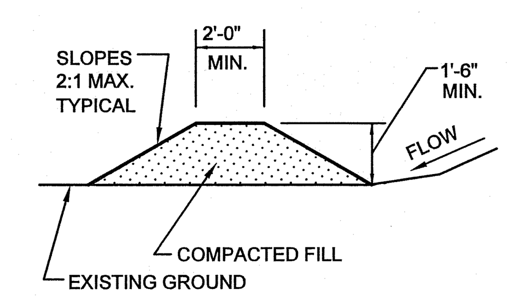


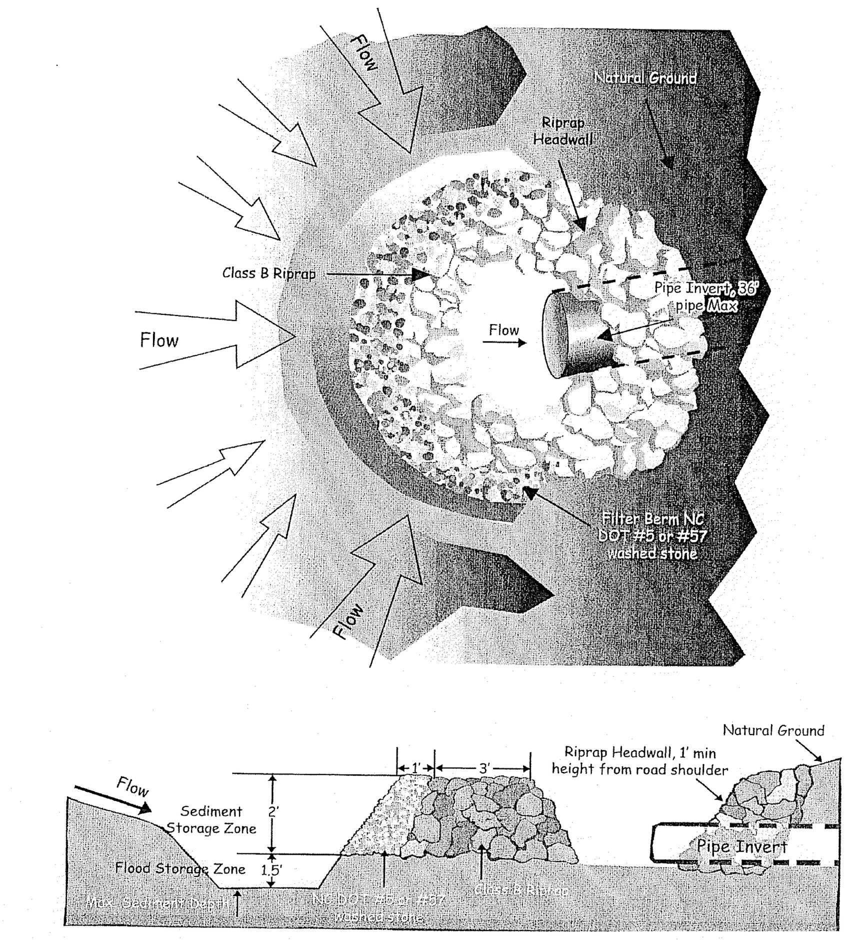
SILT FENCE DETAIL

NOT TO SCALE



TEMPORARY DIVERSION BERM DETAIL

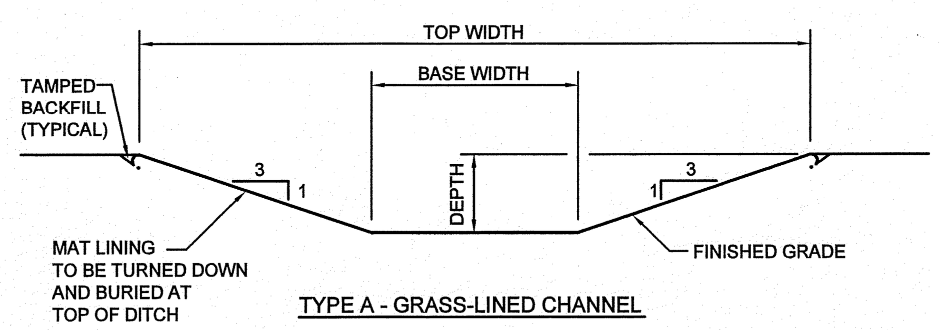
NOT TO SCALE



NOTE: DETAIL TAKEN FROM NC SEDIMENTATION AND EROSION CONTROL MANUAL FIG. 6.55a

ROCK PIPE INLET PROTECTION DETAIL

NOT TO SCALE



TYPE A - GRASS-LINED CHANNEL

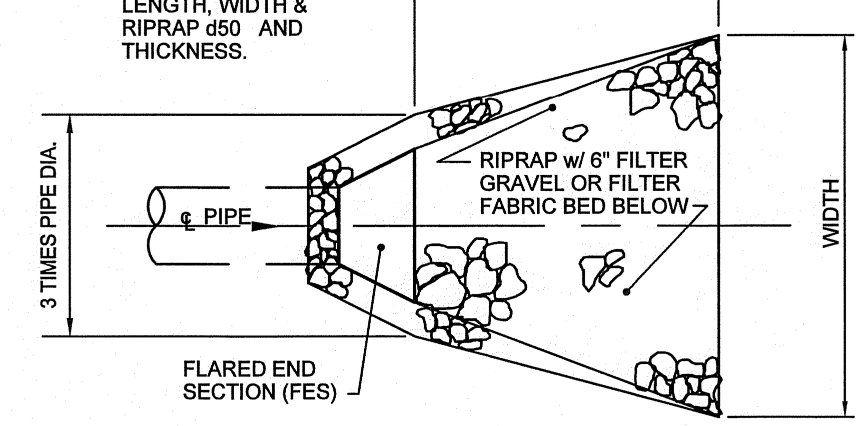
DIVERSION DITCH SCHEDULE

DITCH NO.	TYPE	TOP WIDTH	DEPTH	BASE WIDTH	VELOCITY (fps)	RIP-RAP d50	MIN. THICK.	TEMP. LINER
1	A	6'	1'	0	4.04	-	-	STRAW W/NET

DIVERSION DITCH DETAIL

NOT TO SCALE

NOTE
SEE DRAWING FOR LENGTH, WIDTH & RIPRAP d50 AND THICKNESS.



TYPICAL OUTLET PROTECTION DEVICE

NOT TO SCALE

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE
4/1/2011

LICENSE NUMBER: C-0281
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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	NO REVISIONS TO THIS SHEET.
1/12/2011	LHC	1	NO REVISIONS TO THIS SHEET.

ENGINEERING PLAN - PHASE 3
EROSION CONTROL DETAILS

SCALE: NOT TO SCALE
DATE: 3/25/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G06096
DRAWING NO. E5
SHEET NO. 7 OF 17

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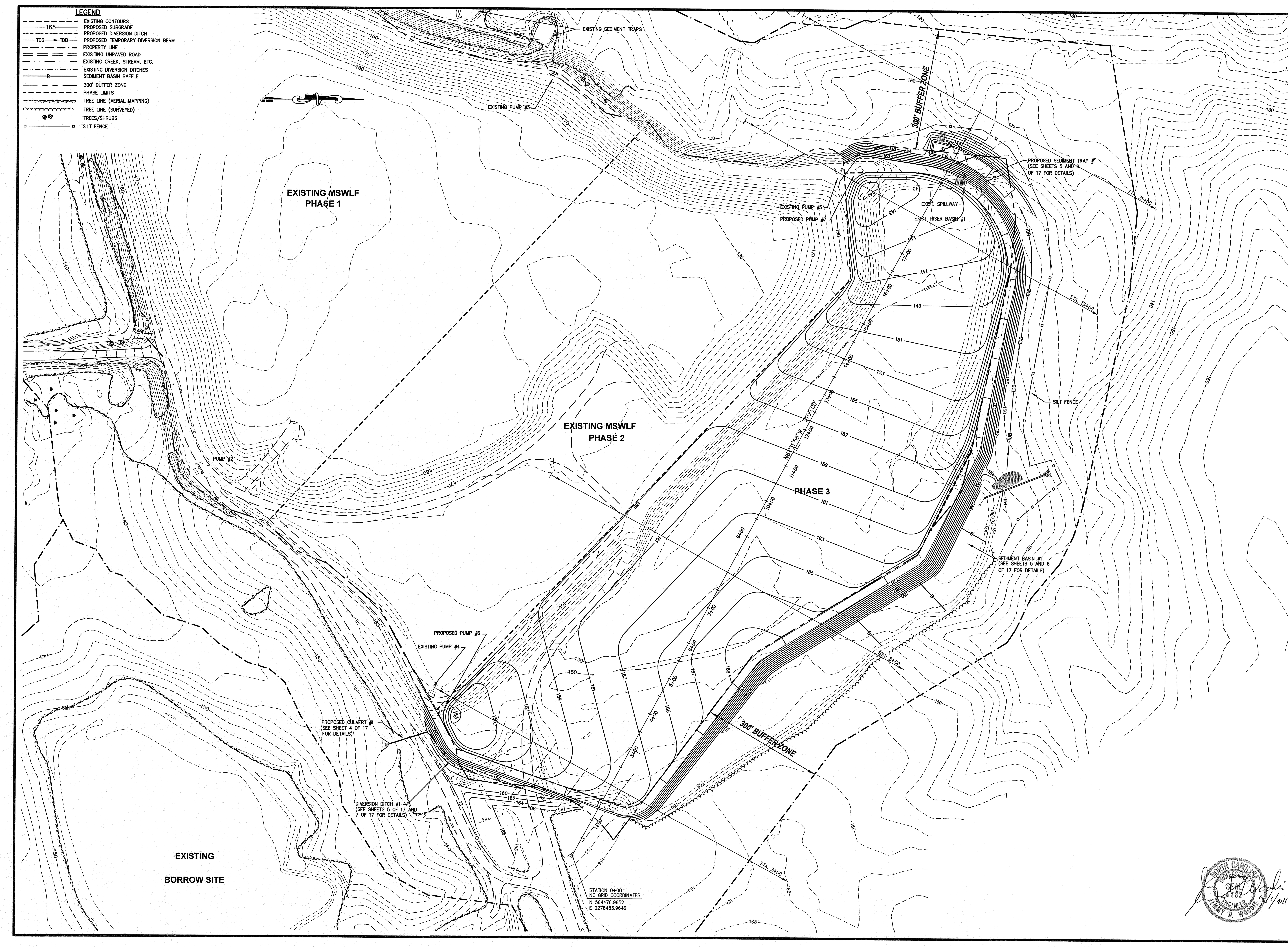

LICENSE NUMBER: C-0281

Municipal Services

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED SUBGRADE
1/12/2011	LHC	2	REVISED EASTERN SUMP ELEVATION
11/1/2010	LCH	1	REVISED GRADING AT PUMP#7 AREA

ENGINEERING PLAN - PHASE 3 PROPOSED SUBGRADE

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 028282 JIMMY D. WOODIE
4/1/2011

SCALE:	1" = 100'
DATE:	3/24/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. E6	SHEET NO. 8 OF 17

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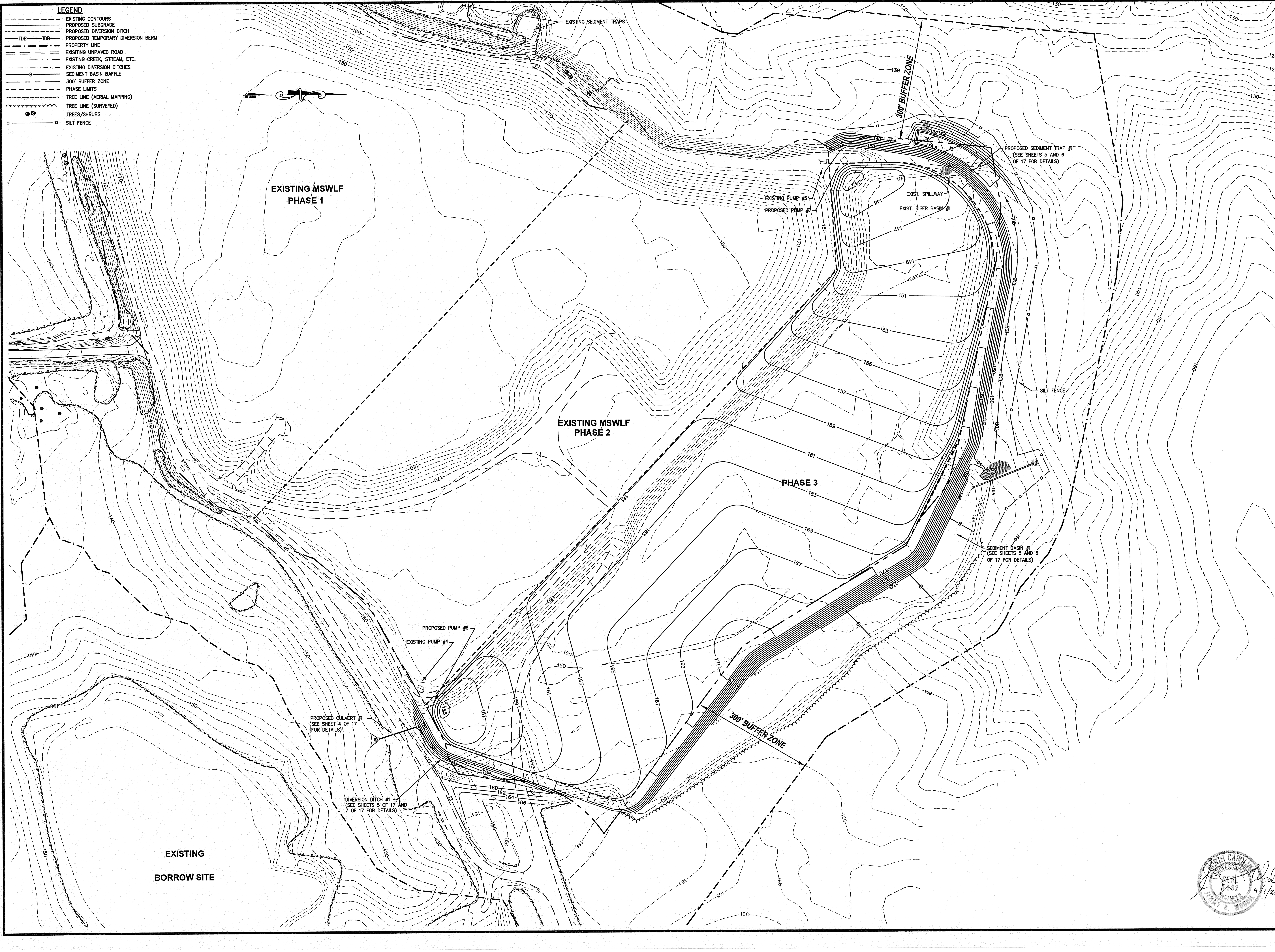


LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393

P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767

P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

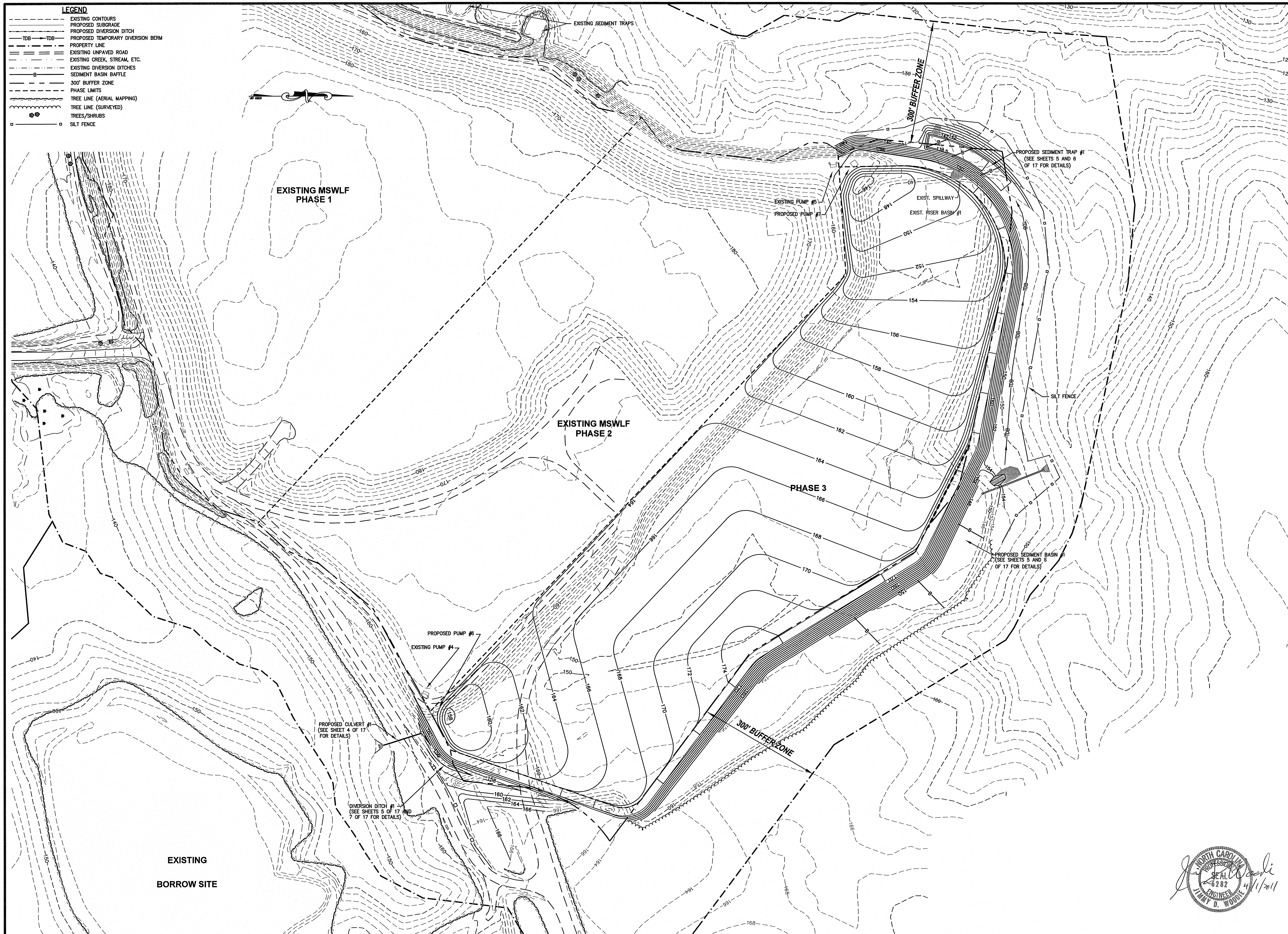
MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED COHESIVE SOIL LINER
1/12/2011	LHC	2	REVISED EASTERN SUMP ELEVATION
11/1/2010	LCH	1	REVISED GRADE AT PUMP #7 AREA

ENGINEERING PLAN - PHASE 3
TOP OF COHESIVE SOIL LINER

SCALE:	1" = 100'
DATE:	3/24/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	E7
SHEET NO.	9 OF 17

4/1/2011



LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED PROTECTIVE COVER
1/12/2011	LHC	2	REVISED EASTERN SUMP ELEVATION
11/1/2010	LCH	1	REVISED GRADING AT PROPOSED PUMP #7 AREA

ENGINEERING PLAN - PHASE 3
TOP OF PROTECTIVE COVER

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

J. Woodie 4/1/2011

SCALE:	1" = 100'
DATE:	3/24/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. E8	SHEET NO. 10 OF 17

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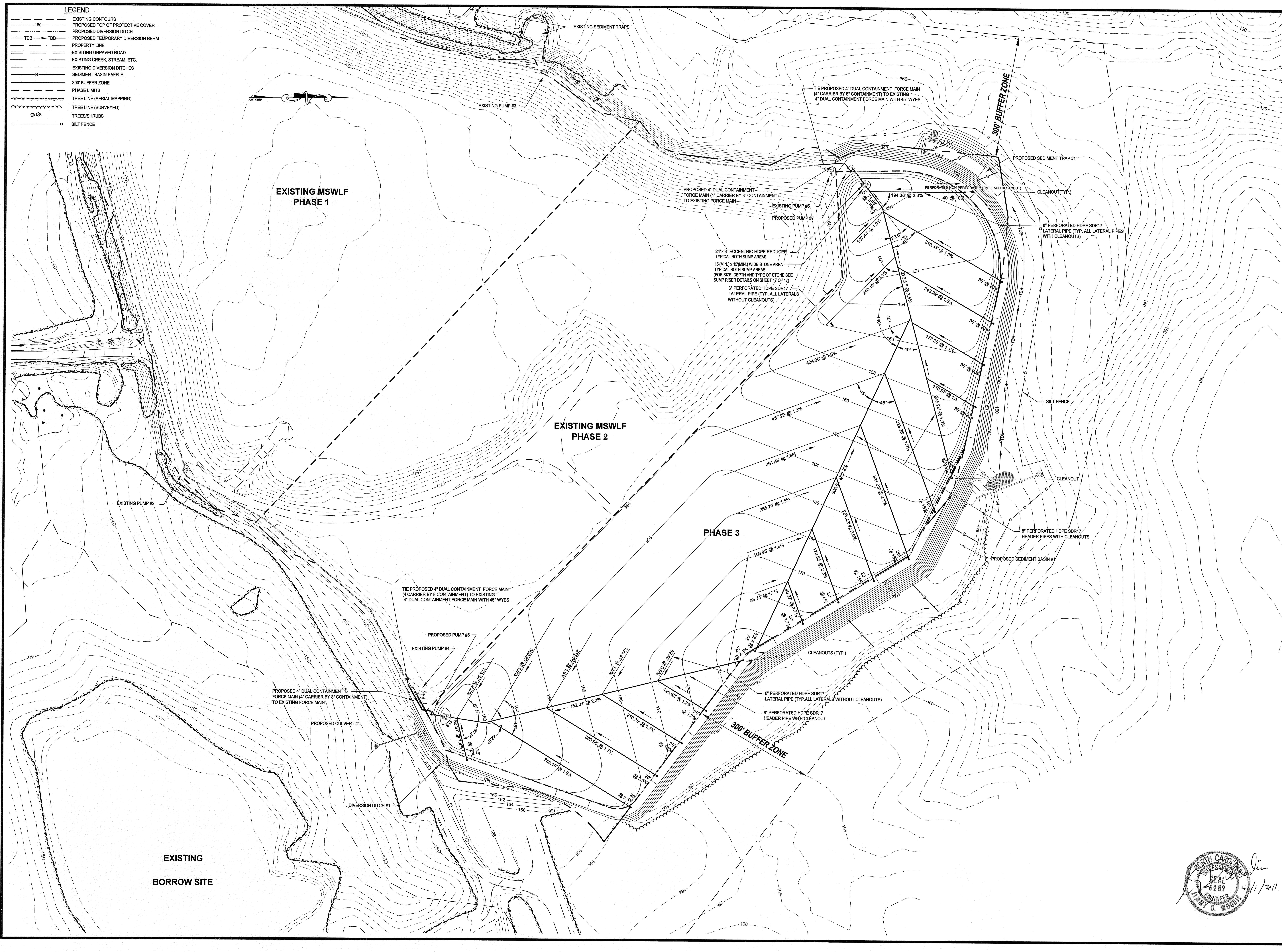

MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

LICENSE NUMBER: C-0281

Municipal Services Engineering Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
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DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED PROTECTIVE COVER LEACHATE SYSTEM
1/12/2011	LHC	2	REVISED EASTERN SUMP ELEVATION AND REDUCER SIZE
11/1/2010	LCH	1	REVISED LEACHATE SYSTEM AND LOCATION OF PUMP #7

ENGINEERING PLAN - PHASE 3
LEACHATE COLLECTION SYSTEM

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6262 JIMMY D. WOODIE
4/1/2011

SCALE:	1" = 100'
DATE:	3/24/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	SHEET NO.
E9	11 OF 17

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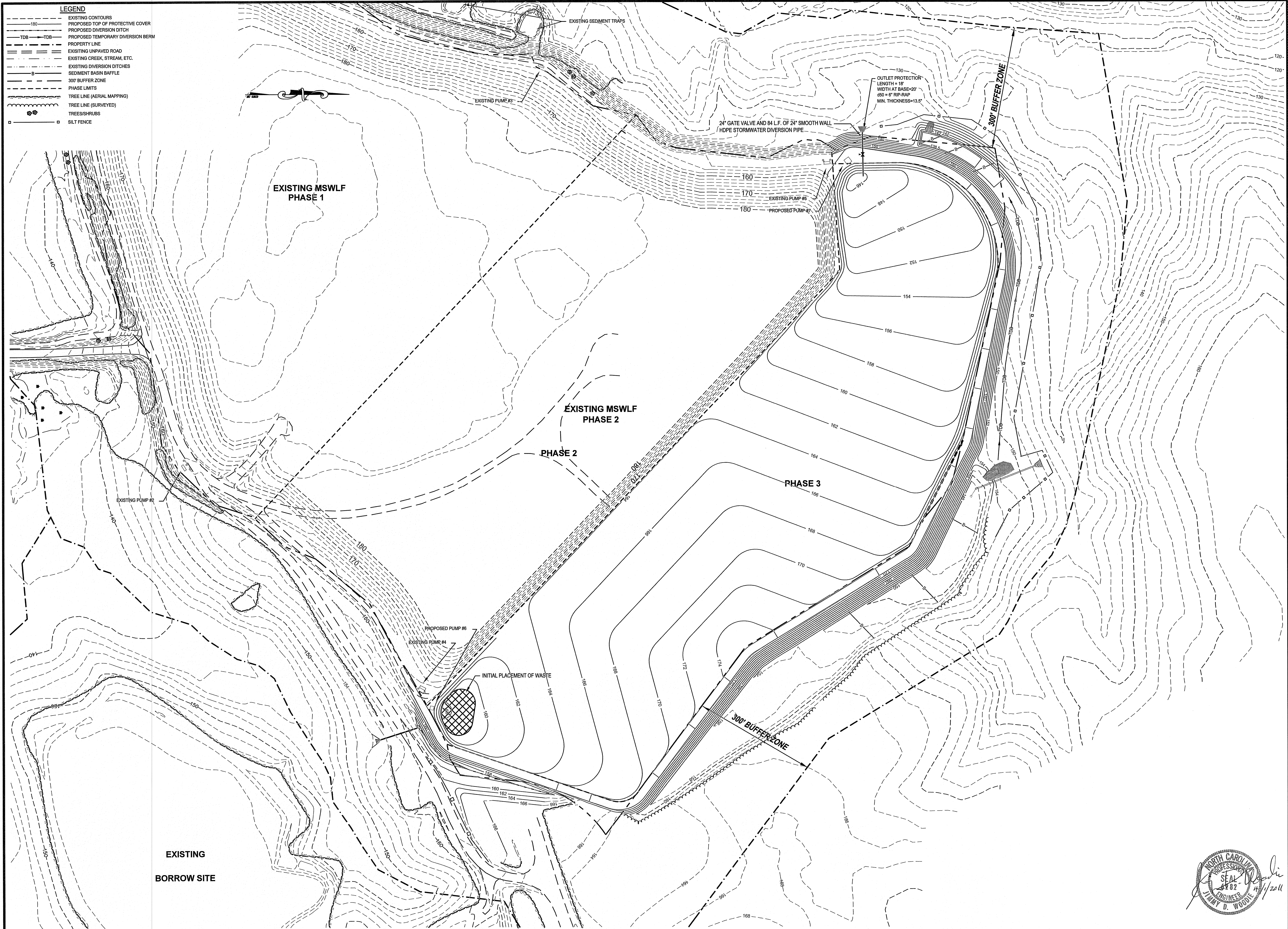

LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	REVISED PROTECTIVE COVER
1/12/2011	LHC	2	REVISED EASTERN SUMP ELEVATION
11/1/2010	LCH	1	REVISED GRADING AT PROP. PUMP #7 AND LOCATION OF STORMWATER PIPE

ENGINEERING PLAN - PHASE 3
INITIAL PLACEMENT OF WASTE AND STORMWATER DIVERSION

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 8282 JIMMY D. WOODIE 4/1/2011

SCALE:	1" = 100'
DATE:	3/27/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	E10
SHEET NO.	12 OF 17

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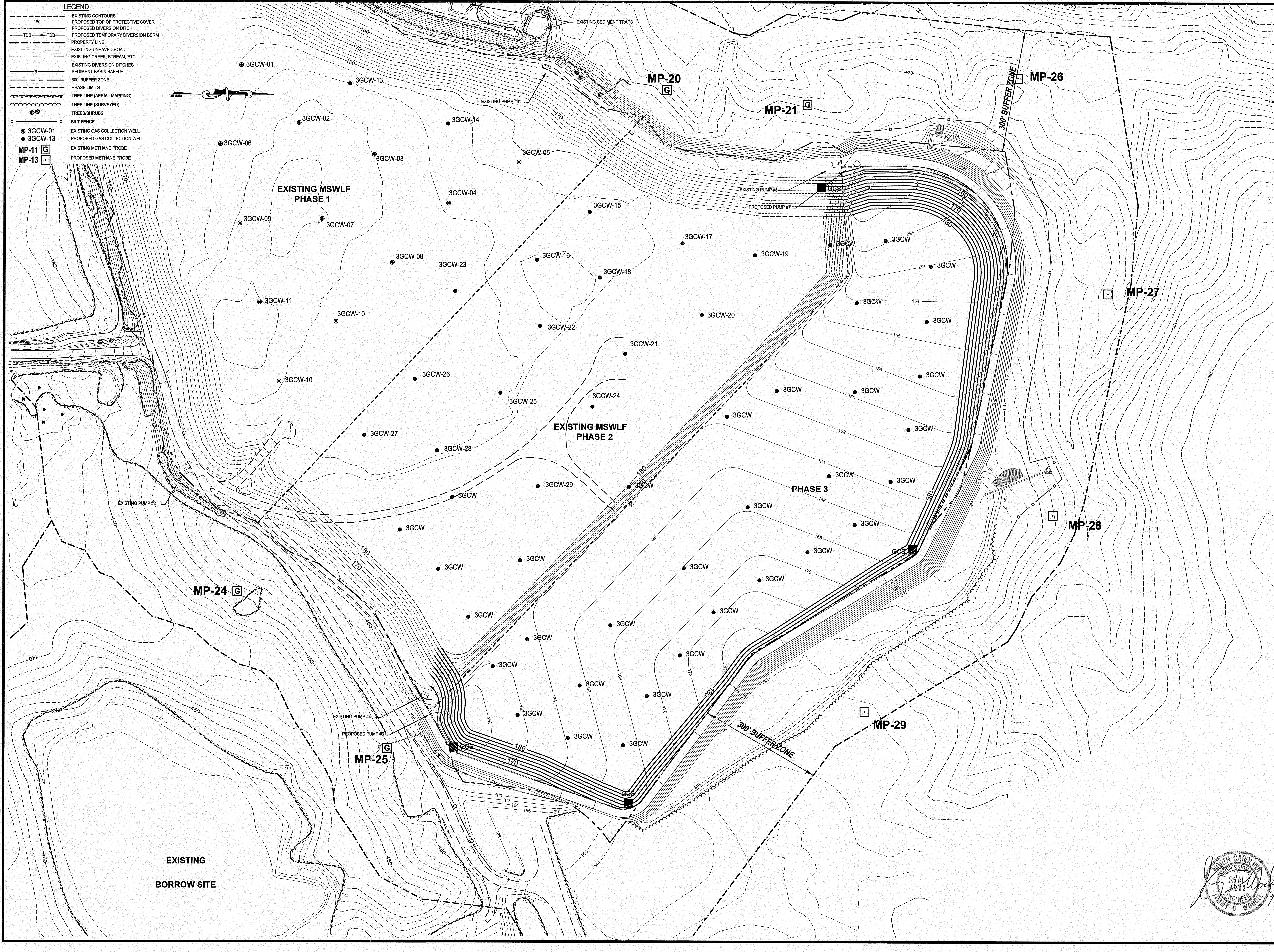


MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

LICENSE NUMBER: C-0281

Municipal Services Engineering Company, P.A.

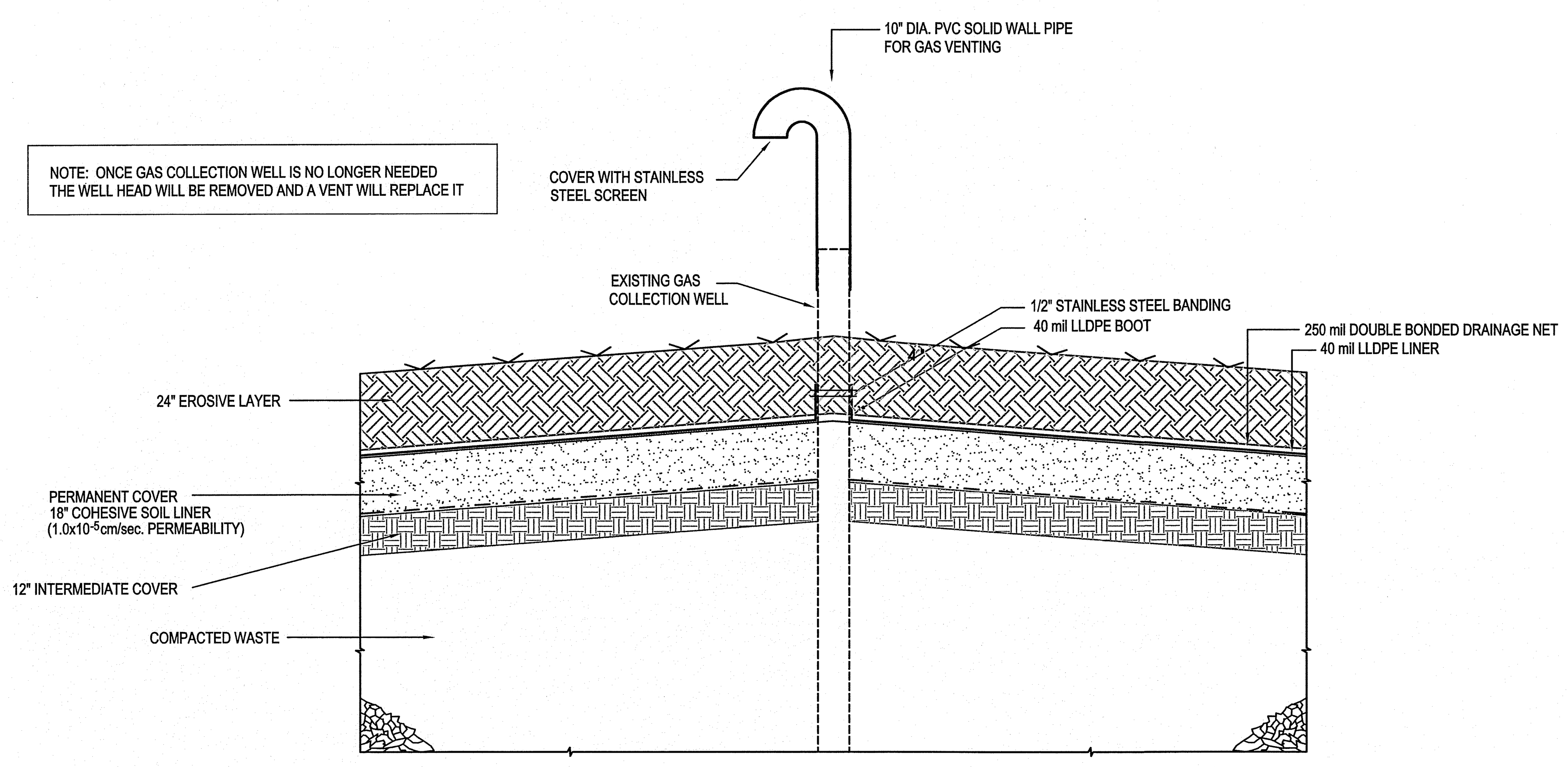
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

DATE	BY	REV.	DESCRIPTION
5/13/2011	LHC	4	REVISED EXISTING AND PROPOSED METHANE PROBES
3/17/2011	LHC	3	REVISED PROTECTIVE COVER AND FILL PLAN
1/12/2011	LHC	2	REVISED EASTERN SUMP ELEVATION
10/26/2010	LCH	1	REVISED TITLE AND EXIST. / PROP. GAS COLLECTION WELLS

ENGINEERING PLAN - PHASE 3
FINAL FILL WITH EXISTING AND PROPOSED GAS COLLECTION WELLS AND METHANE MONITORING PROBE LOCATIONS

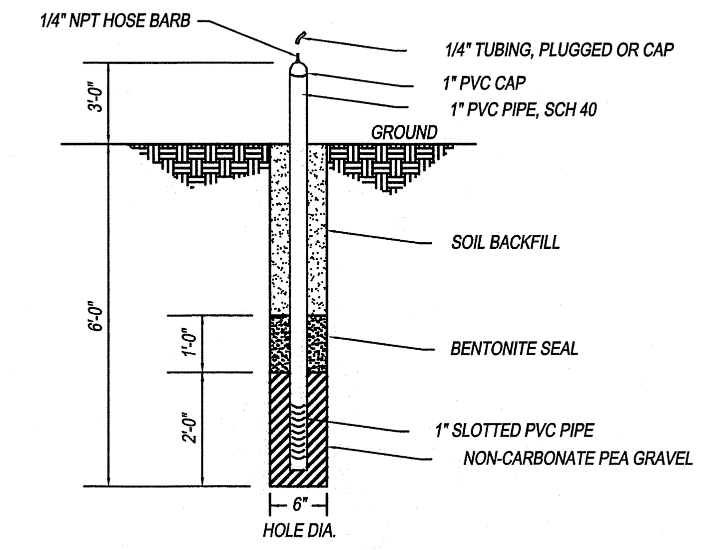
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 21782 JIMMY D. WOODIE 5/13/2011

SCALE:	1" = 100'
DATE:	4/7/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. E11	SHEET NO. 13 OF 17



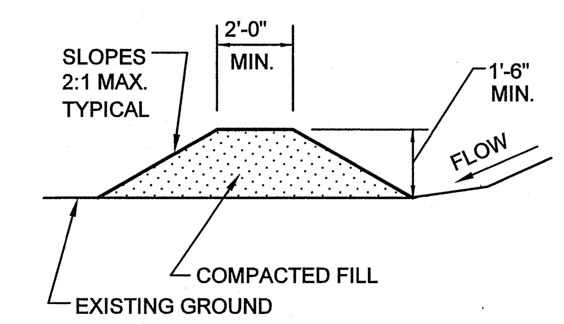
TYPICAL METHANE GAS COLLECTION WELL TO VENT CONVERSION DETAIL

N.T.S.



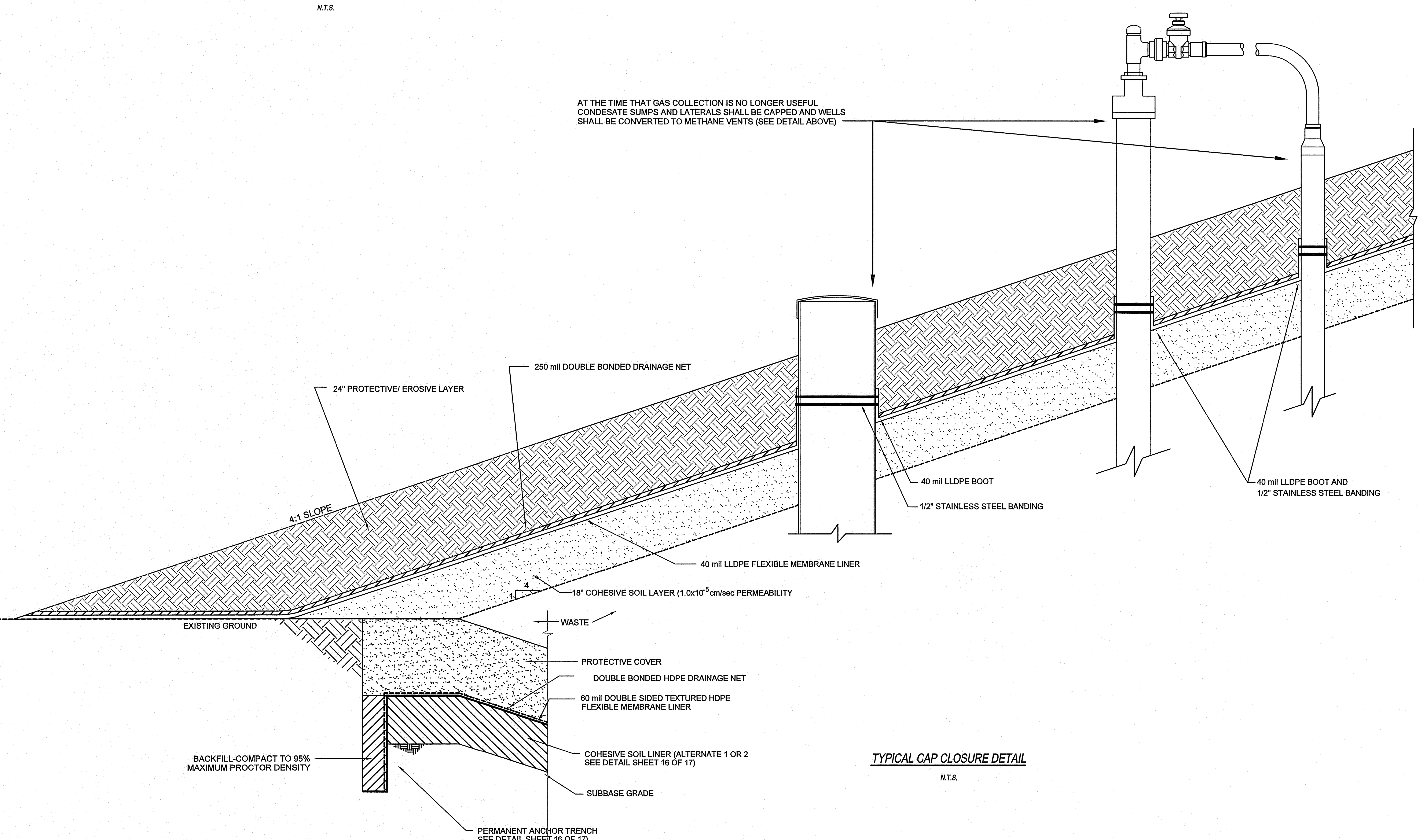
METHANE GAS MONITORING PROBE

N.T.S.



STORMWATER DIVERSION BERM DETAIL

NOT TO SCALE



TYPICAL CAP CLOSURE DETAIL

N.T.S.

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE

4/1/2011

LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

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MUNICIPAL SOLID WASTE LANDFILL FACILITY

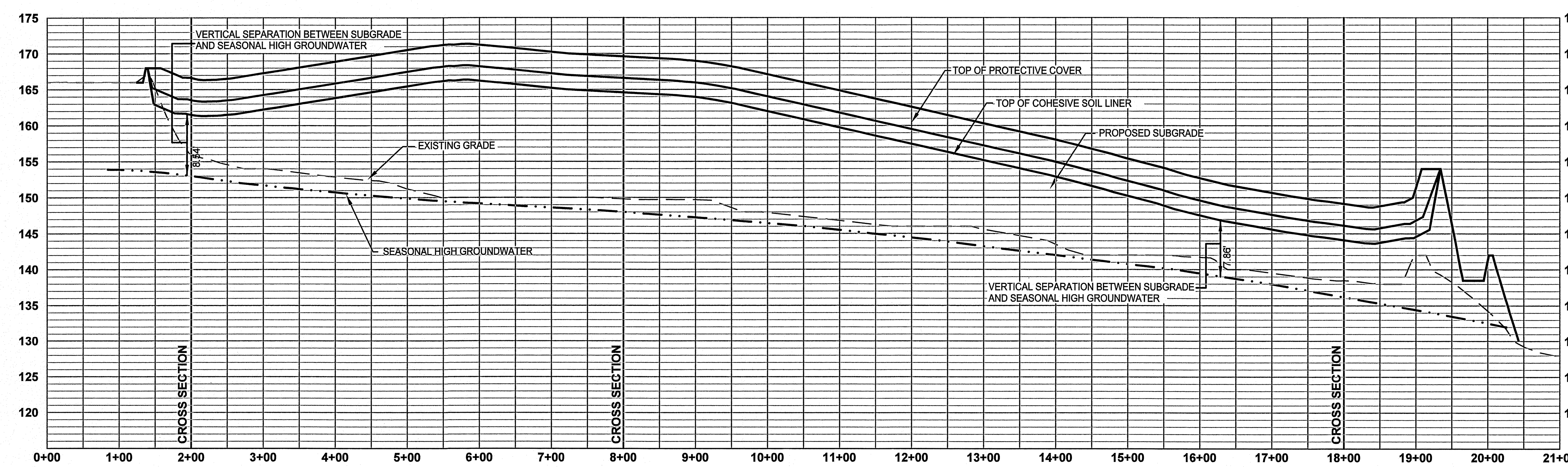
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LCH	3	REVISED LABELS ON CLOSURE DETAIL
1/12/2011	LCH	2	NO REVISIONS TO THIS SHEET
11/1/2010	LCH	1	REVISED DETAILS

ENGINEERING PLAN-PHASE 3
OPERATION DETAILS

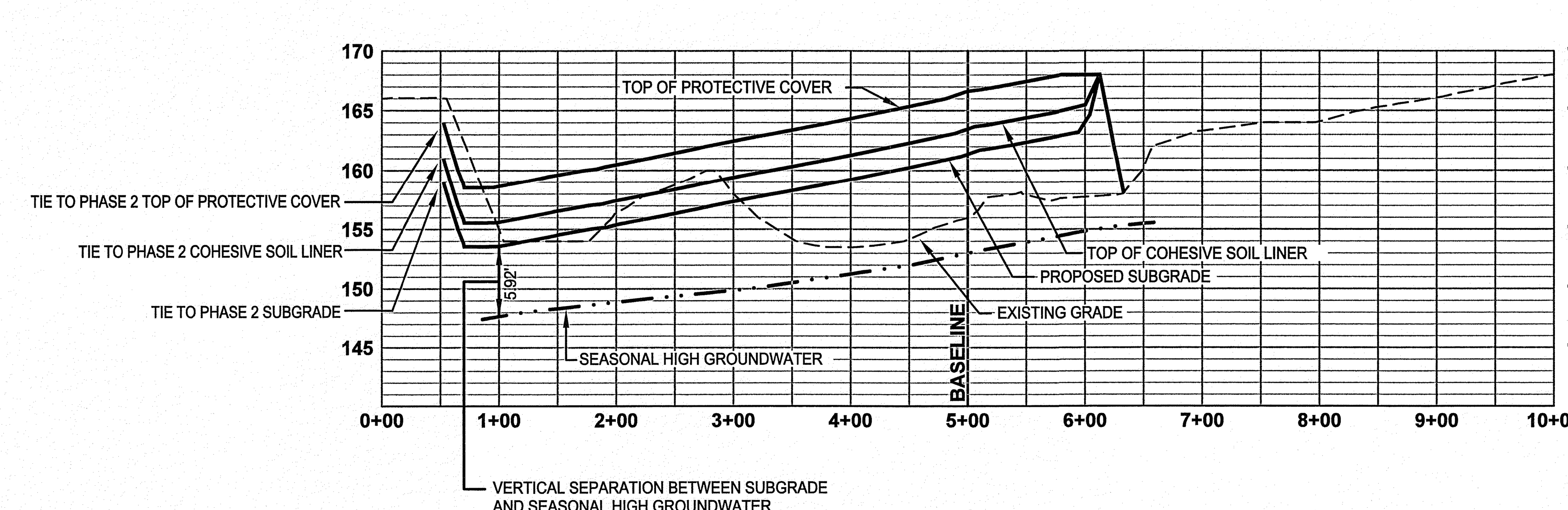
SCALE: 1:1
DATE: 4/6/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE
PROJECT NUMBER G06096
DRAWING NO. E12
SHEET NO. 14 OF 17

P:\SolidWaste\G06096 -- Wayne Co. PTC Ph.3\dwg\engineering\G06096E-14.dwg, 4/1/2011 9:17:16 AM, lch,lch



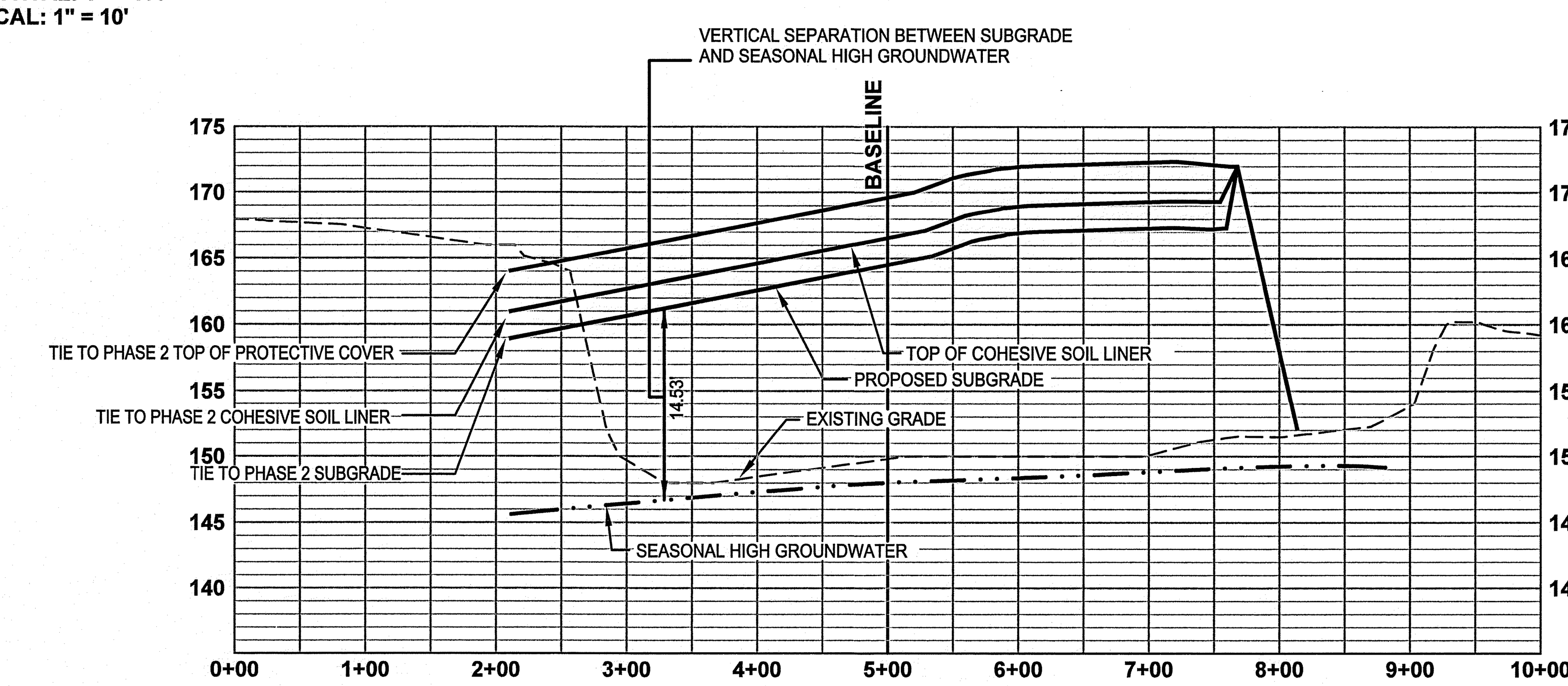
BASELINE PROFILE

SCALE: HORIZONTAL: 1" = 100'
VERTICAL: 1" = 10'



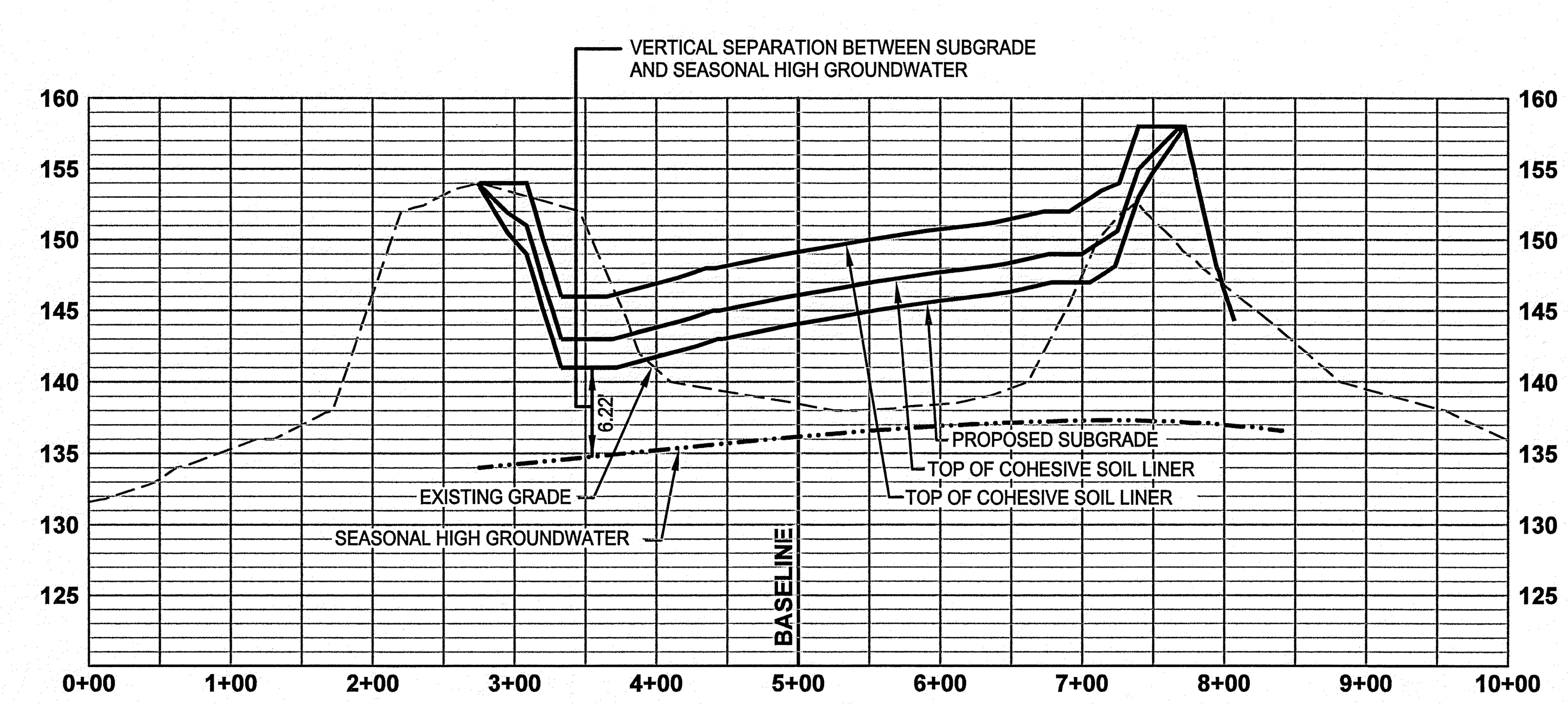
STATION 2+00

SCALE: HORIZONTAL: 1" = 100'
VERTICAL: 1" = 10'



STATION 8+00

SCALE: HORIZONTAL: 1" = 100'
VERTICAL: 1" = 10'



STATION 18+00

SCALE: HORIZONTAL: 1" = 100'
VERTICAL: 1" = 10'

NOTE

THESE CROSS SECTIONS ARE INTENDED TO SHOW THE CROSS SECTIONS AT SPECIFIC POINTS AS DEFINED BY THE BASELINE GRID ON SHEET 8 OF 17. THEY ARE NOT INTENDED TO BE THE SOLE MEANS FOR CALCULATING THE EARTHWORK FOR THIS PROJECT.

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 8282 JIMMY D. WOODIE
4/1/2011

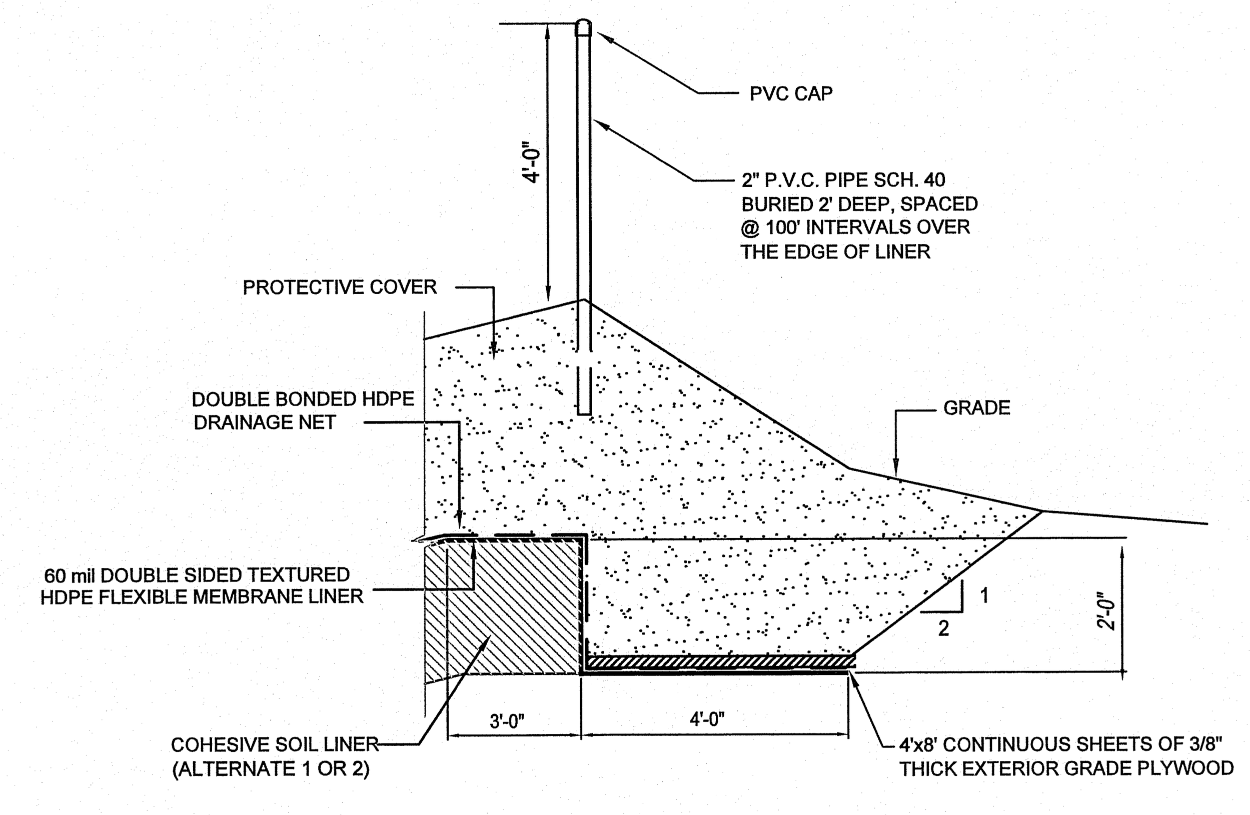
LICENSE NUMBER: C-0281
Municipal Services Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LCH	3	REVISED BASE LINER SYSTEM ON ALL SECTIONS
1/12/2011	LCH	2	REVISED STATION 2+00 AND ADDED NOTES
11/1/2010	LCH	1	ADJUSTED LINEWEIGHT IN CROSS SECTIONS

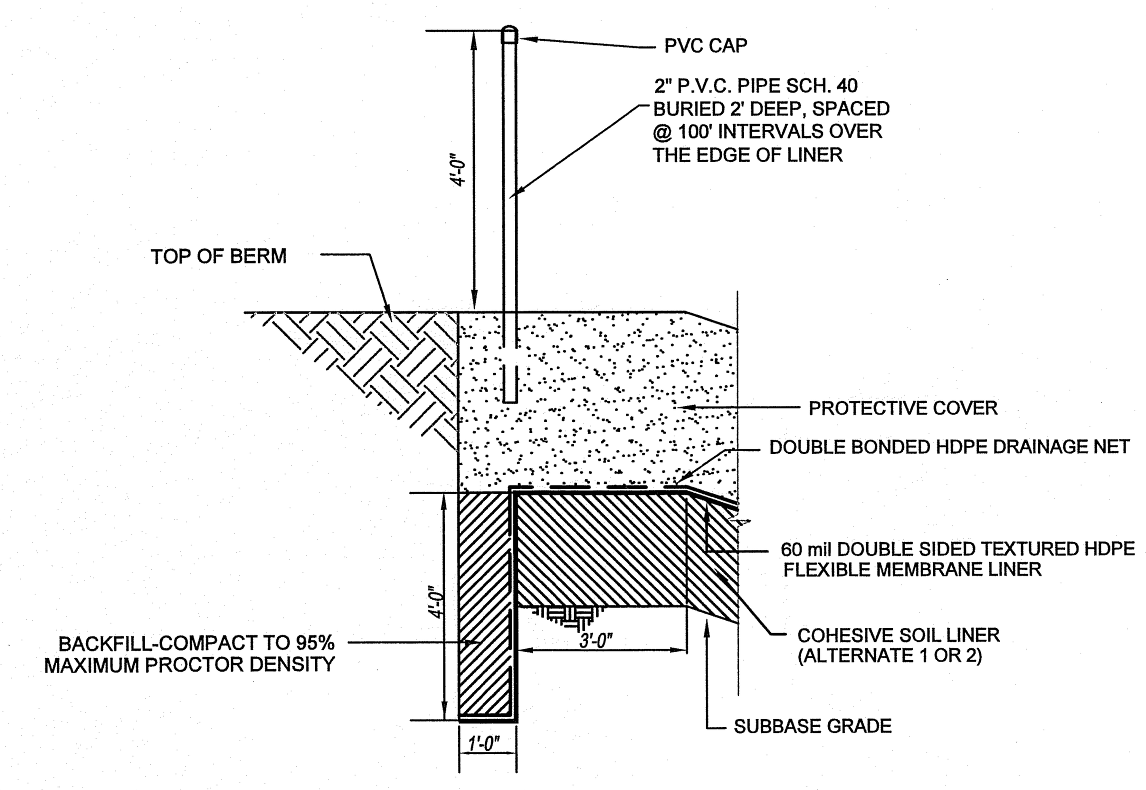
ENGINEERING PLAN - PHASE 3
BASELINE PROFILE AND CROSS SECTIONS

SCALE:	AS SHOWN
DATE:	3/25/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. E13	SHEET NO. 15 OF 17



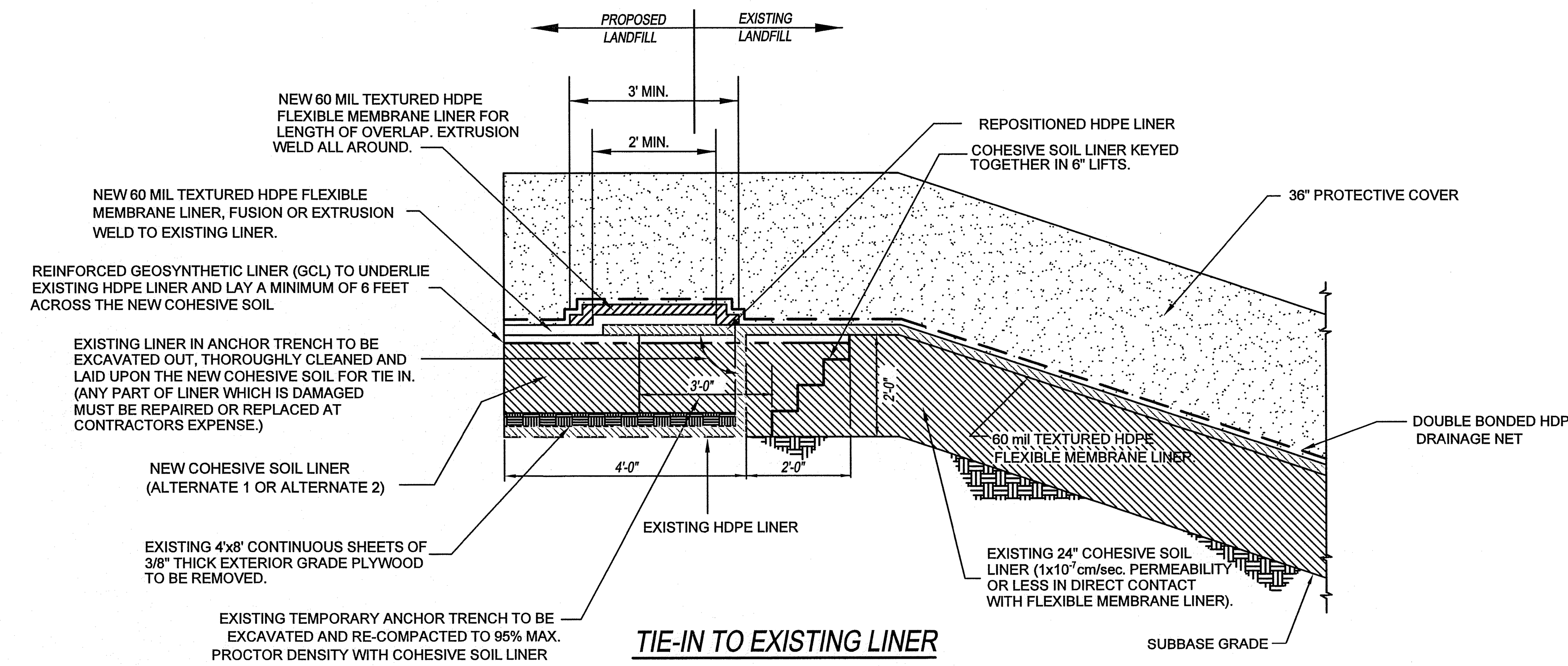
TEMPORARY ANCHOR TRENCH DETAIL

N.T.S.



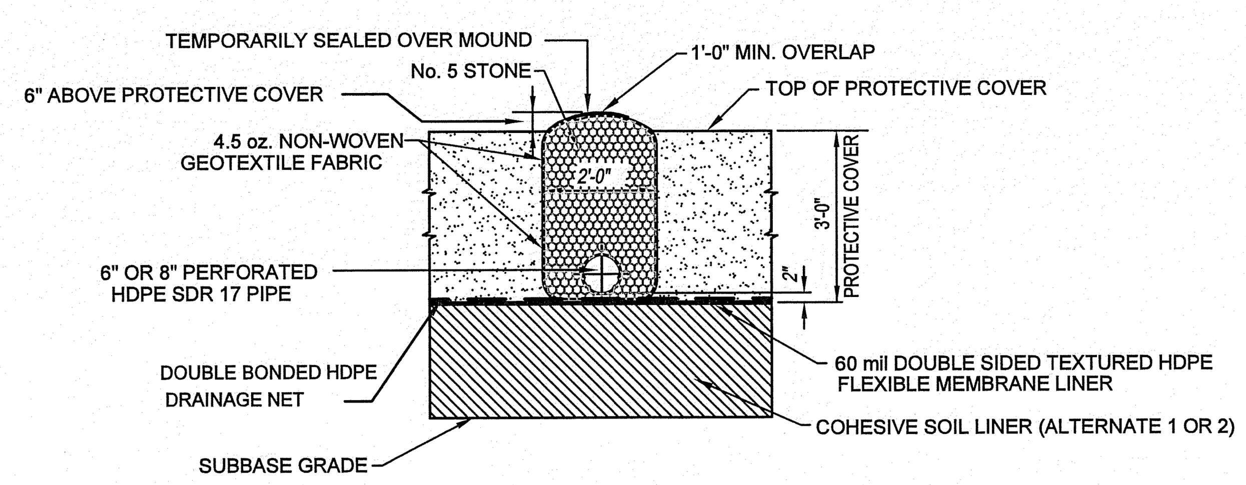
PERMANENT ANCHOR TRENCH DETAIL

N.T.S.



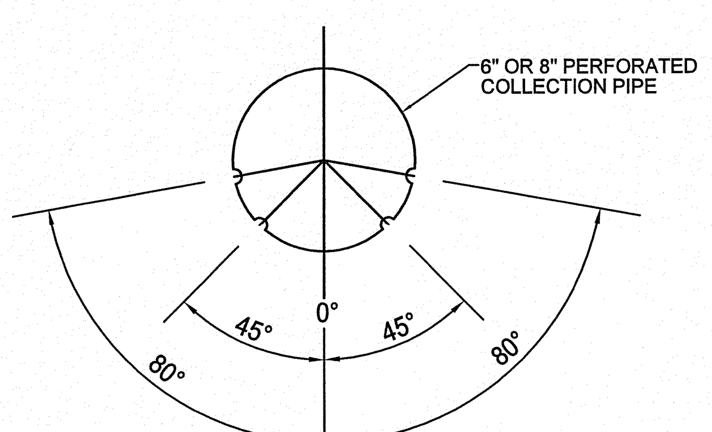
TIE-IN TO EXISTING LINER

N.T.S.



LEACHATE COLLECTION TRENCH DETAIL

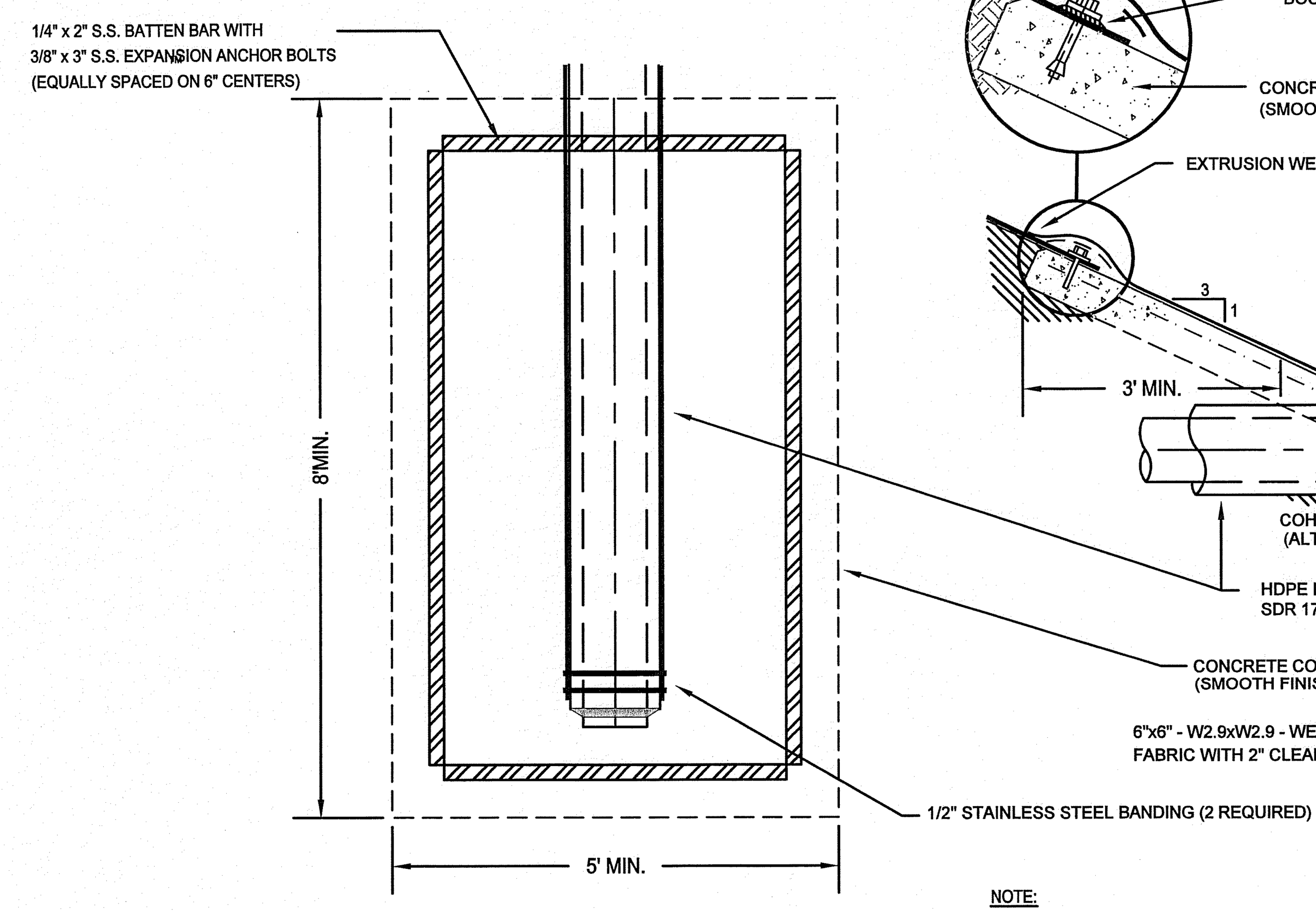
N.T.S.



1. 0° CORRESPONDS TO PIPE INVERT.
2. PROVIDE FOUR 1/2" DIAMETER PERFORATIONS AS SHOWN; 6" O.C.

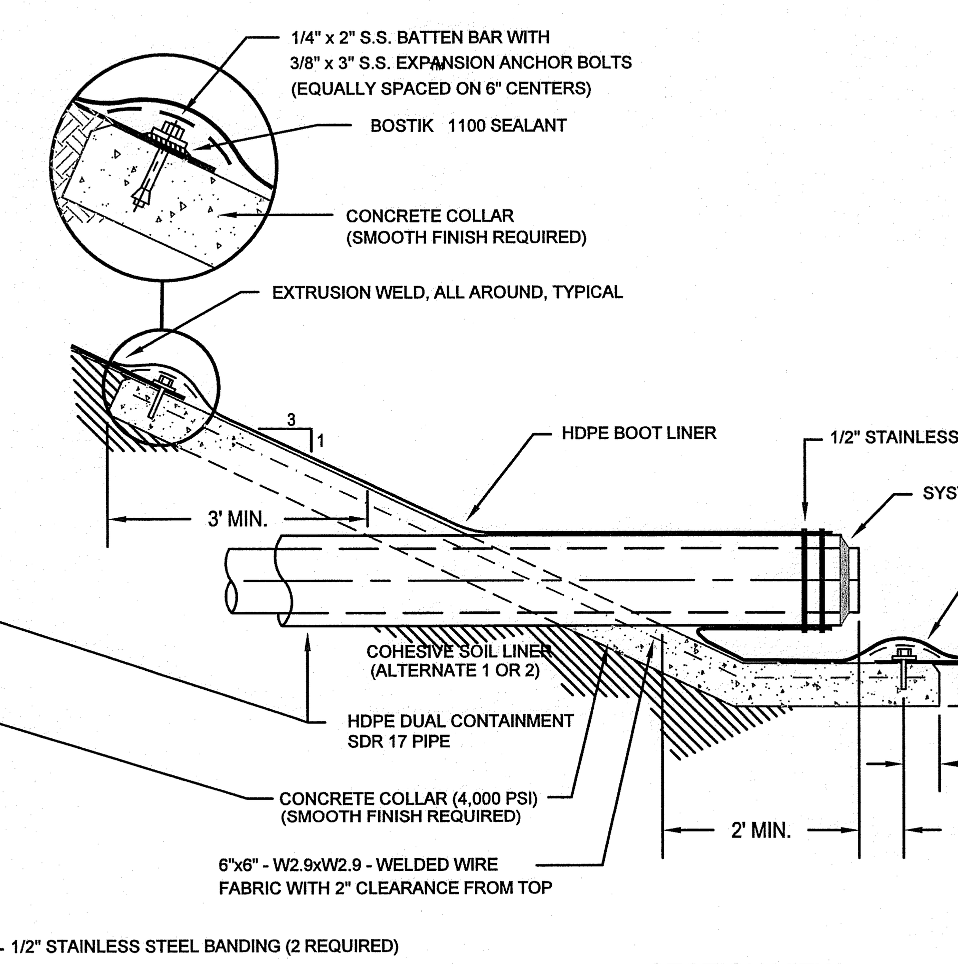
LEACHATE COLLECTION SYSTEM PERFORATION PATTERN DETAIL

N.T.S.



PLAN VIEW

N.T.S.



SECTION VIEW

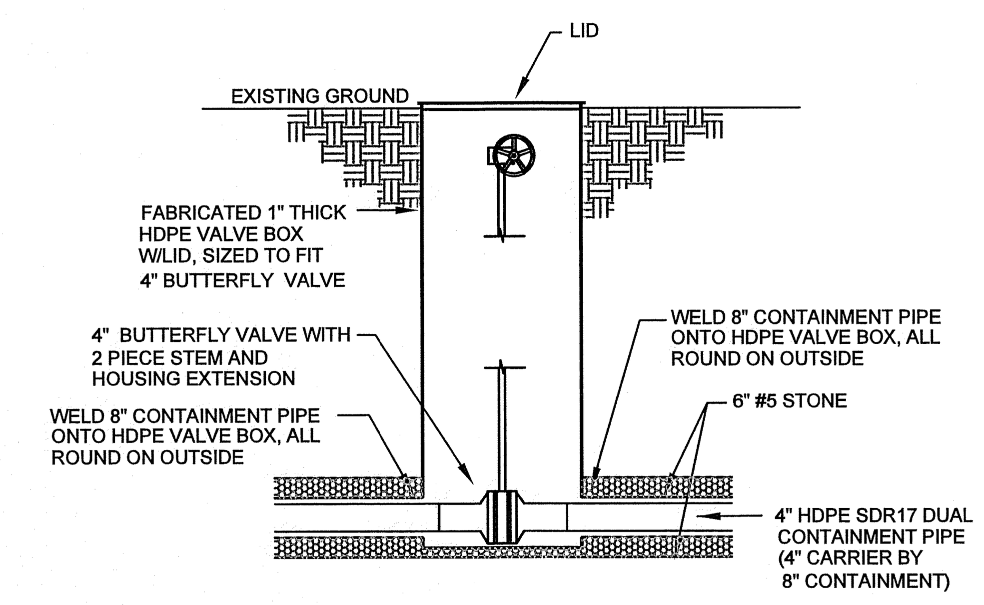
N.T.S.

NOTE:

EARTH ADJACENT TO THE CONCRETE COLLAR SHALL BE COMPACTED TO 95 % MAX. PROCTOR DENSITY TO PREVENT FUTURE DIFFERENTIAL SETTLEMENT. ALL CONCRETE COLLARS ARE TO BE SMOOTH AND CHAMFERED A MINIMUM OF 1" (TYP.) AT ALL CORNER THAT ARE IN CONTACT WITH THE LINER.

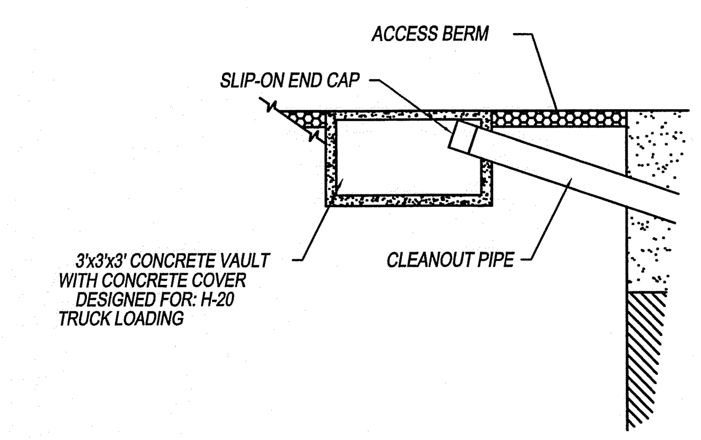
TYPICAL PIPE PENETRATION DETAIL

N.T.S.



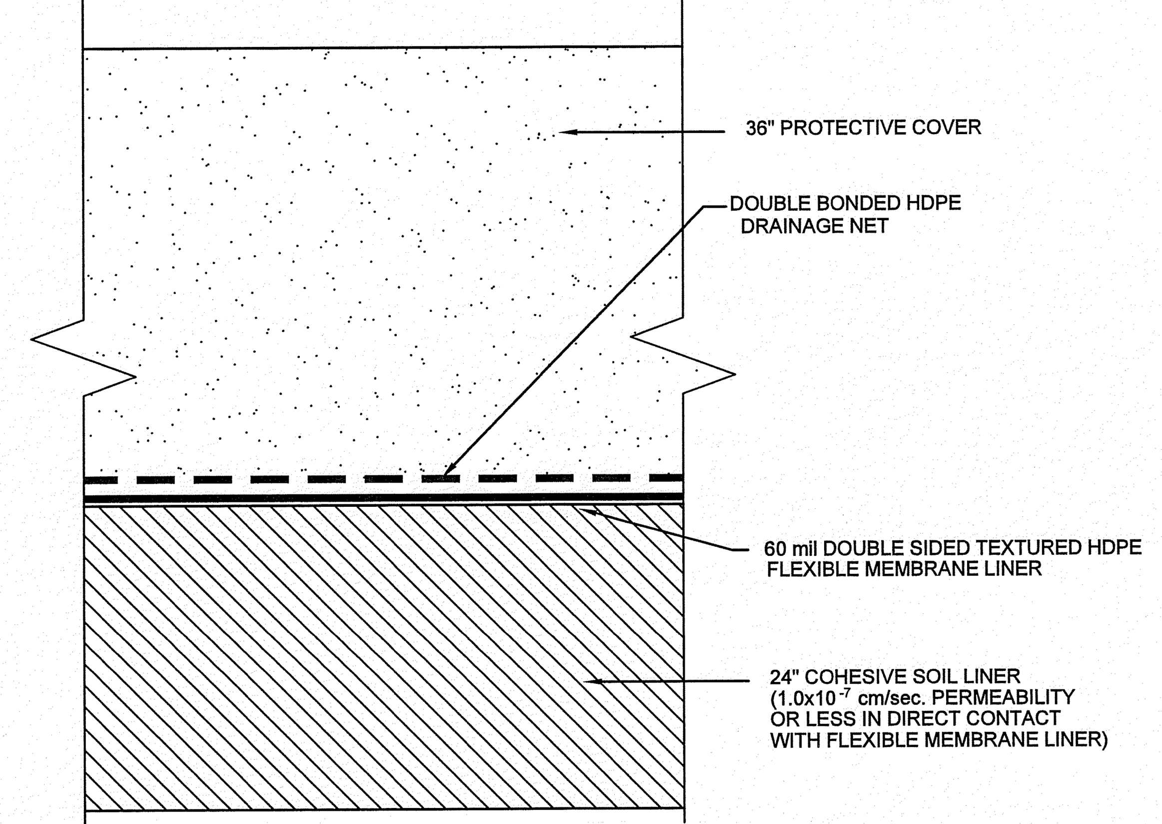
VALVE AND FABRICATED VALVE BOX DETAIL

N.T.S.



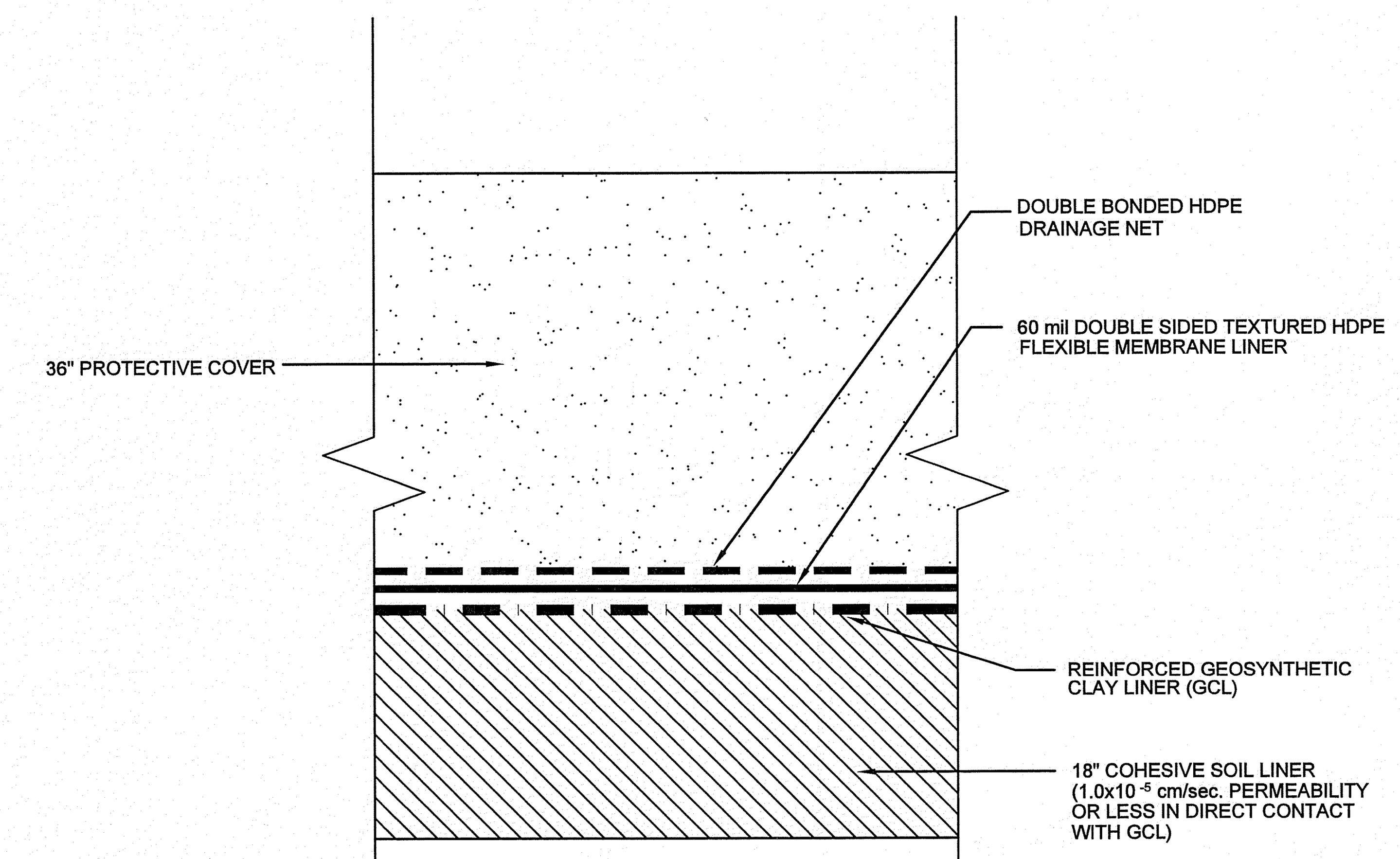
TYPICAL LEACHATE SYSTEM CLEANOUT DETAIL

N.T.S.



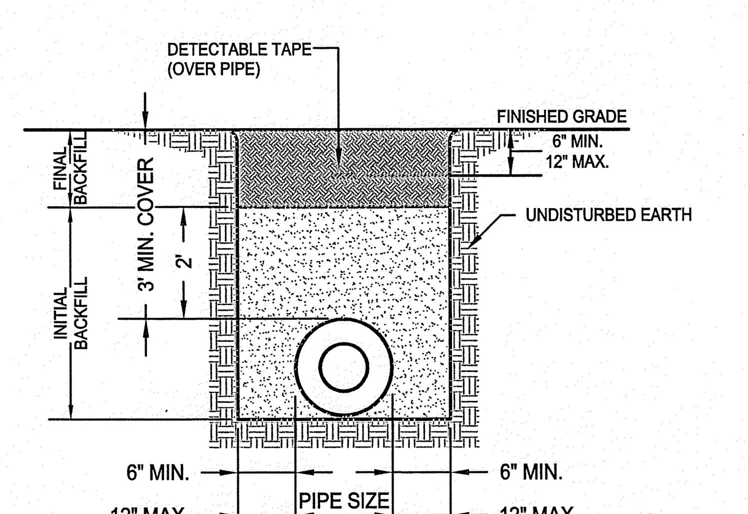
COHESIVE SOIL LINER ALTERNATE 1 DETAIL

N.T.S.



COHESIVE SOIL LINER ALTERNATE 2 DETAIL

N.T.S.

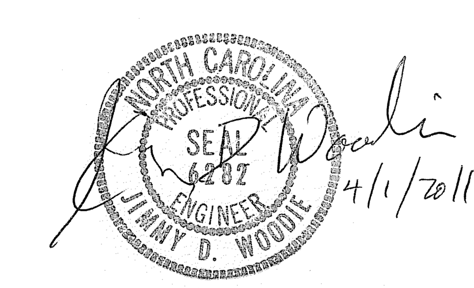


NOTES:

1. EXCAVATE UNDER EACH BELL OR JOINT TO PREVENT ANY LOAD ON BELL OR JOINT.
2. FOR TRENCHES REQUIRING SHORING OR BRACING, DIMENSIONS SHALL BE TAKEN FROM THE INSIDE FACE OF THE SHORING OR BRACING.
3. NO ROCKS OR BOULDERS 4" OR LARGER SHALL BE USED IN THE INITIAL BACKFILL.
4. ALL BACKFILL MATERIAL SHALL BE SUITABLE MATERIAL.
5. BACKFILL SHALL BE TAMPED IN 6" LIFTS IN TRAFFIC AREAS, AND 12" LIFTS IN NON-TRAFFIC AREAS.
6. WHERE ROCK IS ENCOUNTERED IN TRENCH BOTTOM, A CUSHION OF #67 STONE AT LEAST 6" THICK SHALL BE PLACED BETWEEN THE ROCK AND THE PIPE UNLESS OTHERWISE DIRECTED BY THE ENGINEER.
7. WHERE UNSTABLE SOIL IS ENCOUNTERED, EXCAVATE TO A MINIMUM 6" BELOW THE BOTTOM OF THE PIPE BARREL AND REFILL WITH #67 STONE UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

TYPICAL PRESSURE PIPE TRENCH DETAIL

NOT TO SCALE



LICENSE NUMBER: C-0281

Municipal Engineering Services Company, P.A.

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MUNICIPAL SOLID WASTE LANDFILL FACILITY

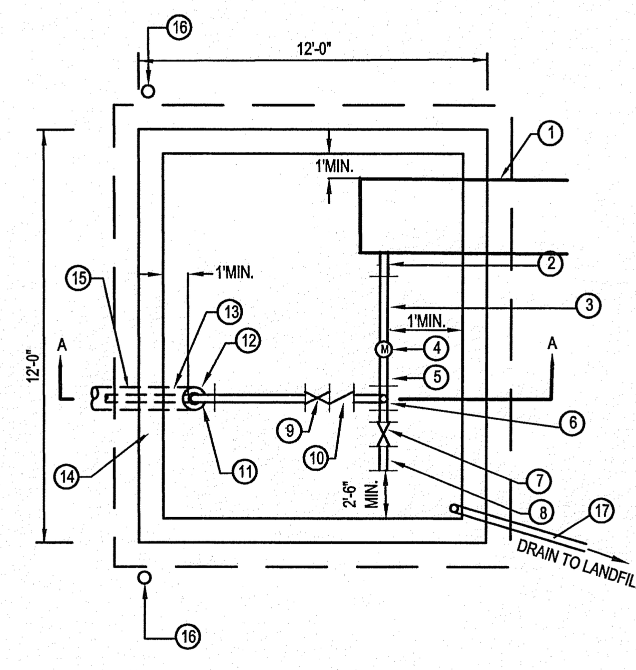
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	NO REVISIONS TO THIS SHEET
1/12/2011	LHC	1	ADDED CLEANOUT AND PIPE TRENCH DETAILS

ENGINEERING PLAN - PHASE 3

CONSTRUCTION DETAILS

SCALE:	AS SHOWN
DATE:	3/25/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. E14	SHEET NO. 16 OF 17

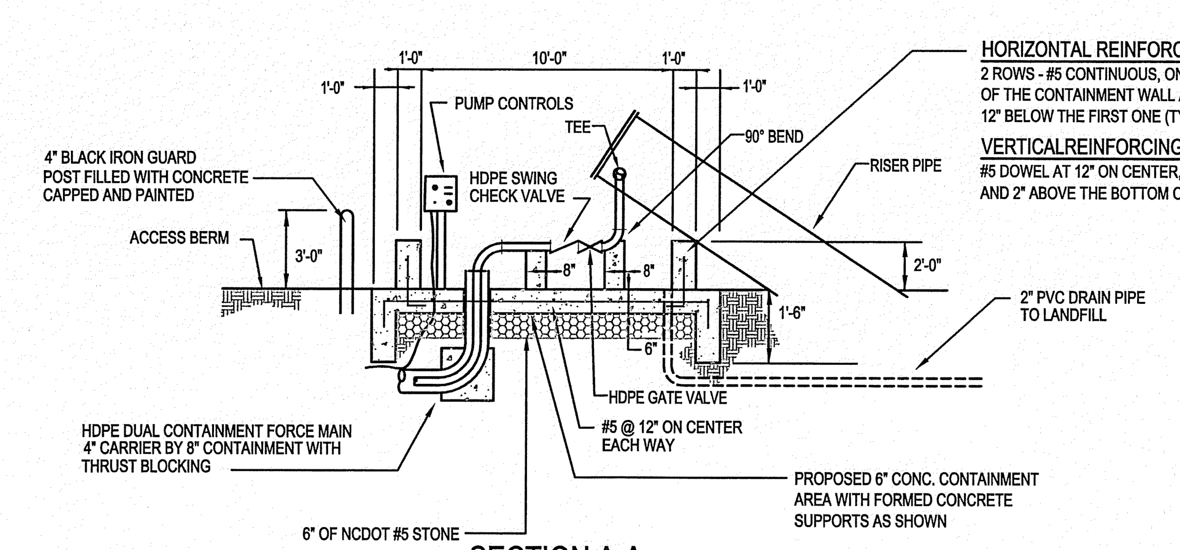


SUMP RISER PAD AND PIPING DETAIL

NOT TO SCALE

1. 24" HDPE SDR 17 SUMP RISER
2. EXIT ASSEMBLY WITH PRESSURE GAUGE AND 3/4" SAMPLE TAP
3. MIN. 18" LONG 4" FLANGED HDPE PIPE
4. 4" BRONZE TURBINE METER, KENT SERIES 3000, MASTER METER, OR APPROVED EQUAL
5. MIN 18" LONG 4" FLANGED HDPE PIPE
6. 4" x 4" FANGED HDPE TEE WITH 2" FLANGED HDPE 90° VERTICAL BEND BELOW TEE
7. 4" FLANGED HDPE GATE VALVE
8. 4" STAINLESS QUICK-DISCONNECT FITTING
9. 4" FLANGED HDPE GATE VALVE
10. 4" FLANGED HDPE SWING CHECK VALVE
11. 1 - 90°, 4" FLANGED HDPE VERTICAL BEND
12. HDPE DUAL CONTAINMENT SOLID STOP WITH WATER STOP BEGIN DUAL CONTAINMENT FORCE MAIN
13. HDPE DUAL CONTAINMENT 90° VERTICAL BEND
14. CONCRETE CONTAINMENT AREA
15. HPDE DUAL CONTAINMENT FORCE MAIN (4" CARRIER BY 8" CONTAINMENT)
16. GUARD POST
17. 2" PVC DRAIN PIPE

NOTE: ALL FITTINGS BY PLASTIC FUSION FABRICATORS OR APPROVED EQUAL

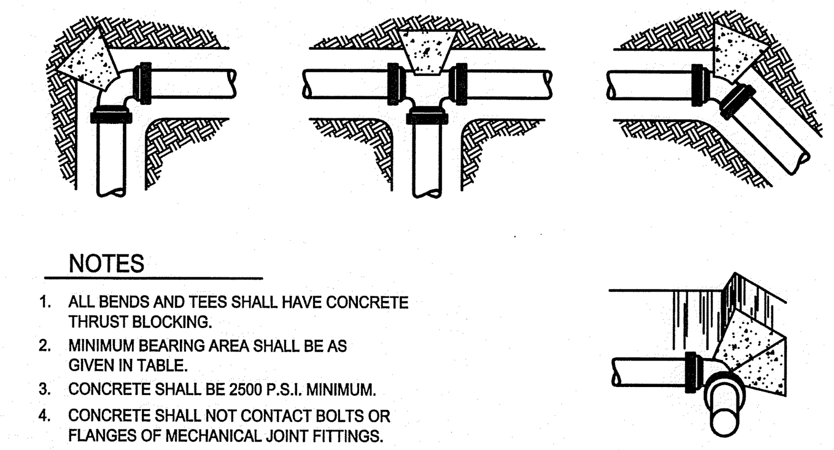


HORIZONTAL REINFORCING:
2 ROWS - #5 CONTINUOUS, ONE 4" BELOW THE TOP OF THE CONTAINMENT WALL AND ANOTHER ONE 12" BELOW THE FIRST ONE (TYPICAL)

VERTICALREINFORCING:
#5 DOWEL AT 12" ON CENTER, 2" BELOW THE TOP OF WALL AND 2" ABOVE THE BOTTOM OF SLAB

SECTION A-A

NOT TO SCALE



NOTES

1. ALL BENDS AND TEES SHALL HAVE CONCRETE THRUST BLOCKING.
2. MINIMUM BEARING AREA SHALL BE AS GIVEN IN TABLE.
3. CONCRETE SHALL BE 2500 P.S.I. MINIMUM.
4. CONCRETE SHALL NOT CONTACT BOLTS OR FLANGES OF MECHANICAL JOINT FITTINGS.

REACTION BEARING AREAS FOR HORIZONTAL WATER PIPE BENDS

BASED ON TEST PRESSURE OF 200 P.S.I. AND SAFETY FACTOR OF 1.5

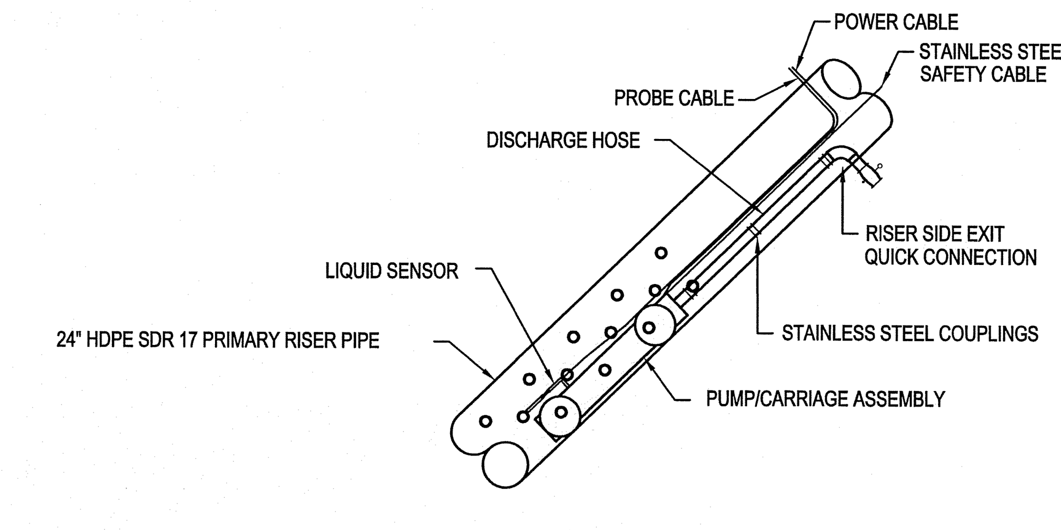
SIZE AND DEGREE OF PIPE BEND		STATIC THRUST IN POUNDS	S_b SOFT CLAY (#/SF)	SILT (#/SF)	GRAVEL OR COURSE SAND (#/SF)	SANDY SILT (#/SF)	SAND (#/SF)	SANDY CLAY (#/SF)	HARD CLAY (#/SF)
			1,000	1,500	1,600	3,000	4,000	6,000	9,000
			BEARING AREA (A_r) IN SF						
8" PIPE	11 1/4°	2,521	4	3	2	1	1	1	0
	22 1/2°	5,018	8	5	5	3	2	1	1
	45°	9,843	15	10	9	5	4	2	2
	90°	18,187	27	18	17	9	7	5	3
	PLUG & BRANCH	12,860	19	13	12	6	5	3	2

REACTION BEARING AREAS ARE IN SQUARE FEET MEASURED IN A VERTICAL PLANE IN THE TRENCH SIDE AT AN ANGLE OF 90 DEGREES TO THE THRUST VECTOR.

USE 6"-90 DEGREE BEND VALUE FOR THE HYDRANTS FOR ADDITIONAL SAFETY FACTOR.

THRUST BLOCKING DETAIL

NOT TO SCALE

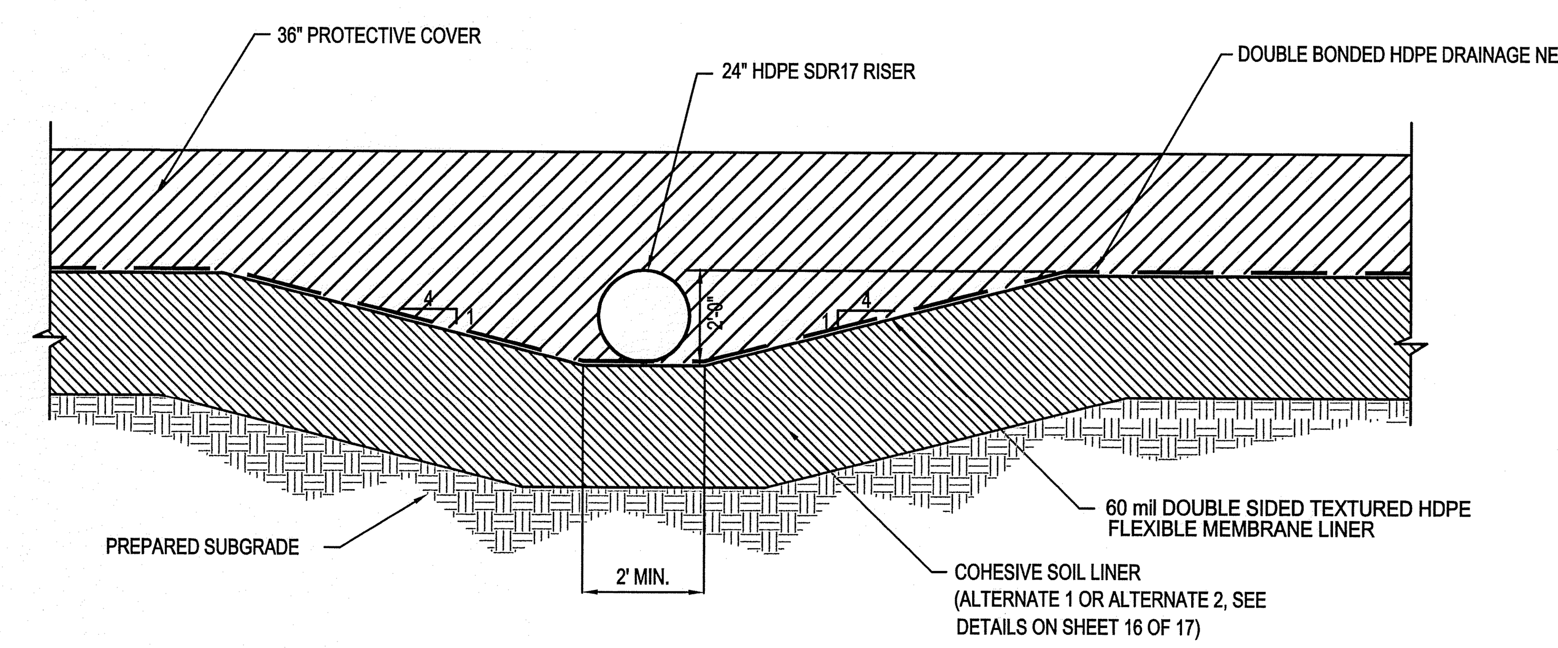


LEACHATE SUMP RISER SCHEMATIC

NOT TO SCALE

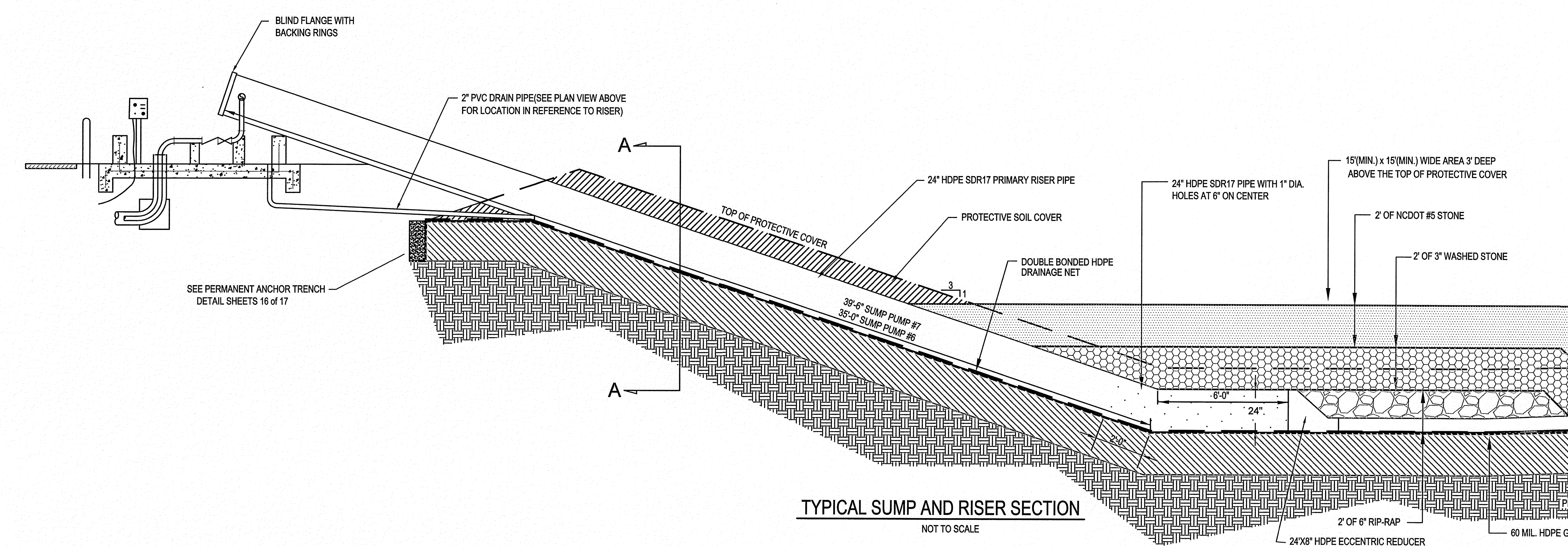
THE PUMP SHALL BE CONSTRUCTED OF ALL 304 STAINLESS STEEL MATERIALS WITH A TEFLON IMPELLER SEAL RING, AND INTERMEDIATE BEARINGS. THE MOTOR SHALL BE AT LEAST 5 H.P., SINGLE PHASE, 230 VOLT, CONSTRUCTED OF STAINLESS STEEL WETTED PARTS.

THE PUMP SHALL INCLUDE A PATENTED STAINLESS STEEL CARRIAGE. THE CARRIAGE SHALL BE DESIGNED FOR SIDE SLOPE RISER LEACHATE APPLICATIONS. THE PUMP ASSEMBLY SHALL HAVE A LOW CENTER OF GRAVITY AND ALL WHEELS OF THE CARRIAGE SHALL REMAIN IN CONTACT WITH THE INSIDE SURFACE OF THE RISER PIPE. THE PUMP SHALL BE EASILY REMOVED FROM THE CARRIAGE SHOULD THE PUMP OR MOTOR REQUIRE SERVICE OR REPLACEMENT. THE PUMP AND CARRIAGE SHALL BE CAPABLE OF ENTRY INTO AN 24" HDPE SDR 17 PIPE AND MUST BE ABLE TO TRAVEL OVER ANY WELDING BEADS AND PERFORATIONS WHICH ARE COMMON TO LEACHATE COLLECTION RISER PIPE FABRICATION. A RETRIEVABLE CABLE ASSEMBLY OF 1/4" STAINLESS STEEL WITH SNAP HOOK AND EYE BOLT SHALL BE PROVIDED.



SECTION A-A
SUMP RISER SIDE SLOPE TRENCH DETAIL

NOT TO SCALE



TYPICAL SUMP AND RISER SECTION

NOT TO SCALE

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	3	NO REVISIONS TO THIS SHEET
1/12/2011	LHC	2	REVISED SHEET REFERENCE NOTES
11/1/2010	LCH	1	REVISED SUMP AND PUMP DETAILS

ENGINEERING PLAN – PHASE 3
SUMP, RISER, PAD AND DETAILS

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 2282 JIMMY D. WOODIE
4/1/2011

SCALE:	AS SHOWN
DATE:	3/25/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. E15	SHEET NO. 17 OF 17

P:\SolidWaste\G06096 – Wayne Co. PTC Ph.3\dwg\engineering\G06096E-17.dwg, 4/1/2011 9:22:14 AM, lch,lch

SECTION 3.0

MATERIALS AND CONSTRUCTION PRACTICES

All tests indicated in this section are described in Section 4.0 Construction Quality Assurance Plan. Tests mentioned in this section are the same tests indicated in Section 4.0.

3.1 Construction Sequence

1. Clear all areas necessary for construction of Riser Basins.
2. Construct Riser Basins.
3. Permanently seed all disturbed areas.
4. Prepare Subgrade.
5. Construct Base Liner System.
6. Construct Penetrations.
7. Construct Protective cover over the Base Liner System.
8. Excavate the Leachate Trenches.
9. Construct Leachate Collection System.
10. Construct the Sewer Line From Leachate Collection System to the Lagoon.
11. Permanently seed any disturbed areas

3.2 Subbase

The fill subgrade will be placed in 8" loose lifts and compacted to at least 95% of maximum dry density and near optimum moisture contents; as determined by Standard Proctor Compaction Test (ASTM D698)' in 6" compacted lifts. Each compacted lift will be tested at one test per six inch (6") lift for each 200 linear feet or fraction thereof of compacted berm(s) less than 50 feet in base width and one test per six (6) inch lift for each 10,000 square feet or fraction thereof of compacted mass fill. If an area fails, it shall be recompacted, reworked or replaced and retested.

Before beginning construction of the base liner system, the Engineer shall visually inspect the exposed surface to evaluate the suitability of the subgrade and document that the surface is properly prepared and that the elevations are consistent with the Division approved engineering plans. The elevations will be verified from survey data based on a 50 foot grid across the subbase.

At a minimum, the subgrade shall be proof-rolled at cut sections utilizing a fully loaded tandem dump truck or equivalent. If movement of the subbase is observed under the tires, the section of movement will be removed and replaced with suitable fill material. This newly placed fill material will then be tested for proper density and moisture.

3.3 Base Liner System (Alternate 1)

3.3.1 Materials and Construction Practices for Cohesive Soil Liner

All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

The soil for the cohesive soil liner shall consist of the red, orange, clayey silt on-site soils if the mica content is less than 0.5 percent by weight passing the No. 200 Sieve and a permeability of 1.0×10^{-7} cm/sec or less for the base liner system is achieved. Off-site cohesive soils may be used if approved by the Engineer and provides a permeability of 1.0×10^{-7} cm/sec or lower for the base liner system. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil liner. The window is developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

A test strip of compacted cohesive soil liner shall be prepared to create a permeability “window” prior to general installation of the cohesive soil liner. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil liner. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least four compacted 6 inch lifts of cohesive soil liner. The test strip may be used as an integral part of the overall cohesive soil liner if it meets the required specification for the liner.

After the test strip passes, soil liner will be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift. A sheepsfoot roller or approved alternative may be used to compact the soil liner provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil liner shall be screened, disked, or prepared using any other, approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. The soil liner must be a minimum of 2.0 feet thick. No additional construction shall proceed on the soil liner at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved. If the soil for the cohesive soil liner is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory.

The thickness and grade of the soil liner will be verified by the Engineer before placement of the geomembrane liner. The thickness and grade will be verified by surveying the clay at 50’ grid points where the elevations of the subbase will be checked with the top of soil liner to verify 2.0 feet of soil liner. The grade will then be verified with the surveyed information. The survey will be performed by NC licensed surveyors.

Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil liner shall have no sudden sharp or abrupt changes in grade. The Contractor shall protect the cohesive soil liner from desiccation, flooding and freezing. Protection, if required, may consist of a thin plastic protective cover, (or other material as approved by the Engineer) installed over the completed cohesive soil liner until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions will be replaced or reworked by the contractor to remove these defects.

The anchor trench shall be excavated by the Contractor to lengths and widths shown on the design drawings prior to geomembrane placement. Anchor trenches excavated in clay soils susceptible to desiccation cracks should be excavated only the distance required for that day’s liner placement to minimize the potential of desiccation cracking of the clay soils. Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

The backfill for the anchor trench shall be compacted to 95% maximum proctor density, There is no grain size requirement, and on-site material shall be used. The frequency of testing shall be for every six (6) inch lift and 500 feet of trench. There is no grain size requirement, and on-site material shall be used.

Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil liner and the surface shall remain the responsibility of the contractor.

3.3.2. <u>Materials and Construction Practices for Flexible Membrane Liner</u>

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

60 mil High Density Polyethylene (HDPE) – Geosynthetic Research Institute (GRI) GM 13 – is to be placed in direct contact with moist cohesive soil liner. The Landfill itself is single lined and will only have a Textured Geomembrane. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner.

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project. Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture. The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing, which will be modified at the completion of the project to reflect actual panel locations.

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds. The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface. No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions, which could result in damage to the geomembrane. Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas. The geomembrane will be deployed in a manner to minimize wrinkles. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed. In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The flexible membrane liner will be welded together by fusion and extrusion fillet welding methods. Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels, which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge. Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets.

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation, which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams may substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day. Fusion Welding is done by first overlapping panels of geomembrane approximately four (4) inches, next clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding. Next, adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths". A movable protective layer may be used, at the discretion of the Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

Extrusion Welding is done by overlapping panels of geomembrane a minimum of three (3) inches and temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane. Next grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area. Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind. Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel. Keep welding rod clean and off the ground.

At a minimum, test seams shall be made upon each start of work for each seaming crew, upon every four hours of continuous seaming, every time seaming equipment is changed or if significant changes in geomembrane temperature and weather conditions are observed. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams. The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width. Visually inspect the seam for squeeze out, footprint, pressure and general appearance. Two random samples one (1) inch wide shall be cut from the test seam. The specimens shall then be tested in peel using a field tensiometer and shall not fail in the seam. If a specimen fails the entire procedure shall be repeated. If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved. After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting, and test results. Passing test results records shall be maintained.

Seaming shall extend to the outside edge of panels to be placed in the anchor trench. While welding a seam, monitor and maintain the proper overlap. Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind. While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly. Align wrinkles at the seam overlap to allow welding through the wrinkle. Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions. All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane. All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind two (2) inches minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

Air pressure testing will be conducted. The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time. An air pump with rubber hose and sharp hollow needle (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi will be used to test the seam. Seal both ends of the seam to be tested. Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld. Inflate the test channel to a pressure between 27 to 30 psi, close valve, and observe initial pressure after approximately 2 minutes. For the 60 mil HDPE liner the seam has to have a minimum initial pressure of 27 psi and a maximum initial pressure of 30 psi. Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize. Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds 3 psi or if the pressure does not stabilize, locate faulty area and repair. At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected. Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

In the event of a Non-Complying Air Pressure Test, check the seam end seals and retest seams. If non-compliance with specified maximum pressure differential re-occurs, repair the seam. When two (2) passing samples are located, the seam between these two (2) locations will be considered non-complying. Capping or removal are the only two (2) acceptable methods of repairing failed seams. Non-destruct test the entire length of the repaired seam.

Vacuum testing will be conducted when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

Vacuum box assembly consists of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, a vacuum gauge, vacuum pump assembly equipped with a pressure controller and pipe connection, a rubber pressure/vacuum hose with fittings and connections, a bucket and means to apply a soapy solution.

The procedure for Vacuum Testing is to trim excess overlap from seam, if any. Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi. Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested. Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner. Close the bleed valve and open the vacuum valve. Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box. Ensure that a leak tight seal is created. For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process. The procedure for Non-Complying Testis to mark all areas where soap bubbles appear and repair the marked areas. Retest repaired areas.

The procedure for Destructive Testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane. All destructive tests will be done according to ASTM D4437. The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications. A one (1) inch sample shall be cut from each end of the test seam for field testing. The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer for peel ASTM D4437. Tensile strength is essentially a measurement of the greatest tension stress a substance can bear without tearing. If the liner tears before any part of the seam does the test is successful. If any field sample fails to pass, it will be assumed the sample fails destructive testing. Destructive samples will be taken every 500 ft. of seam.

In the event of Destructive Test Failure, cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing. All destructive seam samples sent to the Flexible Membrane Liner System's laboratory shall be numbered. If the laboratory samples pass then repair the seam between the two (2) passing samples locations. All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken. Capping or removal of the failed seam, are the only two (2) acceptable methods for repairing failed seams.

The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation. All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely matter to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil liner such as a temporary cover. If cohesive soil liner is damaged, it must be reworked. Procedures available for repair are (1) Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded, (2) Grinding and welding - used to repair sections of extruded seams, (3) Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws, (4) Capping - used to repair lengths of failed seams, (5) Removal of a bad seam and replacement with a strip of new material seamed into place.

Every repair shall be non-destructively tested. Repairs, which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

3.4 Alternate Liner System (Alternate 2)

3.4.1 Materials and Construction Practices for Cohesive Soil Liner

All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

The soil for the cohesive soil liner shall consist of the red, orange, clayey silt on-site soils, if the mica content is less than 0.5 percent by weight passing the No. 200 Sieve and a permeability of 1.0×10^{-5} cm/sec or less, is achieved. Off-site cohesive soils may be used if approved by the Engineer and provides a permeability of 1.0×10^{-5} cm/sec or lower. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil liner. The window is developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

A test strip of compacted cohesive soil liner shall be prepared to create a permeability “window” prior to general installation of the cohesive soil liner. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil liner. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least three compacted 6 inch lifts of cohesive soil liner. The test strip may be used as an integral part of the overall cohesive soil liner if it meets the required specification for the liner.

After the test strip passes, soil liner will be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift. A sheepsfoot roller or approved alternative may be used to compact the soil liner provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil liner shall be screened, disked, or prepared using any other, approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. The soil liner must be a minimum of 1.5 feet thick. No additional construction shall proceed on the soil liner at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved. If the soil for the cohesive soil liner is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory.

The thickness and grade of the soil liner will be verified by the Engineer before placement of the geomembrane liner. The thickness and grade will be verified by surveying the clay at 50’ grid points where the elevations of the subbase will be checked with the top of soil liner to verify 1.5 feet of soil liner. The grade will then be verified with the surveyed information. The survey will be performed by N.C. Professional Surveyor.

Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil liner shall have no sudden sharp or abrupt changes in grade. The Contractor shall protect the cohesive soil liner from desiccation, flooding and freezing. Protection, if required, may consist of a thin plastic protective cover, (or other material as approved by the Engineer) installed over the completed cohesive soil liner until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions will be replaced or reworked by the contractor to remove these defects.

The anchor trench shall be excavated by the Contractor to lengths and widths shown on the design drawings prior to geomembrane placement. Anchor trenches excavated in clay soils susceptible to desiccation cracks should be excavated only the distance required for that day’s liner placement to minimize the potential of desiccation cracking of the clay soils. Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil liner and the surface shall remain the responsibility of the contractor.

3.4.2. Materials and Construction Practices for Geosynthetic Clay Liner (GCL)

The Contractor shall furnish all labor, materials, supervision and equipment to complete the installation of the GCL, including, but not limited to, liner layout, seaming, patching, and all necessary and incidental items required to complete the Work, in accordance with the Contract Drawings and these Specifications.

Sufficient liner material shall be furnished to cover all lined areas shown on the Drawings, including overlaps at field seams and anchor trenches.

The GCL Manufacturer must have produced at least 10 million square feet (1 million square meters) of GCL, with at least 8 million square feet (800,000 square meters) installed. The manufacturer shall submit certification that GCL manufactured for the Project has been produced in accordance with these Specifications along with results from a quality control program. This information must be submitted for review prior to material delivery. The Engineer reserves the right to halt installation until proper certification is submitted and determined acceptable for use.

The Contractor shall submit to the Engineer, six (6) full sets of panel layout construction drawings. Drawings shall be submitted to the Engineer at least two (2) weeks prior to installation.

The manufacturer of the GCL used in this work shall approve all shop drawings and a proposed liner layout to cover the lined area shown on the Drawings.

Details shall be included to show the termination of the liner at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring. A specific anchor trench detail shall be provided.

The Contractor shall submit to the Engineer a physical sample of the liner to be used. The sample shall be labeled with the manufacturer's name, product identification, lot number and roll number.

Upon shipment, the Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification. The Contractor shall also submit to the Engineer inventory tickets, roll numbers or batch identifications, packing papers, and invoices for the liner used.

As installation proceeds, the Contractor shall submit certificates of subgrade acceptance to the Engineer, signed by the Contractor and the GCL Installer for each area that is covered by the GCL.

The Contractor shall provide personnel resumes demonstrating compliance with the following requirements.

1. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million square feet (100,000 square meters) in size.

2. A minimum of one field superintendent per shift shall be designated by the Contractor and approved by the Engineer. Each field superintendent shall have a minimum of three years and five million square feet of field experience in installing GCL's. Any change or replacement of superintendent during the Project must be approved by the Engineer.

3. Liner placement technicians shall have a minimum of one year and one million square feet of GCL placement experience.

The GCLs shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles and shall comply with all of the criteria listed in this Section. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Contractor also must obtain prior approval of the alternative GCL by the Engineer.

Reinforced GCL must be used on all areas of the site. An acceptable GCL product is Bentomat® ST as manufactured by CETCO or an engineer-approved equal. All areas of the project requiring reinforced GCL will be furnished with Bentomat® ST or an engineer-approved equal. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7m) in length and 15 feet (4.6m) in width for Bentomat. Short rolls [(those manufactured to a length greater than 70 feet (21m) but less than a full-length roll)] may be supplied at a rate of no greater than 3 per truckload or 3 rolls for every 36,000 square feet (3,500 square meters) of GCL, whichever is less. A 6-inch (150mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

The GCL manufacturer/Contractor shall provide the Engineer with manufacturing QA/QC certifications for each shipment of GCL, prior to the deployment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager, and shall include:

A. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the parameters swell index and fluid loss shown in CETCO's Technical Data Sheet TR404bm.

B. Manufacturer's test data for finished GCL products(s) of bentonite mass/area, GCL tensile strength, and GCL peel strength demonstrating compliance with the index parameters shown in CETCO's Technical Data Sheet TR404bm.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

D. Manufacturer's test data for finished GCL product(s) including GCL index flux, permeability, and hydrated internal shear strength data demonstrating compliance with the performance parameters shown in CETCO's Technical Data Sheet TR404bm.

Prior to shipment, the GCL manufacturer shall label each roll, identifying: product identification information (Manufacturer's name and address, brand name, product code), lot number, roll number, roll length, width, and weight.

The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

The granular bentonite or bentonite sealing compound used for seaming, penetration sealing, and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer.

CETCO GCL's are delivered in rolls weighing from 2,500 - 2,700 lbs (1,140-1,225 kg). It is necessary to support this weight using an appropriate core pipe. For any installation, the core pipe must not deflect more than 3 inches (75 mm) as measured from end to midpoint when a full GCL roll is lifted. Lifting chains or straps rated for at least twice the load of the GCL should be used in combination with a spreader bar made from an I-beam. The spreader bar ensures that the lifting chains or straps do not chafe against the ends of the GCL roll, which must be able to rotate freely during installation.
A front end-loader, backhoe, dozer, or other equipment can be furnished with the spreader bar and core bar. Alternatively, a forklift with a "stinger" attachment may be used for on-site handling and, in certain cases, installation. **A forklift without a stinger attachment shall not be used to lift or handle the GCL rolls**.

When installing over certain geosynthetic materials, a 4-wheel all-terrain vehicle (ATV) can be used to deploy the GCL from behind. An ATV can be driven directly on the GCL provided that no sudden stops, starts, or turns are made.

Additional equipment needed for installation of CETCO's GCL's include:

- Utility knife and spare blades (for cutting the GCL).
- Granular bentonite or bentonite mastic (for overlapped seams of GCLs with needle punched non-woven geotextiles and for sealing around structures and details).
- Waterproof tarpaulins (for temporary cover on installed material as well as or stockpiled rolls).
- Optional chalk line marker to simplify bentonite placement at seams (when installing a GCL with needle punched non-woven geotextile components).
- Optional flat-bladed vise grips (for positioning the GCL panel by hand).

The manufacturer assumes responsibility for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling, and storage of the GCL are the responsibility of the Contractor, Installer, or other designated party. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage. The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry, and well drained. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks or by use of the dunnage shipped between rolls. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four). Rolls shall never be stacked on end. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation. The integrity and legibility of the labels shall be preserved during storage.

Any surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of vegetation, any debris, sticks, sharp rocks, void spaces, ice, abrupt elevation changes, standing water, cracks larger than one-quarter inch (6mm) in width, and any other foreign matter that could contact the GCL. Subgrade surfaces consisting of granular soils or gravel may not be acceptable due to their large void fraction and puncture potential. Subgrade soils should possess a particle size distribution such that at least 80 percent of the soil is finer than a No. 60 sieve (0.250 mm). Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor. On a continuing basis, the Contractor/GCL Installer shall submit certifications of subgrade acceptance to the Engineer, and the project Construction Observer shall verify acceptance of the subgrade before GCL placement.

It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated in accordance with the project plans and specifications. The excavated trench shall be verified by the Construction Observer prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

Placement of the GCL shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the Engineer.

The contractor shall not install any GCL on this project, at any time, in the absence of the Construction Observer. During start-up of the GCL installation, an agent or representative of the Manufacturer shall provide on-site assistance and instruction to the Contractor and Engineer regarding the appropriate installation techniques. The Construction Observer/Engineer shall inspect each panel, after placement and prior to seaming, for damage and/or defects. All defects and deficiencies shall be properly documented by the GCL Installer and Construction Observer. Defective or damaged panels shall be replaced or repaired, as approved by the Construction Observer/Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the Engineer. The Construction Observer shall observe and verify all repaired defects. Reinforced GCL shall be placed on all areas of the site. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) may be important if the GCL has two different geotextiles. Unless otherwise specified, however, the GCL shall be placed with the white side (non-woven) geotextile facing down. The GCL shall be properly weighted to avoid uplift due to wind. Equipment which could damage the GCL shall not be allowed to travel directly on it. Acceptable installation, therefore, may be accomplished such that the GCL is unrolled in front of the backwards-moving equipment. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues. Equipment necessary to perform the installation (generators, compressors, etc.) shall have a scrap GCL sheet placed underneath to protect the installed GCL from possible damage. The GCL shall be kept free of debris, unnecessary tools and materials. In general, the GCL area shall remain neat in appearance. All damage shall be recorded and located in the record drawings. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement. The GCL shall be placed so that seams are parallel to the direction of the slope. End-of-roll seams should be located at least 3 feet (1m) from the toe and crest of slopes steeper than 4H:1V. GCL rolls shall **not** be released on the slope and allowed to unroll freely by gravity. All GCL panels shall be placed free of tension or stress and lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels. Similarly, the geomembrane placed over GCL shall lie flat and in contact with the underlying GCL with no wrinkles or fold. The GCL shall not be installed in standing/ponded water, during rainy weather/precipitation, excessive moisture, and during extremely/excessive high wind. Only as much GCL shall be deployed as can be covered at the end of the working day with the geomembrane. In no case shall the GCL be exposed to the elements at the end of the day. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it will be necessary to remove and replace the hydrated material. The Engineer, Construction Observer, and GCL supplier should be consulted for specific guidance if premature hydration occurs. The GCL shall not get wet before or during installation. The GCL mat shall not be installed during periods of any precipitation. If a precipitation event occurs after the installation of a GCL panel, but prior to covering with the geomembrane panel, a thin film plastic sheeting, may be used to cover and to temporarily protect the GCL from moisture, if approved by the Engineer.

Panels shall be placed from the highest elevation to the lowest within the area to be lined, to facilitate drainage in the event of precipitation. It is not permissible to stretch the GCL in order to fit a designated area. Panels shall not be dragged across the subgrade into position except where necessary to obtain the correct overlap for adjacent panels.

As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope. The front edge of the trench should be rounded so as to eliminate any sharp corners. The GCL should cover the entire trench floor but does not extend up the rear trench wall. The amount of trench open at any time shall be limited to one day of GCL installation capacity. The anchor trench shall be adequately drained to prevent water ponding and softening the adjacent soils. Loose soil shall be removed from the floor of the trench. The soil backfill should be placed in the trench to provide resistance against pullout. The size and shape of the trench, as well as the appropriate backfill procedures, should be in accordance with the project drawings and specifications.

The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required for Bentomat® ST.

The minimum dimension of the longitudinal overlap should be 6 inches (150 mm). End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure 24 inches (600 mm). In the opinion of the Engineer/Construction Observer, any seam, or edge of GCL material exposed for more than 24 hours or considered partially hydrated when seaming occurs shall receive a 3-foot overlap (rainlap) from the adjoining GCL panel. All seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the record drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be seamed. Seam areas or runs shall also be flat and clear of any large rocks, debris, or ruts. Contacting surfaces shall be clean and clear of dirt or native soil with all edges pulled tight to maximize contact and to smooth out any wrinkles or creases. All seams constructed on sloped surface shall be vertical seams. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. Bentonite-enhanced seams are constructed between the overlapping adjacent panels described above. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6 inch (150 mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap. The bentonite shall be applied at a minimum application rate of one-quarter pound per lineal foot (0.4 kg/m).

Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid irregular tearing of the geotextile components of the GCL during the cutting process. The GCL shall be sealed around penetrations and structures embedded in the subgrade. Granular bentonite or a bentonite mastic shall be used liberally (approximately 2 lbs/in ft or 3 kg/m) to seal the GCL to these structures. When the GCL is placed over an earthen subgrade, a “notch” (approximately 3 inches wide and 8 inches deep) shall be cut against the edge of the subgrade area around the penetration. The mat shall be brought up to the edge of the structure and trimmed to fit into the notch. The Contractor shall then hand-apply a pure bead of bentonite into half the notch. The mat shall then be inserted into the notch, with the remaining volume of the notch refilled with the pure bentonite and compacted. A secondary collar of GCL should be placed around the penetration. It is helpful to first trace an outline of the penetration on the GCL and then cut a “star” pattern in the collar to enhance the collar’s fit to the penetration. Vertical penetrations are prepared by notching into the subgrade. The penetration is completed with two separate pieces of GCL. A secondary collar is option in this case. When the GCL is terminated at a structure or wall that is embedded into the subgrade, the subgrade should be notched as described in Items B and D above. The notch is filled with granular bentonite, and the GCL should be placed over the notch and up against the structure. The connection to the structure can be accomplished by placement of soil or stone backfill in this area.

If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Dry bentonite or bentonite mastic should be applied around the damaged area at the rate of one-half pound per lineal foot prior to placement of the patch. Any epoxy-based adhesives shall be used to keep the patch in position during backfill operations.

Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles [such as 4-wheel all-terrain vehicles (ATV)] may be used to facilitate the installation of any geosynthetic material placed over the GCL, provided the ATV makes no sudden stops, starts, or turns. The GCL supplier or Engineer should be contacted with specific recommendations on the appropriate procedures in this situation. When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position. Any leading edge of panels left uncovered shall be protected at the end of the working day with a waterproof sheet, which is adequately secured with sandbags or other ballast. Soil cover shall be placed over the GCL/geomembrane using low ground pressure construction equipment that minimizes stresses on the GCL/geomembrane, according to the existing project specification requirements for protective cover soil installation over geomembrane liner.

3.4.3. <u>Materials and Construction Practices for Flexible Membrane Liner</u>

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

The 60 mil. High Density Polyethylene (HDPE) – Geosynthetic Research Institute (GRI) GM 13 – is to be placed in direct contact with moist cohesive soil liner. The Landfill itself is single lined and will only have a Textured Geomembrane. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner.

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project. Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture. The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds. The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface. No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions, which could result in damage to the geomembrane. Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas. The geomembrane will be deployed in a manner to minimize wrinkles. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed. In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The flexible membrane liner will be welded together by fusion and extrusion fillet welding methods. Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels, which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge. Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets.

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation, which is in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams may substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day. Fusion Welding is done by first overlapping panels of geomembrane approximately four (4) inches, next clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding. Next, adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths". A movable protective layer may be used, at the discretion of the Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

Extrusion Welding is done by overlapping panels of geomembrane a minimum of three (3) inches and temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane. Next grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼” outside of the extrusion weld area. Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind. Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel. Keep welding rod clean and off the ground.

At a minimum, test seams shall be made upon each start of work for each seaming crew, upon every four hours of continuous seaming, every time seaming equipment is changed or if significant changes in geomembrane temperature and weather conditions are observed. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams. The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width. Visually inspect the seam for squeeze out, footprint, pressure and general appearance. Two random samples one (1) inch wide shall be cut from the test seam. The specimens shall then be tested in peel using a field tensiometer and shall not fail in the seam. If a specimen fails the entire procedure shall be repeated. If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved. After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting, and test results. Passing test results records shall be maintained.

Seaming shall extend to the outside edge of panels to be placed in the anchor trench. While welding a seam, monitor and maintain the proper overlap. Inspect seam area to assure area is clean and free of moisture, dust, dirt, and debris of any kind. While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly. Align wrinkles at the seam overlap to allow welding through the wrinkle. Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions. All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane. All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind two (2) inches minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

Air pressure testing will be conducted. The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time. An air pump with rubber hose and sharp hollow needle (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi will be used to test the seam. Seal both ends of the seam to be tested. Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld. Inflate the test channel to a pressure between 27 to 30 psi, close valve, and observe initial pressure after approximately 2 minutes. For the 60 mil HDPE liner the seam has to have a minimum initial pressure of 27 psi and a maximum initial pressure of 30 psi. Initial pressure settings are read after a two-minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize. Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds 3 psi or if the pressure does not stabilize, locate faulty area and repair. At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected. Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

In the event of a Non-Complying Air Pressure Test, check the seam end seals and retest seams. If non-compliance with specified maximum pressure differential re-occurs, repair the seam. When two (2) passing samples are located, the seam between these two (2) locations will be considered non-complying. Capping or removal, are the only two (2) acceptable methods of repairing failed seams. Non-destruct test the entire length of the repaired seam.

Vacuum testing will be conducted when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

Vacuum box assembly consists of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, a vacuum gauge, vacuum pump assembly equipped with a pressure controller and pipe connection, a rubber pressure/vacuum hose with fittings and connections, a bucket and means to apply a soapy solution.

The procedure for Vacuum Testing is to trim excess overlap from seam, if any. Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi. Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested. Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner. Close the bleed valve and open the vacuum valve. Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box. Ensure that a leak tight seal is created. For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process. The procedure for Non-Complying Test is to mark all areas where soap bubbles appear and repair the marked areas. Retest repaired areas.

The procedure for Destructive Testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane. All destructive tests will be done according to ASTM D4437. The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications. A one (1) inch sample shall be cut from each end of the test seam for field-testing. The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer for peel ASTM D4437. Tensile strength is essentially a measurement of the greatest tension stress a substance can bear without tearing. If the liner tears before any part of the seam does the test is successful. If any field sample fails to pass, it will be assumed the sample fails destructive testing. Destructive samples will be taken every 500 ft. of seam.

In the event of Destructive Test Failure, cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing. All destructive seam samples sent to the Flexible Membrane Liner System's laboratory, shall be numbered. If the laboratory samples pass then repair the seam between the two (2) passing samples locations. All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken. Capping or removal of the failed seam are the only two (2) acceptable methods for repairing failed seams.

The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation. All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely matter to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil liner such as a temporary cover. If cohesive soil liner is damaged, it must be reworked. Procedures available for repair are (1) Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded, (2) Grinding and welding - used to repair sections of extruded seams, (3) Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws, (4) Capping - used to repair lengths of failed seams, (5) Removal of a bad seam and replacement with a strip of new material seamed into place.

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test, shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

3.5 HDPE Double Bonded Drainage Net

3.5.1 Materials and Construction Practices

The geonets will be handled in such a manner as to ensure the geonets are not damaged in any way. On slopes, the geonets will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet will be positioned by hand after being unrolled to minimize wrinkles. Geonets can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geonets will not be welded to the geomembrane. Geonets will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geonet that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geonet will be overlapped by at least four inches and securely tied. Tying, can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one (1) foot intervals. In the corners of the side slopes where overlaps between perpendicular geonet strips are required, an extra layer of geonet will be unrolled along the slope, on top of the previously installed geonets, from the top to bottom of the slope.

Any holes or tears in the geonet will be repaired by placing a patch extending two feet beyond edges of the hole or tear. The patch will be secured to the original geonet by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geonet will be joined.

3.6 Protective Cover

3.6.1. Materials and Construction Practices

The soil for the select site backfill shall consist of suitable site soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension, which has been screened. No permeability, grain size, or other tests are required for this material. This material is not being used as a drainage media, leachate collection lines are installed every fifty feet and designed to collect water flowing on top of the protective cover.

Leachate that may permeate thru the protective cover will flow into the composite geonet. The velocity of the leachate thru the protective cover will not be adequate to carry sediment. However, the geotextiles that are bonded to the drainage net are intended to filter out sediment so that it will clog the geonet. The Apparent Opening Size (AOS) of the geotextile is large enough to let water pass but small enough to filter out soil particles greater than the number 100 sieve or 0.15 mm.

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The protective cover shall be composed of select backfill and backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

A minimum of 12 inches of cover between low ground pressure equipment such as the Caterpillar D6H LGP, or approved equal, and the liner is required at all times. Roadways for entering and for transporting material over slopes and floor shall have a minimum depth of four feet. Avoid undue stress on the liner at all times. Cover material must be pushed up side slopes, never down to help minimize wrinkles. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Material must be placed to minimize wrinkles, wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner. If damage does occur, report it to the Project Manager immediately so that repairs can be performed without needless delay. Cover shall be placed and maintained in a uniform thickness, free of ruts and irregularities. Do not work wet cover material that cannot support equipment. Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

3.7 Liner Tie-In

3.7.1. Materials and Construction Practices

The edge of the existing HDPE liner shall be exposed. The HDPE liner will be rolled back to expose the cohesive soil. The existing cohesive soil will be keyed into to each subsequent lift of the next phase's cohesive soil. If geosynthetic clay liner (GCL) is used, the GCL shall cover the keyed in area of both the existing and new cohesive soil liners and be in direct contact with the existing and new HDPE liners.

The new HDPE liner shall be overlapped over the existing HDPE liner and an extrusion or fusion weld completed along the entire length of the overlapped liners at the tie in and then non-destructively tested. Once the extrusion weld has been completed, a three foot cap will be placed over entire tie in seam and the seams non-destructively tested.

3.8 Leachate Collection System

3.8.1. Materials and Construction Practices

All materials and equipment, shall be furnished by an established and reputable manufacturer, or supplier. All materials and equipment, shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications, or shall be the product of the listed manufacturers, or similar and equal; thereto, as approved by the Engineer.

The Leachate Collection System consists of No. 5 stone, 4.5 oz. Non-woven Geotextile fabric, and SDR 17 HDPE pipe will be used in the construction of the Leachate Collection System.

A 2' wide by 3' deep trench will be dug out of the protective cover as indicated on the operation drawings located in section 5 of this document. Excavation for the leachate collection shall be done only after the three foot of protective cover has been installed over the flexible membrane liner. Mechanical equipment can be used for the first two and one-half feet of excavation. The remaining one-half foot or whatever protective cover remains above the flexible membrane liner shall be excavated by hand so as to not damage the liner. If damage occurs to the liner the Engineer or Owner shall be notified immediately and the repair shall take place shortly thereafter.

The 4.5oz non-woven geotextile fabric will be placed in the trench such that it can completely surround the trench. No. 5 stone will be placed at a depth of 2" in the whole length of the trench. Next the butt fused perforated SDR 17 6" or 8" HDPE pipe will be placed on top of the 2" thick stone and then covered with the No. 5 stone. After the placement of the stone the 4.5oz geotextile will be closed over top of the trench. All the leachate collection pipe, as shown on the operation drawings, is connected in a way such that all leachate runs to the low spot in the landfill where it will be gravity fed into the sewer line.

Butt Fusion for HDPE pipe. Clean pipe ends inside and outside with a clean cloth to remove dirt, water, grease and other foreign materials. Square (face) the pipe ends using facing tool of the fusion machine. Check line-up of pipe ends in fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. This is commonly referred to as "adjusting high-low". It is advisable at this point to make sure the clamps are tight so that the pipe does not slip during the fusion process. Insert clean heater plate between aligned ends, and bring ends firmly in contact with plate, but do not apply pressure while achieving melt pattern. Carefully move the pipe ends away from the heater plate and remove the plate. (If the softened material sticks to the heater plate, discontinue the joint. Clean heater plate, re-square pipe ends and start over.)

Note: One pipe end usually moves away from the heater plate first. It is good practice to "bump" the plate away from the other side and then lift it out. Never drag or slide it over the melted pipe end.
Bring melted ends together rapidly. Do not slam. Apply enough pressure to form a double roll back to the body of the pipe brad around the entire circumference of the pipe about 1/8" to 3/16" wide. Pressure is necessary to cause the heated material to flow together. Allow the joint to cool and solidify properly. This occurs when the brad feels hard and your finger can remain comfortably on the brad. Remove the pipe from the clamps and inspect the joint appearance.

Knife Gate Valves will be placed in several places to control stormwater and leachate as indicated in the operation drawings.

3.9 Sewer Line

3.9.1. Materials and Construction Practices

The sewer line consists of a SDR 17 HDPE dual containment pipe, 8” carrier by 12” containment, Polyethylene manholes are placed along the sewer line. The sewer line runs to the Leachate Lagoon where it is aerated as needed, recirculated or pumped to its appropriate location.

All Gravity Flow Pipeline shall be installed using a laser for control of vertical and horizontal alignment. The Contractor shall follow accepted practices in the utilization of the laser. A certified laser operator shall be present on the job at all times. Care shall be exercised to assure that the alignment control range of the instrument is not exceeded; but in no case, shall the range exceed 500 feet. Care shall be taken to prevent vibration of or direct sunlight on the instrument. Where present, a blower shall be provided to purge glue vapors from the pipe. An air velocity meter shall be provided so that the velocity of air in the pipe will not be great enough to cause the light beam to be distorted. The Contractor shall coordinate the work to minimize the number of take downs and set ups at each point. Periodic checks of the laser shall be made to assure that alignment is maintained.

Each pipe shall be laid on an even, firm bed, so that no uneven strain will come to any part of the pipe. Before each piece of pipe is lowered into the trench, it shall be thoroughly inspected to insure it’s being clean. Each piece of pipe shall be lowered separately. No piece of pipe or fitting which is known to be defective, shall be laid or placed in the lines. If any defective pipe or fitting shall be discovered after the pipe is laid it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe.

Butt Fusion for HDPE pipe. Clean pipe ends inside and outside with a clean cloth to remove dirt, water, grease and other foreign materials. Square (face) the pipe ends using facing tool of the fusion machine. Check line-up of pipe ends in fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. This is commonly referred to as "adjusting high-low". It is advisable at this point to make sure the clamps are tight so that the pipe does not slip during the fusion process. Insert clean heater plate between aligned ends, and bring ends firmly in contact with plate, but do not apply pressure while achieving melt pattern. Carefully move the pipe ends away from the heater plate and remove the plate. (If the softened material sticks to the heater plate, discontinue the joint. Clean heater plate, re-square pipe ends and start over.)

Note: One pipe end usually moves away from the heater plate first. It is good practice to "bump" the plate away from the other side and then lift it out. Never drag or slide it over the melted pipe end.

Bring melted ends together rapidly. Do not slam. Apply enough pressure to form a double roll back to the body of the pipe brad around the entire circumference of the pipe about 1/8" to 3/16" wide. Pressure is necessary to cause the heated material to flow together. Allow the joint to cool and solidify properly. This occurs when the brad feels hard and your finger can remain comfortably on the brad. Remove the pipe from the clamps and inspect the joint appearance.

HDPE Dual Containment Force main - ASTM D3350. All HDPE pipe shall be tested at its rated working pressure. In no case shall there be any visible leakage, nor shall there be leakage between any section of pipe.

3.10 Closure Cohesive Soil Cap

3.10.1. Materials and Construction Practices

All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

The soil for the cohesive soil cap shall consist of on-site soils if a permeability of 1.0 x 10^{-5} cm/sec or less is achieved. Off-site cohesive soils may be used if approved by the Engineer and provides a permeability of 1.0 x 10^{-5} cm/sec or lower Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil cap. The window shall be plotted on a semi-log plot with moisture content versus density. Laboratory testing to develop the window shall include a series of remolded samples compacted to various dry densities and moisture contents utilizing the same compactive effort (ASTM D 698 or D 1557). The remolded samples shall be tested for permeability to determine whether or not the particular soil type will provide the maximum permeability (1.0 x 10^{-5} cm/sec) at various dry densities and moisture contents. The window is then developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

A test strip of compacted cohesive soil cap shall be prepared to verify the permeability "window" prior to general installation of the cohesive soil cap. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil cap. At a minimum, the verification will consist of three moisture density tests, one Atterberg limits test, one grain size distribution test (ASTM D2487, D4318, and D422), and one Shelby Tube sample for each lift constructed in the test pad. Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 x10^{-5}cm/sec. Tests shall be performed in accordance with the ASTM D5084. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least three compacted 6 inch lifts of cohesive soil cap. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil cap. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeability of 1.0 x 10^{-5} cm/sec of the cohesive soil cap. The test strip may be used as an integral part of the overall cohesive soil cap if it meets the required specification for the cap. All results shall be given to the Construction Observer (CO).

After the test strip passes, soil will be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift. A sheepsfoot roller or approved alternative may be used to compact the soil cap provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil cap shall be screened, disked, or prepared using any other, approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. The clay cap must be a minimum of 1.5 feet thick. No additional construction shall proceed on the soil cap at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved. If the soil for the cohesive soil cap is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory.

The thickness and grade of the clay cap will be verified by the engineer before placement of the geomembrane liner. The thickness and grade will be verified by surveying the cap at 50' grid points where the elevations of the subbase will be checked with the top of soil cap to verify 1.5 feet of cap. The grade will then be verified with the surveyed information. The survey will be performed by N.C. Professional Surveyors.

Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil cap shall have no sudden sharp or abrupt changes in grade. The Contractor shall protect the cohesive soil cap from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil cap until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions will be replaced or reworked by the contractor to remove these defects.

The anchor trench shall be excavated by the Contractor to lengths and widths shown on the design drawings prior to geomembrane placement. Anchor trenches excavated in clay soils susceptible to desiccation cracks should be excavated only the distance required for that days liner placement to minimize the potential of desiccation cracking of the clay soils. Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil cap and the surface shall remain the responsibility of the contractor.

3.11 Closure Flexible Membrane Liner

3.11.1 Materials and Construction Practices

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

The 40 mil Linear Low Density Polyethylene (LLDPE) is to be placed in direct contact with moist cohesive soil cap. The extrusion cap and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner.

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project. Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture. The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing, which will be modified at the completion of the project to reflect actual panel locations.

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds. The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface. No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions, which could result in damage to the geomembrane. Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas. The geomembrane will be deployed in a manner to minimize wrinkles. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed. In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The flexible membrane liner will be welded together by fusion and extrusion fillet welding methods. Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels, which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device, which continuously monitors the temperature of the wedge. Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets.

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation, which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will affect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams may substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day. Fusion Welding is done, by first overlapping panels of geomembrane approximately four (4) inches, next clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding. Next, adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths". A movable protective layer may be used, at the discretion of the Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

Extrusion Welding is done by overlapping panels of geomembrane a minimum of three (3) inches and temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane. Next grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area. Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind. Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel. Keep welding rod clean and off the ground.

Test seams shall be performed at the beginning of each seaming period and at approximately every 4-working hour intervals for each seaming apparatus used that day. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams. The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width. Visually inspect the seam for squeeze out, footprint, pressure and general appearance. Two random samples one (1) inch wide shall be cut from the test seam. The specimens shall then be tested in peel using a field tensiometer and shall not fail in the seam. If a specimen fails the entire procedure shall be repeated. If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved. After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting, and test results. Passing test results records shall be maintained.

Seaming shall extend to the outside edge of panels to be placed in the anchor trench. While welding a seam, monitor and maintain the proper overlap. Inspect seam area to assure area is clean and free of moisture, dust, dirt, and debris of any kind. While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly. Align wrinkles at the seam overlap to allow welding through the wrinkle. Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions. All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane. All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind two (2) inches minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

Air pressure testing will be conducted. The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time. An air pump with rubber hose and sharp hollow needle (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi will be used to test the seam. Seal both ends of the seam to be tested. Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld. Inflate the test channel to a pressure between 25 to 30 psi, close valve, and observe initial pressure after approximately 2 minutes. For the 40 mil LLDPE liner the seam has to have a minimum initial pressure of 25 psi and a maximum initial pressure of 30 psi. Initial pressure settings are read after a two-minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize. Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds 4 psi or if the pressure does not stabilize, locate faulty area and repair. At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected. Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

In the event of a Non-Complying Air Pressure Test, check the seam end seals and retest seams. If non-compliance with specified maximum pressure differential re-occurs, repair the seam. When two (2) passing samples are located, the seam between these two (2) locations will be considered non-complying. Capping or removal, of the non-complying seam are the only two (2) acceptable methods for repairing failed seams. Non-destruct test the entire length of the repaired seam.

Vacuum testing will be conducted when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

Vacuum box assembly consists of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, a vacuum gauge, vacuum pump assembly equipped with a pressure controller and pipe connection, a rubber pressure/vacuum hose with fittings and connections, a bucket and means to apply a soapy solution.

The procedure for Vacuum Testing is to trim excess overlap from seam, if any. Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi gauge. Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested. Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner. Close the bleed valve and open the vacuum valve. Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box. Ensure that a leak tight seal is created. For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles. If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process. The procedure for Non-Complying Test is to mark all areas where soap bubbles appear and repair the marked areas. Retest repaired areas.

The procedure for Destructive Testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane. All destructive tests will be done according to ASTM D4437. The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications. A one (1) inch sample shall be cut from each end of the test seam for field-testing. The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer for peel ASTM D4437. Tensile strength is essentially a measurement of the greatest tension stress a substance can bear without tearing. If the liner tears before any part of the seam does the test is successful. If any field sample fails to pass, it will be assumed the sample fails destructive testing. Destructive samples will be taken every 500 ft. of seam.

In the event of Destructive Test Failure, cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing. All destructive seam samples sent to the Flexible Membrane Liner System's laboratory, shall be numbered. If the laboratory samples pass then repair the seam between the two (2) passing samples locations. All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken. Capping or removal, of the failed seam are the only two (2) acceptable methods for repairing failed seams.

The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation. All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure, shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely matter to protect the moist cohesive soil cap and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil cap such as a temporary cover. If cohesive soil cap is damaged, it must be reworked. Procedures available for repair are (1) Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded, (2) Grinding and welding - used to repair sections of extruded seams, (3) Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws, (4) Capping - used to repair lengths of failed seams, (5) Removal of a bad seam and replacement with a strip of new material seamed into place.

Every repair shall be non-destructively tested. Repairs, which pass the non-destructive test, shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

3.12 Closure HDPE Double Bonded Drainage Net

3.12.1 Materials and Construction Practices

The geonets will be handled in such a manner as to ensure the geonets are not damaged in any way. On slopes, the geonets will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet will be positioned by hand after being unrolled to minimize wrinkles. Geonets can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geonets will not be welded to the geomembrane. Geonets will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geonet that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geonet will be overlapped by at least four inches and securely tied. Tying can be achieved, by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one-foot intervals. In the corners of the side slopes where overlaps between perpendicular geonet strips are required, an extra layer of geonet will be unrolled along the slope, on top of the previously installed geonets, from the top to bottom of the slope.

Any holes or tears in the geonet will be repaired by placing a patch, extending two feet beyond edges of the hole or tear. The patch will be secured to the original geonet by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geonet will be joined.

3.13 Closure Protective Cover

3.13.1 Materials and Construction Practices

The soil for the select site backfill shall consist of suitable site soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension, which has been screened. No permeability, grain size, or other tests are required for this material.

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The protective cover shall be composed of 24" of select backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

A minimum of 12 inches of cover between low ground pressure equipment such as the Caterpillar D6H LGP, or approved equal, and the liner is required at all times. Roadways for entering and for transporting material over slopes and floor shall have a minimum depth of four feet. Avoid undue stress on the liner at all times. Cover material must be pushed up side slopes, never down to help minimize wrinkles. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Material must be placed to minimize wrinkles, wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner. If damage does occur, report it to the Project Manager immediately so that repairs can be performed without needless delay. Cover shall be placed and maintained in a uniform thickness, free of ruts and irregularities. Do not work wet cover material that cannot support equipment. Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

3.14 Closure Methane Venting System

3.14.1 Materials and Construction Practices

The Methane Gas Venting System will consist of No. 5 stone, 8 oz. Geotextile fabric, and 8" PVC pipe will be used in the construction of the Gas venting system.

A 2' wide by 1' deep trench will be dug out of the intermediate cover as indicated on the operation drawings located in section 5 of this document. An 8oz geotextile fabric will be placed inside the trench such that it can completely surround the trench. No. 5 stone will be placed solely in the whole length of the trench except for the first 10' in all directions of the 10" PVC solid walled vent pipe, where 8" PVC pipe shall be placed and covered with the No. 5 stone. After the placement of the stone the 8oz geotextile will be closed over top of the trench.

SECTION 4.0

CONSTRUCTION QUALITY ASSURANCE PLAN

4.1 Introduction

The Division of Waste Management (Division) requires that the Engineer certify the constructed landfill is built according to approved plans and specifications. The Engineer that will accomplish this task is the one who did the planning and has written the specifications.

Before construction can begin a pre-construction meeting will be held and the responsibilities and duties of each party will be discussed.

The parties involved in the construction of the landfill are the Owner, Contractor and Engineer. The Contractor is contractually responsible to the Owner. The Engineer is the Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of the Engineer as the Owner's representative are set forth in the Contract Document and will not be changed without written consent of the Owner and Engineer.

The Contactor will purchase and supply all materials that are part of the landfill construction. They will employ subcontractors who will install and non-destructively test all flexible membrane liners. They will also employ a North Carolina licensed geotechnical engineer and land surveyor. The geotechnical engineer will test, report and certify the results for all structural and cohesive soils that are incorporated in the landfill. The surveyor will report and certify elevations of the as-built sub-grade, top of clay and protective cover.

The Contractor is responsible for following and meeting the requirements set forth in the contract documents. The Contractors will provide to the Owner of the landfill and the Engineer a completed landfill constructed by Division approved plans and specifications. The Contractor will give the Engineer a schedule for completion of the landfill including dates for expected construction of the clay test pad, base liner system installation, installation of protective cover, installation of leachate collection system, construction of final cover system, gas venting system and estimated time for project completion. The contractor is responsible for providing a foreman to remain on site at all times during construction, provide qualified personnel to conduct quality control, scheduling and coordinating the subcontractors, provide progress reports and as-built drawings, and coordinating construction activities with the Engineer. The foreman is responsible for supervising and coordinating with his crew, subcontractors, quality control personnel, attending all meetings and notifying the Engineer's Construction Observer when any discrepancies occur. The Contractor will meet with the Construction Observer on a daily basis to discuss the days construction activities. The results of all tests and any change in schedule shall be given to the Construction Observer as soon they are known by the contractor. The Contractor must be registered in the state of North Carolina.

As the owner's representative, the Engineer will employ the onsite construction observer. The Engineer will also employ all third party laboratories for conformance testing of the geosynthetics, destructive flexible membrane liner tests and random cohesive soil permeability tests.

The Engineer is responsible for providing the engineering design, drawings and specifications, contract documents and CQA needed for construction of the landfill. The Engineer is responsible for conduction of the pre-construction meeting, which will lay out the foundation for the project. The engineer will approve any design changes and certify to the Division that the landfill was constructed according to the requirements of Rule .1621 Construction Quality Assurance Plan and .1624 Construction requirements for MSWLF Facilities, and Division approved plans and specifications. This will be accomplished by on site observation, independent laboratory soil testing to test site specific soil properties including permeability and independent material testing laboratories for destructive testing of the flexible membrane liner. The Engineer will be providing Quality Assurance by spot testing along side the contractor, who will be providing the Quality Control. The Engineer will certify that the construction was completed in accordance with the CQA manual. The Engineer must be a professional engineer registered in North Carolina.

The Construction Observer (CO) is the Engineer's representative on-site. It is the CO's responsibility to know and interpret the plans and specifications of the project. On a daily basis the CO will coordinate with the Foreman to help ensure a quality product for the Owner. The CO will keep a daily log on the activities of the Contractor, keep notes on all meetings, and handle all quality assurance activities indicated in this document. The CO will keep a log of all material delivered on site and ensure the materials meets or exceeds the specifications indicated in this report. If the need arises additional meetings will be scheduled as seen fit by the CO.

4.2 Inspection Activities and Sampling Strategies

Each component of the liner system shall have the interface friction angle conformance test (ASTM D5321) and shall have a minimum passing value of 26 degrees. Test frequency shall be 1 test per every 200,000 square feet of material.

4.2.1. Base Liner System Subbase

The fill subgrade will be placed in 8" loose lifts and compacted to at least 95% of maximum dry density and near optimum moisture contents; as determined by Standard Proctor Compaction Test (ASTM D698) in 6" compacted lifts. No aggregate particles greater than 6" in any direction will be allowed in the subgrade or berm/embankment. Each compacted lift will be tested at one test per six inch (6") lift for each 200 lineal feet or fraction thereof of compacted berm(s) less than 50 feet in base width and one test per six (6) inch lift for each 10,000 square feet or fraction thereof of compacted mass fill. If an area fails, it shall be recompacted, reworked or replaced and retested.

Before beginning construction of the base liner system, the Engineer shall visually inspect the exposed surface to evaluate the suitability of the subgrade and document that the surface is properly prepared and that the elevations are consistent with the Division approved engineering plans. The elevations will be verified from survey data based on a 50 foot grid across the subbase.

At a minimum, the subgrade shall be proof-rolled at cut sections utilizing a fully loaded tandem dump truck or equivalent. If movement of the subbase is observed under the tires, the section of movement will be removed and replaced with suitable fill material. This newly placed fill material will then be tested for proper density and moisture.

4.2.2 Base Liner System Cohesive Soil Liner

All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Cohesive Soil Liner Borrow Material

Test Name	Test Method	Contractor/Engineer Frequency
Moisture/Density	ASTM D698/D1557	1 per 5000 c.y.
Remolded Permeability	ASTM D5084	1 per 5000 c.y.
Atterberg Limits	ASTM D4318	1 per 5000 c.y.
Visual Classification	ASTM D2487	1 per 5000 c.y.
Grain Size Distribution	ASTM D422	1 per 5000 c.y.

Cohesive Soil Liner Test Pad

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	3 per lift
Permeability	ASTM D5084	1 per lift
Remolded Permeability	ASTM D5084	1 per lift
Atterberg Limits	ASTM D4318	1 per lift
Visual Classification	ASTM D2487	1 per lift
Grain Size Distribution	ASTM D422	1 per lift

In-Place Cohesive Soil Liner

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	1 per lift per acre
Permeability	ASTM D5084	1 per lift per acre
Atterberg Limits	ASTM D4318	1 per lift per acre
Visual Classification	ASTM D2487	1 per lift per acre
Grain Size Distribution	ASTM D422	1 per lift per acre

(a) Suitable on-site and/or off-site soils may be used as cohesive soil liner if it can achieve an in-place permeability of 1.0 x 10^{-7} cm/sec or less for the base liner system or 1.0 x 10^{-5} cm/sec or less for the alternate base liner system and meets all testing requirements indicated in the material testing paragraph in this section. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

(b) A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil liner. The window shall be plotted on a semi-log plot with moisture content versus density. Laboratory testing to develop the window shall include a series of remolded samples compacted to various dry densities and moisture contents utilizing the same compactive effort (ASTM D 698 or D 1557). The remolded samples shall be tested for permeability to determine whether or not the particular soil type will provide the maximum permeability (1.0 x 10^{-7} cm/sec or 1.0 x 10^{-5} cm/sec) at various dry densities and moisture contents. The window is then developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

(c) Atterberg limits and grain size distribution shall also be conducted on the bulk samples used to prepare the permeability window ASTM D2487, D4318, D422. These tests can be used as indices on random samples collected from the borrow site during construction to verify the soil type is the same as was used to develop the "window". As a minimum, sufficient visual classifications and Atterberg limits shall be conducted in association with each permeability test to verify that the construction materials meet specifications.

(d) A test strip of compacted cohesive soil liner shall be prepared to verify the permeability "window" prior to general installation of the cohesive soil liner. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil liner. At a minimum, the verification will consist of three moisture density tests, one Atterberg limits test, one grain size distribution test (ASTM D698, ASTM D2487, D4318, and D422), and one Shelby Tube sample for each lift constructed in the test pad. Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil liner after placement and compaction. The permeability must be a maximum of 1.0 x10^{-7}cm/sec or 1.0 x10^{-5} cm/sec for alternate liner systems. Tests shall be performed in accordance with the ASTM D5084. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least four compacted 6 inch lifts of cohesive soil liner. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil liner. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeabilities of the cohesive soil liners. The test strip may be used as an integral part of the overall cohesive soil liner if it meets the required specification for the liner. All results shall be given to the Construction Observer.

(e) The soils shall be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift compacted preferably at a moisture content between 0 to 3% above optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698). A sheepsfoot roller or approved alternative may be used to compact the soil liner provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil liner shall be screened, disked, or prepared using any other approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. After each lift, the surface shall be scarified prior to the placement of the next lift to provide good bonding from one lift to the next.

(f) The cohesive soil liner shall be tested to evaluate the coefficient of permeability. The coefficient of permeability of the soil liner shall be equal to or less than 1.0 x 10^{-7} cm/sec (1.0 x 10^{-5} cm/sec for alternate base liner) after placement and compaction. The soil liner must be a minimum of 2.0 feet thick (1.5 feet thick for alternate base liner).

(g) Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil liner after placement and compaction. The permeability must be a maximum of 1.0 x10^{-7} cm/sec (1.0 x 10^{-5} cm/sec for alternate base liner). Tests shall be performed in accordance with the ASTM D5084 with a hydraulic gradient of 20 and confining pressure of 10 psi.

(h) The soil liner shall be tested a minimum of one soil sample per lift per acre for laboratory permeability. All permeability testing will be on random samples judged by the Engineer to be representative of the most permeable soil conditions for the area being tested. The Engineer shall certify that the materials used in construction were tested according to the Division approved plans. If after placement of the soil liner it fails the required tests, the material will either be reworked or replaced and retested. The soil liner must remain moist at all times, if any section becomes dry, rework the dry area and moisten.

(i) A minimum of two (2) inches of soil shall be removed prior to securing each sample for permeability testing. The sampling tube shall be advanced vertically into the soil with as little soil disturbance as possible and should be pushed using a uniform pressure. The sampling tube (Shelby tube), when extracted, shall be free of dents, and the ends shall not be distorted. A backhoe or approved alternative should be used to advance the sampling tube (Shelby tube) as long as disturbance is minimized. Drive tube samples of the liner may be obtained for permeability testings. If the Engineer judges the sample to be too disturbed, another sample shall be taken. Once an acceptable sample has been secured and properly prepared, all sample excavations or other holes created by survey stakes, etc. shall be backfilled to grade with a 50% mixture of bentonite and similar soils in maximum 3-inch loose lifts and hand tamped with a blunt tool to achieve a tight seal equivalent to the original density.

(j) No additional construction shall proceed on the soil layers at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved.

(k) As a minimum, sufficient visual classifications (ASTM Test Designation D2487), gradation analyses (ASTM Test Designation D422) and Atterberg limits (ASTM Test Designation D4318) shall be conducted in association with each permeability test to verify that the construction materials meet specifications. The minimum number of tests will be 1 per lift per acre.

(l) If the soil for the cohesive soil liner is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory and mixed in the field using either a pug mill or a soil stabilizer. Where additives are required, the soil shall be placed in maximum 8-inch thick loose lifts and compacted preferably between 0 to +3% optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698) for the soil-additive mixture. All other compaction procedures for the soil apply.

(m) Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil liner shall have no sudden sharp or abrupt changes in grade such as tire ruts.

(n) The Contractor shall protect the cohesive soil liner from desiccation, flooding and freezing. Protection, if required, may consist of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil liner until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions shall be replaced or reworked by the contractor to remove these defects. Areas where the cohesive soil has been replaced, desiccation cracks and/or heaving is deeper than two (2) inches shall be retested.

(o) The thickness and grade of the soil liner will be verified by the surveyor before placement of the geomembrane liner. The soil liner will be surveyed at 50' grid points where the elevations of the subbase will be checked with the top of soil liner to verify 2.0 feet of soil liner (1.5 feet of soil liner for the alternate base liner). The grade will then be verified with the surveyed information. The survey will be performed by N.C. Professional Surveyors.

(p) The anchor trench shall be excavated by the Contractor to lengths and widths shown on the design drawings prior to geomembrane placement. Anchor trenches excavated in cohesive soils susceptible to desiccation cracks should be excavated only the distance required for that days liner placement to minimize the potential of desiccation cracking of the cohesive soils. Corners in the anchor trench shall be slightly rounded where the geomembrane adjoins the trench to minimize sharp bends in the geomembrane.

(q) The tie in of the cohesive soil to the adjoining Phases will be stepped into the adjoining cohesive soil as the lifts of the constructed Phase are being compacted. The flexible membrane liner and drainage net will be folded back so that the adjoining cohesive liner is exposed so that the tie in can be completed.

(r) Surface Acceptance. Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil liner and the surface shall remain the responsibility of the contractor.

4.2.3 <u>Alternate Base Liner System Specifications</u>

(1.1) <u>General</u>

This specification covers the technical requirements for the furnishing and installation of the Geosynthetic Clay Liner (GCL) described herein. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the contract drawings.

The Contractor shall furnish all labor, materials, supervision and equipment to complete the installation of the GCL, including, but not limited to, liner layout, seaming, patching, and all

necessary and incidental items required to complete the Work, in accordance with the Contract Drawings and these Specifications.
Sufficient liner material shall be furnished to cover all lined areas shown on the Drawings, including overlaps at field seams and anchor trenches.

It is the intent of these Specifications to ensure a quality finished product. It shall be the responsibility of the Contractor to ensure that this requirement is met.

(1.2) Definitions

For the purposes of this specification guideline, the following terms are defined below:

Geosynthetic Clay Liner (GCL) - A manufactured hydraulic barrier consisting of clay bonded to a layer or layers of geosynthetics. The GCL may be reinforced or unreinforced as required by site conditions. This site will require reinforced GCL over the entire area.

Geomembrane - An essentially impermeable geosynthetic composed of one or more geosynthetic sheets.

Geotextile - Any permeable textile used with foundation, soil, rock, earth, or any other geotechnical engineering related material as an integral part of a human-made project, structure, or system.

Minimum Average Roll Value - The minimum average value of a particular physical property of a material, for 95 percent of all the material in the lot.

Overlap - Where two adjacent GCL panels contact, the distance measuring perpendicular from the overlying edge of one panel to the underlying edge of the other.

(1.3) Submittals/Qualifications

A. The GCL Manufacturer must have produced at least 10 million square feet (1 million square meters) of GCL, with at least 8 million square feet (800,000 square meters) installed. The manufacturer shall submit certification that GCL manufactured for the Project has been produced in accordance with these Specifications along with results from a quality control program. This information must be submitted for review prior to material delivery. The Engineer reserves the right to halt installation until proper certification is submitted and determined acceptable for use.

B. The Contractor shall submit to the Engineer, six (6) full sets of panel layout construction drawings. Drawings shall be submitted to the Engineer at least two (2) weeks prior to installation.

C. The manufacturer of the GCL used in this work shall approve all shop drawings and a proposed liner layout to cover the lined area shown on the Drawings.

D. Details shall be included to show the termination of the liner at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring. A specific anchor trench detail shall be provided.

E. The Contractor shall submit to the Engineer a physical sample of the liner to be used. The sample shall be labeled with the manufacturer's name, product identification, lot number and roll number.

F. Upon shipment, the Contractor shall furnish the GCL manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the project are in accordance with the requirements of this specification. The Contractor shall also submit to the Engineer inventory tickets, roll numbers or batch identifications, packing papers, and invoices for the liner used.

G. As installation proceeds, the Contractor shall submit certificates of subgrade acceptance to the Engineer, signed by the Contractor and the GCL Installer for each area that is covered by the GCL.

H. The Contractor shall provide personnel resumes demonstrating compliance with the following requirements.

4. A project reference list for the GCL(s) consisting of the principal details of at least ten projects totaling at least 10 million square feet (100,000 square meters) in size.

5. A minimum of one field superintendent per shift shall be designated by the Contractor and approved by the Engineer. Each field superintendent shall have a minimum of three years and five million square feet of field experience in installing GCL's. Any change or replacement of superintendent during the Project, must be approved by the Engineer.

6. Liner placement technicians shall have a minimum of one year and one million square feet of GCL placement experience.

(1.4) Construction Quality Assurance (CQA)

A. The Engineer shall provide an construction observer (CO) for CQA of the GCL installation. The inspector shall be responsible for observing and documenting activities related to the CQA of the GCL. The contractor shall not install any GCL on this project, at any time, in the absence of the CQA construction observer.

B. Testing of the GCL, as necessary to support the CQA effort, shall be performed by a third party laboratory retained by the Engineer and independent from the GCL manufacturer and installer. The laboratory shall be accredited by the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP).

(2) Products

(2.1) General

A. The GCLs shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles and shall comply with all of the criteria listed in this Section. Prior to using an alternate GCL, the Contractor must furnish independent test results demonstrating that the proposed alternate material meets all requirements of this specification. The Contractor also must obtain prior approval of the alternative GCL by the Engineer.

B. Reinforced GCL must be used on all areas of the site.

(2.2) Materials

A. An acceptable GCL product is Bentomat® ST as manufactured by CETCO or an engineer-approved equal.

B. All areas of the project requiring reinforced GCL will be furnished with Bentomat® ST or an engineer-approved equal.

C. The GCL(s) and their components shall have the properties shown in the attached CETCO's Technical Data Sheet (TR404bm).

D. The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7m) in length and 15 feet (4.6m) in width for Bentomat. Short rolls [(those manufactured to a length greater than 70 feet (21m) but less than a full-length roll)] may be supplied at a rate of no greater than 3 per truckload or 3 rolls for every 36,000 square feet (3,500 square meters) of GCL, whichever is less.

E. A 6-inch (150mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

(2.3) <u>Product Quality Documentation</u>

The GCL manufacturer/Contractor shall provide the Engineer with manufacturing QA/QC certifications for each shipment of GCL, prior to the deployment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager, and shall include:

A. Certificates of analysis for the bentonite clay used in GCL production demonstrating compliance with the parameters swell index and fluid loss shown in CETCO's Technical Data Sheet TR404bm.

B. Manufacturer's test data for finished GCL products(s) of bentonite mass/area, GCL tensile strength, and GCL peel strength demonstrating compliance with the index parameters shown in CETCO's Technical Data Sheet TR404bm.

C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

D. Manufacturer's test data for finished GCL product(s) including GCL index flux, permeability, and hydrated internal shear strength data demonstrating compliance with the performance parameters shown in CETCO's Technical Data Sheet TR404bm.

BENTOMAT® ST CERTIFIED PROPERTIES

MATERIAL PROPERTY	TEST METHOD	TEST FREQUENCY $ft^2(m^2)$	REQUIRED VALUES
Bentonite Swell Index[1]	ASTM D 5890	1 per 50 tonnes	24 ml/2g min.
Bentonite Fluid Loss[1]	ASTM D 5891	1 per 50 tonnes	18 ml max.
Bentonite Mass/Area[2]	ASTM D 5993	40,000 ft^2 (4,000 m^2)	0.75 lb/ft^2 (3.6 kg/m^2) min
GCL Tensile Strength[3]	ASTM D 6768	200,000 ft^2 (20,000 m^2)	30 lbs/in (53 N/cm) MARV
GCL Peel Strength[3]	ASTM D 6496	40,000 ft^2 (4,000 m^2)	3.5 lbs/in (6.1 N/cm) min
GCL Index Flux[4]	ASTM D 5887	Weekly	1 x 10^{-8} m^3/m^2/sec max
GCL Hydraulic Conductivity[4]	ASTM D 5887	Weekly	5 x 10^{-9} cm/sec max
GCL Hydrated Internal Shear Strength[5]	ASTM D 5321 ASTM D 6243	Periodic	500 psf (24 kPa) typ @ 200 psf

Bentomat ST is a reinforced GCL consisting of a layer of granular sodium bentonite between woven and nonwoven geotextiles, which are needlepunched together.

Notes

[1] Bentonite property tests performed at a bentonite processing facility before shipment to CETCO's GCL production facilities.
[2] Bentonite mass/area reported at 0 percent moisture content.
[3] All tensile strength testing is performed in the machine direction using ASTM D 6768. All peel strength testing is performed using ASTM D 6496. Upon request, tensile and peel results can be reported per modified ASTM D 4632 using 4 inch grips.
[4] Index flux and permeability testing with deaired distilled/deionized water at 80 psi (551kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tailwater pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5x10^{-9} cm/sec for typical GCL thickness. Actual flux values vary with field condition pressures. The last 20 weekly values prior the end of the production date of the supplied GCL may be provided.
[5] Peak values measured at 200 psf (10 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

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(2.4) Material Conformance Testing

The Engineer/Contractor shall perform the material conformance tests listed in Table 1.

Table 1: QA Testing Program for GCL Material Conformance

PROPERTY	TEST METHOD	UNITS	VALUE[1]	TEST FREQUENCY
Hydraulic Conductivity	ASTM D5084[2]	cm/s	$\leq 5.0 \times 10^{-9}$	100,000 ft^2
Bentonite Content	ASTM D3776[3]	psf	0.75 (@0% moisture)	100,000 ft^2
Thickness	ASTM D1777	inch	0.20	100,000 ft^2
Grab Tensile Strength	ASTM D4632	lbs	90	100,000 ft^2
Interface Friction Test	ASTM D5321[6]	degrees	≥ 25.0[4]	2
Interface Friction Test	ASTM D5321[6]	degrees	≥ 21.0[5]	2
Shear Strength	ASTM D5321	psf	500	2

[1] Minimum Average Roll Values (MARV).
[2] Conduct test at 5 psi effective stress.
[3] Alternatively, use ASTM D5993 for measuring the mass per unit area of GCL.
[4] GCL against the soil liner (peak value).
[5] GCL (woven geotextile) against the textured FML (peak value).
[6]Conduct test at 3 psi effective stress and hydrate the GCL.

Samples for material conformance testing shall be obtained upon delivery of the GCL. Samples shall be taken across the entire width of the roll. Samples shall be 1 foot to 3 feet long by the roll width. All material conformance testing, shall be performed by a third party Geosynthetics Laboratory retained by the Engineer. All test results must be available at the Engineer's office prior to the deployment of any GCL roll at the site. The Engineer will examine all results from laboratory testing.

(2.5) Product Labeling

A. Prior to shipment, the GCL manufacturer shall label each roll, identifying:

1. Product identification information (Manufacturer's name and address, brand name, product code).
2. Lot number and roll number.
3. Roll length, width, and weight.

(2.6) Packaging

A. The GCL shall be wound around a rigid core whose diameter is sufficient to facilitate handling. The core is not necessarily intended to support the roll for lifting but should be sufficiently strong to prevent collapse during transit.

B. All rolls shall be labeled and bagged in packaging that is resistant to photodegradation by ultraviolet (UV) light.

(2.7) Accessory Bentonite

A. The granular bentonite or bentonite sealing compound used for seaming, penetration sealing, and repairs shall be made from the same natural sodium bentonite as used in the GCL and shall be as recommended by the GCL manufacturer.

(2.8) Equipment Requirements

A. CETCO GCLs are delivered in rolls weighing from 2,500 - 2,700 lbs (1,140-1,225 kg). It is necessary to support this weight using an appropriate core pipe. For any installation, the core pipe must not deflect more than 3 inches (75 mm) as measured from end to midpoint when a full GCL roll is lifted.

B. Lifting chains or straps rated for at least twice the load of the GCL should be used in combination with a spreader bar made from an I-beam. The spreader bar ensures that the lifting chains or straps do not chafe against the ends of the GCL roll, which must be able to rotate freely during installation.

C. A front end-loader, backhoe, dozer, or other equipment can be furnished with the spreader bar and core bar. Alternatively, a forklift with a “stinger” attachment may be used for on-site handling and, in certain cases, installation. **A forklift without a stinger attachment shall not be used to lift or handle the GCL rolls**.

D. When installing over certain geosynthetic materials, a 4-wheel all-terrain vehicle (ATV) can be used to deploy the GCL from behind. An ATV can be driven directly on the GCL provided that no sudden stops, starts, or turns are made.

E. Additional equipment needed for installation of CETCO’s GCLs includes:

- Utility knife and spare blades (for cutting the GCL).
- Granular bentonite or bentonite mastic (for overlapped seams of GCLs with needle punched non-woven geotextiles and for sealing around structures and details).
- Waterproof tarpaulins (for temporary cover on installed material as well as or stockpiled rolls).
- Optional chalk line marker to simplify bentonite placement at seams (when installing a GCL with needle punched non-woven geotextile components).
- Optional flat-bladed vise grips (for positioning the GCL panel by hand).

(3) EXECUTION

(3.1) Shipping and Handling

A. The manufacturer assumes responsibility for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling, and storage of the GCL are the responsibility of the Contractor, Installer, or other designated party.

B. A visual inspection of each roll should be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging should be marked and set aside for further inspection. The packaging should be repaired prior to being placed in storage.

The party responsible for unloading the GCL should contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

(3.2) Storage

A. Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry, and well-drained.

B. Rolls should be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks or by use of the dunnage shipped between rolls. Rolls should be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four). Rolls shall never be stacked on end.

C. All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

D. The integrity and legibility of the labels shall be preserved during storage.

(3.3) Earthwork/Subgrade Preparation

A. Any surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of vegetation, any debris, sticks, sharp rocks, void spaces, ice, abrupt elevation changes, standing water, cracks larger than one-quarter inch (6mm) in width, and any other foreign matter that could contact the GCL.

B. Subgrade surfaces consisting of granular soils or gravel may not be acceptable due to their large void fraction and puncture potential. Subgrade soils should possess a particle size distribution such that at least 80 percent of the soil is finer than a No. 60 sieve (0.250 mm).

C. Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

D. On a continuing basis, the Contractor/GCL Installer shall submit certifications of subgrade acceptance to the Engineer, and the project Construction Observer shall verify acceptance of the subgrade before GCL placement.

E. It shall be the installer's responsibility thereafter to indicate to the Engineer any change in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

F. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated in accordance with the project plans and specifications. The excavated trench shall be verified by the Construction Observer prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

(3.4) <u>GCL Placement</u>

Placement of the GCL shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the CQA Engineer.

A. The contractor shall not install any GCL on this project, at any time, in the absence of the Construction Observer. During start-up of the GCL installation, an agent or representative of the Manufacturer shall provide on-site assistance and instruction to the Contractor and CQA Engineer regarding the appropriate installation techniques.

B. The Construction Observer/Engineer shall inspect each panel, after placement and prior to seaming, for damage and/or defects. All defects and deficiencies shall be properly documented by the GCL Installer and Construction Observer. Defective or damaged panels shall be replaced or repaired, as approved by the Construction Observer/Engineer. The Contractor will correct defects and deficiencies to the satisfaction of the Engineer. The Construction Observer shall observe and verify all repaired defects.

C. Reinforced GCL shall be placed on all areas of the site.

D. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) may be important if the GCL has two different geotextiles. Unless otherwise specified, however, the GCL shall be placed with the white side (non-woven) geotextile facing down.

E. The GCL shall be properly weighted to avoid uplift due to wind.

F. Equipment which could damage the GCL shall not be allowed to travel directly on it. Acceptable installation, therefore, may be accomplished such that the GCL is unrolled in front of the backwards-moving equipment. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues. Equipment necessary to perform the installation (generators, compressors, etc.) shall have a scrap GCL sheet placed underneath to protect the installed GCL from possible damage.

G. The GCL shall be kept free of debris, unnecessary tools and materials. In general, the GCL area shall remain neat in appearance. All damage shall be recorded and located in the record drawings.

H. Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

I. The GCL shall be placed so that seams are parallel to the direction of the slope. End-of-roll seams should be located at least 3 feet (1m) from the toe and crest of slopes steeper than 4H:1V. GCL rolls shall **not** be released on the slope and allowed to unroll freely by gravity.

J. All GCL panels shall be placed free of tension or stress and lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels. Similarly, the geomembrane placed over GCL shall lie flat and in contact with the underlying GCL with no wrinkles or fold.

K. The GCL shall not be installed in standing/ponded water, during rainy weather/precipitation, excessive moisture, and during extremely/excessive high wind. Only as much GCL shall be deployed as can be covered at the end of the working day with the geomembrane. In no case shall the GCL be exposed to the elements at the end of the day. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it will be necessary to remove and replace the hydrated material. The Engineer, Construction Observer, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

L. The GCL shall not get wet before or during installation. The GCL mat shall not be installed during periods of any precipitation. If a precipitation event occurs after the installation of a GCL panel, but prior to covering with the geomembrane panel, a thin film plastic sheeting may be used to cover and to temporarily protect the GCL from moisture, if approved by the Engineer.

M. Panels shall be placed from the highest elevation to the lowest within the area to be lined, to facilitate drainage in the event of precipitation.

N. It is not permissible to stretch the GCL in order to fit a designated area. Panels shall not be dragged across the subgrade into position except where necessary to obtain the correct overlap for adjacent panels.

(3.5) <u>Anchorage</u>

A. As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope. The front edge of the trench should be rounded so as to eliminate any sharp corners. The GCL should cover the entire trench floor but does not extend up the rear trench wall.

B. The amount of trench open at any time shall be limited to one day of GCL installation capacity. The anchor trench shall be adequately drained to prevent water ponding and softening the adjacent soils. Loose soil shall be removed from the floor of the trench. The soil backfill should be placed in the trench to provide resistance against pullout. The size and shape of the trench, as well as the appropriate backfill procedures, should be in accordance with the project drawings and specifications.

C. The backfill for the anchor trench shall be compacted to 95% maximum proctor density. There is no grain size requirement, and on-site material shall be used. The frequency of testing shall be for every six (6) inch lift and 500 feet of trench.

(3.6) <u>Seaming</u>

A. The GCL seams are constructed by overlapping their adjacent edges. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required for Bentomat® ST.

B. The minimum dimension of the longitudinal overlap should be 6 inches (150 mm). End-of-roll overlapped seams should be similarly constructed, but the minimum overlap should measure

24 inches (600 mm). In the opinion of the CQA Engineer/Inspector, any seam, or edge of GCL material exposed for more than 24 hours or considered partially hydrated when seaming occurs shall receive a 3-foot overlap (rainlap) from the adjoining GCL panel.

C. All seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the record drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be seamed.

D. Seam areas or runs shall also be flat and clear of any large rocks, debris, or ruts. Contacting surfaces shall be clean and clear of dirt or native soil with all edges pulled tight to maximize contact and to smooth out any wrinkles or creases.

E. All seams constructed on sloped surface shall be vertical seams.

F. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

G. Bentonite-enhanced seams are constructed between the overlapping adjacent panels described above. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6inch (150 mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap. The bentonite shall be applied at a minimum application rate of one-quarter pound per lineal foot (0.4 kg/m).

(3.7) <u>Detail Work/Sealing Around Penetration and Structures</u>

A. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid irregular tearing of the geotextile components of the GCL during the cutting process. The GCL shall be sealed around penetrations and structures embedded in the subgrade. Granular bentonite or a bentonite mastic shall be used liberally (approximately 2 lbs/in ft or 3 kg/m) to seal the GCL to these structures.

B. When the GCL is placed over an earthen subgrade, a "notch" (approximately 3 inches wide and 8 inches deep) shall be cut against the edge of the subgrade area around the penetration. The mat shall be brought up to the edge of the structure and trimmed to fit into the notch. The Contractor shall then hand-apply a pure bead of bentonite into half the notch. The mat shall then be inserted into the notch, with the remaining volume of the notch refilled with the pure bentonite and compacted.

C. A secondary collar of GCL should be placed around the penetration. It is helpful to first trace an outline of the penetration on the GCL and then cut a "star" pattern in the collar to enhance the collar's fit to the penetration.

D. Vertical penetrations are prepared by notching into the subgrade. The penetration is completed with two separate pieces of GCL. A secondary collar is option in this case.

E. When the GCL is terminated at a structure or wall that is embedded into the subgrade, the subgrade should be notched as described in Items B and D above. The notch is filled with granular bentonite, and the GCL should be placed over the notch and up against the structure. The connection to the structure can be accomplished by placement of soil or stone backfill in this area.

(3.8) <u>Damage Repair</u>

A. If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Dry bentonite or bentonite mastic should be applied around the damaged area at the rate of one-half pound per lineal foot prior to placement of the patch. Any epoxy-based adhesives shall be used to keep the patch in position during backfill operations.

(3.9) <u>Placement of Overlaying Materials</u>

A. Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles [such as 4-wheel all-terrain vehicles (ATV)] may be used to facilitate the installation of any geosynthetic material placed over the GCL, provided the ATV makes no sudden stops, starts, or turns. The GCL supplier or CQA engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

B. When a textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

C. Any leading edge of panels left uncovered shall be protected at the end of the working day with a waterproof sheet, which is adequately secured with sandbags or other ballast.

D. Soil cover shall be placed over the GCL/geomembrane using low ground pressure construction equipment that minimizes stresses on the GCL/geomembrane, according to the existing project specification requirements for protective cover soil installation over geomembrane liner.

4.2.4. <u>Base Liner System Flexible Membrane Liner Method of Deployment</u>

All materials and equipment, shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Flexible Membrane Liner Tests

Test Name	Description	Test Method	Frequency
Air Test	Air Test Seams		Every Seam
Vacuum Test	Every welded area		Where air test impossible
Destructive Tests	Seam Strength	ASTM D4437	Every 500' of seam

Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The 60 mil High Density Polyethylene (HDPE) - Geosynthetic Research Institute (GRI) GM13, is to be placed in direct contact with moist cohesive soil liner or Geosynthetic Clay Liner (GCL). The Landfill itself is single lined and will only have a single Textured Geomembrane. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner and shall meet the following minimum properties:

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll *(2)*
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) *(3)* • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in. 45 lb/in. 12% 100%	84 lb/in. 60 lb/in. 12% 100%	105 lb/in. 75 lb/in. 12% 100%	126 lb/in. 90 lb/in. 12% 100%	168 lb/in. 120 lb/in. 12% 100%	210 lb/in. 150 lb/in. 12% 100%	252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance *(4)*	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 1603 *(5)*	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	note *(6)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(7)* (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	200,000 lb
Oven Aging at 85°C *(7)*, *(8)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance *(9)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(11)*	GM11 D 3895 D 5885	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	N.R. *(10)* 50%	per each formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 6.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches
(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(5) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3
(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(9) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(11) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(1) Preparation for Geomembrane Deployment

(a) Panel Layout

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project.

(b) Identification

Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture.

(c) Verification

Prior to site delivery, the manufacturer's quality certification for each roll will be delivered to the Engineer. The Engineer will inspect all certifications. If a certification does not meet minimum requirements outlined on GRI Test Method GM13 Table 2(a) for 60 mil, the individual roll will be rejected.

The Engineer will remove a sample from 1 out of 4 rolls delivered to the site and have a third party lab test for thickness, density, carbon black content, carbon black dispersion and tensile properties. The lab will have been accredited by the Geosynthetic Accreditation Institute (GAI).

(2) Field Panel Placement

(a) Location

The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

(b) Weather Conditions

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds.

(c) Method of Deployment shall follow the manufacturer's recommendations and sound, accepted engineering practices.

(1) The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface.

(2) No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions which could result in damage to the geomembrane.

(3) Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas.

(4) The geomembrane will be deployed in a manner to minimize wrinkles. The geomembrane will have no fold overs.

(5) Any damage to a panel of the geomembrane will be repaired. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed.

(3) Field Seaming

(a) Layout

In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

(b) Personnel

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

(c) Equipment

(1) Fusion Welding

Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge.

(2) Extrusion Fillet Welding

Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

(d) Weather Conditions

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can effect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will effect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day.

(4) Seam Preparation

(a) Fusion Welding

(1) Overlap the panels of geomembrane approximately four (4) inches.

(2) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding.

(3) Adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

(4) A movable protective layer may be used, at the discretion of the Flexible Geomembrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

(b) Extrusion Welding

(1) Overlap the panels of geomembrane a minimum of three (3) inches.

(2) Temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane.

(3) Grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area.

(4) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.

(5) Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel.

(6) Keep welding rod clean and off the ground.

(5) <u>Test Seams</u>

Test seams shall be performed at the beginning of each seaming period and at approximately every 4-working hour intervals for each seaming apparatus used that day. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams.

(a) Test Seam Length

The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width.

(b) Sample Procedure

(1) Visually inspect the seam for squeeze out, footprint, pressure and general appearance.

(2) Two random samples one (1) inch wide shall be cut from the test seam. The specimens shall then be tested in peel using a field tensiometer and shall not fail in the seam. If a specimen fails the entire procedure shall be repeated.

(3) The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer that has a constant separation of 2.0 in/min for peel and shear. The passing destructive test requirements for a 60-mil liner seam is: minimum peel adhesion of 91 ppi for hot wedge and 78 ppi for extrusion fillet seams, minimum shear strength of 120 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam. If a specimen fails, the entire procedure shall be repeated.

(4) After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting, and test results.

(5) Passing test results records shall be maintained.

(6) General Seaming Procedures

(a) Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

(b) While welding a seam, monitor and maintain the proper overlap.

(c) Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind.

(d) While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly.

(e) Align wrinkles at the seam overlap to allow welding through the wrinkle.

(f) Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions.

(g) All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane.

(h) All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind ¼ of an inch minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

4.2.5 Base Liner System Flexible Membrane Liner Tests

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

(a) Air Pressure Testing

The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time.

(1) Equipment for Air Testing

An air pump (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi.

A rubber hose with fittings and connections.

A sharp hollow needle, or other approved pressure feed device with a pressure gauge capable of reading and sustaining a pressure between 25 to 30 psi.

(2) Procedure for Air Testing

Seal both ends of the seam to be tested.

Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld.

Inflate the test channel to a pressure between 25 to 30 psi, in accordance with the following schedule, close valve, and observe initial pressure after approximately 2 minutes.

INITIAL PRESSURE SCHEDULE *

Material (Mil)	Min. Psi	Max. Psi
40	25	30
60	27	30
80	30	30
100	30	30

* Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize.

Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds the following or if the pressure does not stabilize, locate faulty area and repair.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL AFTER 5 MINUTES - HDPE

Material (Mil)	Pressure Diff.
40	4 psi
60	3 psi
80	3 psi
100	3 psi

At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected.

Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

(3) In the event of a Non-Complying Air Pressure Test, the following procedure shall be followed:

Check seam end seals and retest seams.

If non-compliance with specified maximum pressure differential re-occurs, repair the seam. Capping or removal/reseam of the non-complying seam are the only two (2) acceptable methods of repairing failed seams.

Non-destruct test the entire length of the repaired seam.

(b) Vacuum Testing

This test is used when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

(1) Equipment for Vacuum Testing

Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

Vacuum pump assembly equipped with a pressure controller and pipe connection.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and means to apply a soapy solution.

A soapy solution.

(2) Procedure for Vacuum Testing

Trim excess overlap from seam, if any.

Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi gauge.

Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested.

Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.

Close the bleed valve and open the vacuum valve.

Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box.

Ensure that a leak tight seal is created.

For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process.

(3) Procedure for Non-Complying Test

Mark all areas where soap bubbles appear and repair the marked areas.

Retest repaired areas.

(c) Destructive Testing

(1) Concept

The purpose of destructive testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane.
(2) Procedure for Destructive Testing

All Destructive tests will be done according to GRI test method GM19. Destructive test samples shall be marked and cut out randomly at a minimum average frequency of one test location every 500 feet of seam length.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds at the discretion of the Flexible Membrane Liner Superintendent and Engineer.

Sample Size

The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications.

A one (1) inch sample shall be cut from each end of the test seam for field testing.

The two (2), one (1) inch wide samples shall be tested in the field with a tensiometer, that has a constant separation rate of 2.0 inch per minute for peel and shear. The passing destructive test requirements for a 60-mil liner seam is: minimum peel adhesion of 91 ppi for hot wedge and 78 ppi for extrusion fillet seams, minimum shear strength of 120 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam.

(3) Procedure in the event of Destructive Test Failure

Cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.

If the laboratory samples pass then repair the seam between the two (2) passing samples locations.

Capping or removal, of the failed seam are the only two (2) acceptable methods for repairing failed seams.

All destructive seam samples sent to the Engineer's laboratory shall be numbered.

(d) Quality Assurance Laboratory Testing

(1) Destructive samples sent to the laboratory will be tested for shear/peel strength, elongation, and peel separation according to table 1(a) of GRI Test Method GM19. Five (5) specimens shall be tested for each test method with data recorded. Four (4) out of the five (5) specimens must pass and the fifth specimen must be 80% of the passing test values. The passing test values are as follows:

Hot Wedge Seams
Shear Strength-120 ppi
Shear elongation at break – 50%
Peel Strength- 91 ppi
Peel separation-25%
Extrusion Fillet Seams
Shear Strength-120 ppi
Shear Elongation at break-50%
Peel Strength- 78 ppi
Peel separation-25%

(2) Defects and Repairs

(a) The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation.

(b) All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

(c) <u>Repair</u> <u>Procedures</u>

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure, shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely manner to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil liner or geosynthetic clay liner (GCL) such as a temporary cover. If cohesive soil liner is damaged, it must be reworked. If the GCL is damage, it must be replaced with non-hydrated GCL. Procedures available for liner repair:

Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded.

Grinding and welding - used to repair sections of extruded seams.

Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws.

Capping - used to repair lengths of failed seams.

Removal of a bad seam and replacement with a strip of new material seamed into place.

(d) <u>Verification</u> <u>of</u> <u>Repairs</u>

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

(e) <u>Liner</u> <u>Acceptance</u>

The constructed liner will be accepted when all non-destruct and destruct tests have passed their respective tests and the results have been verified by the Engineer. Geocomposite can be installed over the liner once it has been accepted.

4.2.6 <u>Protective Cover for Landfill Construction</u>

HPDE Geocomposite Drainage Netting manufactured by SKAPS Industries, or approved equal. Q/C testing information/certification for each property on geocomposite will be provided by the contractor/manufacture for the rolls delivered. The thickness, transmissivity and ply adhesion will be tested by the Engineer's third party laboratory for quality assurance. One roll from every 200,000 $ft.^2$ of material delivered to the site will be tested.

SKAPS TRANSNET HDPE GEOCOMPOSITE WITH 250 MIL GEONET

Last Updated on Wednesday, 08 September 2010 07:57

SKAPS TRANSNET™ GeoComposite consists of SKAPS GeoNet made from HDPE resin with non-woven polypropylene GeoTextile fabric heat bonded on both sides of GeoNet.

Property	Test Method	Unit	Required Value		Qualifier
				with 8 oz.	
Geonet					
Thickness	ASTM D 5199	mil		250 ±10	Range
Carbon Black	ASTM D 4218	%		2 to 3	Range
Tensile Strength	ASTM D 5035	lb/in		50	Minimum
Melt Flow	ASTM D 1238[3]	g/10 min		1	Maximum
Density	ASTM D 1505	g/cm^3		0.94	Minimum
Transmissivity[1]	ASTM D 4716	m^2/sec		$2.5x10^{-3}$	MARV[2]
Composite					
Ply Adhesion (Minimum)	ASTM D 7005	lb/in		0.5	MARV
Ply Adhesion (Average)	ASTM D 7005	lb/in		1	MARV
Transmissivity[1]	ASTM D 4716	m2/sec		$2x10^{-4}$	MARV
GeoTextile					
Fabric Weight	ASTM D 5261	oz/yd^2		8	MARV
Grab Strength	ASTM D 4632	lbs		225	MARV
Grab Elongation	ASTM D 4632	%		50	MARV
Tear Strength	ASTM D 4533	lbs		90	MARV
Puncture Resistance	ASTM D 4833	gpm/ft^2		130	MARV
CBR Puncture	ASTM D 6241	lbs		650	MARV
Water Flow Rate	ASTM D 4491	gpm/ft^2		100	MARV
Permittivity	ASTM D 4491	sec^{-1}		1.26	MARV
Permeability	ASTM D 4491	cm/sec		0.3	MARV
AOS	ASTM D 4751	US Sieve		80	MARV

Notes:

1. Transmissivity measured using water at 21 ± 2 °C (70 ± 4 °F) with a gradient of 0.1 and a confining pressure of 10000 psf between steel plates after 15 minutes. Values may vary between individual labs.

2. MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.

3. Condition 190/2.16

The geocompsite will be handled in such a manner as to ensure the geocomposite are not damaged in any way. On slopes, the geocomposite will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles. Geocomposite can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geocomposite will not be welded to the geomembrane. Geocomposite will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geocomposite that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geocomposite will be overlapped by at least four inches and securely tied. Tying can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one foot intervals. In the corners of the side slopes where overlaps between perpendicular geocomposite strips are required, an extra layer of geocomposite will be unrolled along the slope, on top of the previously installed geocomposite, from the top to bottom of the slope.

Any holes or tears in the geocomposite will be repaired by placing a patch, utilizing the same geocomposite material, extending two feet beyond edges of the hole or tear. The patch will be secured to the original geocomposite by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geocomposite will be joined.

The engineer will visually inspect the drainage layer before placement of the protective soil, if any defects are detected they will be repaired before placement of protective soil.

Protective Cover Soil

The soil for the protective cover shall consist of suitable soil, free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension. The soil will be screened in the presence of the Engineer. The screening can be either on or off site. If screened soil is not used, the only acceptable alternate is a N.C. DOT approved sand. The borrow site for sand will be NCDOT approved for sand of any gradation. The NCDOT approval and gradation report shall be submitted to the Engineer. There are no permeability, grain size, or other tests that will be required for this material. This material is not being used as a drainage media; leachate collection lines are installed and designed to collect water flowing on top of the protective cover.

Installation Protective Soil Cover

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The protective cover shall be composed of select backfill and backfill.

The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

When installing the cover, the contractor shall adhere to the following guidelines:

(1) A minimum of 12 inches of cover between low ground pressure equipment such as the Caterpillar D6H LGP, or approved equal, and the liner is required at all times. Roadways for entering and for transporting material over slopes and floor shall have a minimum depth of four feet.

(2) Avoid undue stress on the liner at all times. Cover material must be pushed up side slopes, never down to help minimize wrinkles. Material must be placed to minimize wrinkles. Wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Fold over of the liner will not be allowed. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner.

(3) If damage does occur, report it to the Construction Observer immediately so that repairs can be performed without needless delay. All repairs to any component of the liner system will be done and tested according to the required repairs and testing for that component.

(4) Cover shall be placed and maintained in a uniform thickness, free of ruts and irregularities.

(5) Do not work wet cover material that cannot support equipment.

(6) Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

(7) The thickness and grade of the protective soil will be verified by the surveyor. The soil liner will be surveyed at 50' grid points where the elevations of the top of cohesive soil will be checked with the top of protective cover to verify 3.0 feet protective cover. The grade will then be verified with the surveyed information. The survey will be performed by a NC licensed surveyors.

Protective soil will be used to backfill all anchor trenches. The anchor trenches will be filled as the protective cover is being installed up the slopes on the geocomposite. The fill will consist of 8 inch loose lifts, that will be compacted to 6 inch lifts. The lifts will be compacted to 95% of the Standard Proctor and tested for density on 2 foot intervals for every 500 ft. of anchor trench. The results of the tests will become part of the Contractor's Geotechnical Engineer's final report.

4.2.7 <u>Leachate Collection System</u>

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications, or shall be the product of the listed manufacturers, or similar and equal; thereto, as approved by the Engineer.

(1) <u>High Density Polyethylene Pipe</u>

The polyethylene pipe shall be high performance, ultra-high molecular weight, high density polyethylene pipe, conforming to ASTM D1248 (Type III, Class C, Category 5, Grade P34). Minimum cell classification values shall be 335434C as referenced in ASTM D3350. The pipe shall be SDR 17. The pipe shall contain 2 percent carbon black.

(2) Stone Surrounding Perforated Collection Piping

Stone for leachate collection system shall meet the requirements of NC DOT aggregate, standard size No. 5 and shall contain no fines greater than 2% by weight passing the #200 sieve and consist of rock dust produced through normal handling of the aggregate. Stone must pass the sieve analysis test for No. 5 stone performed at the quarry. The quarry will provide their standard sieve analysis of the stone being delivered to the site and the Engineer will have a third party laboratory sieve analysis for approximately every 500 tons of stone delivered to the site.

The stone shall be non-carbonaceous mineral, which must be chemical compatible with leachate with the maximum acceptable concentration of calcium carbonate per ASTM D4373 for the stone used in the leachate collection system.

(3) Geotextile Filter Fabric

Filter fabric surrounding the stone/collection piping shall be non-woven needle punched drainage fabric with the following minimum properties:

1)	Weight	4.5 oz/yd^2	ASTM D-5261
2)	Thickness	60 mils	ASTM D-1777
3)	Grab Strength	125 lbs.	ASTM D-4632
4)	Grab Elongation	60%	ASTM D-4632
5)	Trapezoidal Tear Strength	60 lbs.	ASTM D-4533
6)	Puncture Strength	65 lbs.	ASTM D-4833
7)	Mullen Burst Strength	185 psi	ASTM D-3786
8)	Permittivity	1.8 sec^{-1}	ASTM D-4491
9)	Apparent Opening Size (AOS)	0.212 mm (US sieve size 70)	ASTM D-4751

Filter fabric shall be manufactured by Polyfelt, Mirafi, or approved equal.

(4) Knife Gate Valves

Knife Gate Valves shall be bonnetless, wafer type made with a cast iron body, with several support ribs for a strong flanged connection. All sizes shall have a fabricated stainless steel liner. Standard flange holes will be drilled and tapped. Flange drilling dimensions will meet M.S.C. SP-81 and A.N.S.I. B16.5, Class 125/150 requirements. The raised face flange shall meet M.S.S. SP-81 face-to-face dimensions. Valves shall have all wetted parts of stainless steel. Stainless steel liner shall extend through the valve chest to the top of the packing gland. Both sides of the gate shall be finished ground. The stem shall be stainless steel and shall have double pitch threads. The yoke nut shall be acid-resisting bronze. The valve shall have a raised seat with a relieved area around the seat to prevent jamming. The valve gate shall be suitable for 125 psi pressure differential. Packing gland shall have three (3) layers of fiber packing with a 4th elastomer seal. Resilient seated knife gate valves shall have a round port with a replaceable resilient seat interlocked by a metal retaining ring. The metal ring shall act as a wiper blade to clean the gate before it passes over the seat. The resilient seat shall be captured and locked in place on three (3) sides only exposing one surface for sealing which prevents blowout. Knife gate valves shall be a series 304G as manufactured by Red Valve or equal.

(5) Polyethylene Manholes

Polyethylene manholes shall be produced using polyethylene compounds conforming to the requirement of Type III, Category "3", Class B, as defined and described in ASTM D-1248. Clean reworked material or reprocessed material may be use din the manufacture provided that the manhole components meet all the requirements of the product specification.

Polyethylene manholes shall be produced in the rotational molding process. The manhole will consist of an appropriate combination of base, elevation, and top section based on project requirements. Interior access to all manholes shall be designed so that a portable ladder or permanent step system can be supported by the installed manhole. Manholes may be supplied with factory molded steps. Manway reducers shall be concentric with respect to the larger portion of the manhole. The manhole shall be designed to accept and shall be furnished with concrete filled polyethylene manhole lids weighing not less than 190 pounds and must be compatible with a Dewey Brothers RCR-2001 standard cast iron frame. Manhole segment joints shall be designed to function as a full tongue and grove with the groove portion no less than 2.75 inches in depth, and shall include water tight gaskets and/or sealing compounds as recommended by the manufacturer.

Polyethylene manholes shall have a nominal cylinder internal diameter of 48 inches. The manway reducer nominal inside diameter shall be 27.75 inches. Wall thickness of all components shall be determined in accordance with ASTM D-2122 and shall be a minimum of .330 inches.

(6) Trenching for Leachate Piping

The Engineer shall provide on the Contract Drawings a horizontal layout for the proposed leachate collection system along with a minimum of two (2) benchmarks. The Contractor shall be responsible for verifying the accuracy of any and all bench marks prior to use. No claim for extra work will be allowed for alleged inaccuracy for any benchmark. It shall be the Contractor's responsibility to protect the original line and benchmarks set by the Engineer. Should this information become destroyed or damaged, the cost of the replacement will be borne by the Contractor.

Excavation for the leachate collection shall be done only after the three foot of protective cover has been installed over the flexible membrane liner. The width of the excavation shall be no wider than two feet. Surface water that may have been trapped in the trench shall be removed immediately.

Mechanical equipment can be used for the first two and one-half feet of excavation. The remaining one-half foot or whatever protective cover remains above the flexible membrane liner shall be excavated by hand so as to not damage the liner. If damage occurs to the liner the Engineer or Owner shall be notified immediately and the repair shall take place shortly thereafter. All repairs to any component of the liner system will be done and tested according to the required repairs and testing for that component.

(7) Leachate Trench Construction

Geotextile filter fabric shall be installed along the entire length of the trenching or as required by Project Specifications on top of the exposed flexible membrane liner/geocomposite net. This fabric is intended to protect the liner/net from the stone that surrounds the perforated collection piping.

In addition, the fabric shall be installed up the walls of the trench with enough excess at the top so that the stone can be completely covered with filter fabric.

The leachate collection pipe shall be placed in the bottom of the trench and the stone shall be placed around and over the pipe up to approximately six inches above the top of the protective cover.

The as-built location of the leachate collection trenches and sump shall be part of the CQA documentation.

(8) Videoing of Lines

All the lines that have cleanouts attached shall be videoed after installation to assure that the lines are clean and free of debris. The video shall include the entire length of the line that has been constructed. The video shall become part of the QC documentation.

4.2.8 Sewer Line

All HDPE pipe shall be laid in conformance with the ASTM standard for installing flexible thermoplastic pipe ASTM D2321. This specification shall be strictly conformed with unless otherwise noted by the Project Specifications or required by the Engineer on site because of local conditions.

All Dual Containment HDPE Pipe shall confirm to ASTM D3350.

(1) Construction Methods

All Gravity Flow Pipeline shall be installed using a laser for control of vertical and horizontal alignment. The Contractor shall follow accepted practices in the utilization of the laser. A certified laser operator shall be present on the job at all times. Care shall be exercised to assure that the alignment control range of the instrument is not exceeded; but in no case, shall the range exceed 500 feet. Care shall be taken to prevent vibration of or direct sunlight on the instrument. Where present, a blower shall be provided to purge glue vapors from the pipe. An air velocity meter shall be provided so that the velocity of air in the pipe will not be great enough to cause the light beam to be distorted. The Contractor shall coordinate the work to minimize the number of take downs and set ups at each point. Periodic checks of the laser shall be made to assure that alignment is maintained.

Each pipe shall be laid on an even, firm bed, so that no uneven strain will come to any part of the pipe. Before each piece of pipe is lowered into the trench, it shall be thoroughly inspected to insure it’s being cleaned. Each piece of pipe shall be lowered separately. No piece of pipe or fitting which is known to be defective, shall be laid or placed in the lines. If any defective pipe or fitting shall be discovered after the pipe is laid it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe.

(2) Butt Fusion for HDPE pipe

Clean pipe ends inside and outside with a clean cloth to remove dirt, water, grease and other foreign materials.

Square (face) the pipe ends using facing tool of the fusion machine.

Check line-up of pipe ends in fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. This is commonly referred to as "adjusting high-low". It is advisable at this point to make sure the clamps are tight so that the pipe does not slip during the fusion process.

Insert clean heater plate between aligned ends, and bring ends firmly in contact with plate, but do not apply pressure while achieving melt pattern. Carefully move the pipe ends away from the heater plate and remove the plate. (If the softened material sticks to the heater plate, discontinue the joint. Clean heater plate, re-square pipe ends and start over.)

Note: One pipe end usually moves away from the heater plate first. It is good practice to "bump" the plate away from the other side and then lift it out. Never drag or slide it over the melted pipe end.

Bring melted ends together rapidly. Do not slam. Apply enough pressure to form a double roll back to the body of the pipe brad around the entire circumference of the pipe about 1/8" to 3/16" wide. Pressure is necessary to cause the heated material to flow together.

Allow the joint to cool and solidify properly. This occurs when the brad feels hard and your finger can remain comfortably on the brad. Remove the pipe from the clamps and inspect the joint appearance.

(3) Tests

HDPE Dual Containment Force main - ASTM F2164-02. All HDPE pipe shall be tested at 1.5 times the rated working pressure. The outer pipe shall be tested separately from the inner pipe. In no case shall there be any visible leakage, nor shall there be leakage between any section of pipe.

4.2.9 Closure Cap System

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

4.2.10 Conformance Testing for Interface Friction Angles of Capping Materials

Conformance testing for Interface Friction Angles, for every 200,000 square feet of capping materials is as follows:

Minimum Friction Angle for soil to textured LLDPE liner is 26 degrees and the test method is ASTM 5321.

Minimum Friction Angle for textured LLDPE liner to 250 mil double bonded geocomposite drainage net is 24 degrees and the test method is ASTM 5321.

Minimum Friction Angle for 250 mil double bonded geocomposite drainage net to soil is 26 degrees and the test method is ASTM 5321.

4.2.11 Closure Cohesive Soil Cap

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Cohesive Soil Cap Borrow Material

Test Name	Test Method	Contractor/Engineer Frequency
Moisture/Density	ASTM D698/D1557	1 per 5000 c.y.
Remolded Permeability	ASTM D5084	1 per 5000 c.y.
Atterberg Limits	ASTM D4318	1 per 5000 c.y.
Visual Classification	ASTM D2487	1 per 5000 c.y.
Grain Size Distribution	ASTM D422	1 per 5000 c.y.

Cohesive Soil Cap Test Pad

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	3 per lift
Permeability	ASTM D5084	1 per lift
Remolded Permeability	ASTM D5084	1 per lift
Atterberg Limits	ASTM D4318	1 per lift
Visual Classification	ASTM D2487	1 per lift
Grain Size Distribution	ASTM D422	1 per lift

In-Place Cohesive Soil Cap

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	1 per lift per acre
Permeability	ASTM D5084	1 per lift per acre
Atterberg Limits	ASTM D4318	1 per lift per acre
Visual Classification	ASTM D2487	1 per lift per acre
Grain Size Distribution	ASTM D422	1 per lift per acre

(a) Suitable on-site and/or off-site soils may be used as cohesive soil cap if it can achieve an in-place permeability of 1.0 x 10^{-5} cm/sec or less and meets all testing requirements indicated in the material testing paragraph in this section. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

(b) A permeability “window” shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil cap. The window shall be plotted on a semi-log plot with moisture content versus density. Laboratory testing to develop the window shall include a series of remolded samples compacted to various dry densities and moisture contents utilizing the same compactive effort (ASTM D 698 or D 1557). The remolded samples shall be tested for permeability to determine whether or not the particular soil type will provide the maximum permeability (1.0 x 10^{-5} cm/sec) at various dry densities and moisture contents. The window is then developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

(c) Atterberg limits and grain size distribution shall also be conducted on the bulk samples used to prepare the permeability window ASTM D2487, D4318, D422. These tests can be used as indices on random samples collected from the borrow site during construction to verify the soil type is the same as was used to develop the “window”. As a minimum, sufficient visual classifications and Atterberg limits shall be conducted in association with each permeability test to verify that the construction materials meet specifications.

(d) A test strip of compacted cohesive soil cap shall be prepared to verify the permeability “window” prior to general installation of the cohesive soil cap. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil cap. At a minimum, the verification will consist of three moisture density tests, one Atterberg limits test, one grain size distribution test (ASTM D2487, D4318, and D422), and one Shelby Tube sample for each lift constructed in the test pad. Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 x10^{-5}cm/sec. Tests shall be performed in accordance with the ASTM D5084. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least three compacted 6 inch lifts of cohesive soil cap. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil cap. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeability of 1.0 x 10^{-5} cm/sec of the cohesive soil cap. The test strip may be used as an integral part of the overall cohesive soil cap if it meets the required specification for the cap. All results shall be given to the Construction Observer.

(e) The soils shall be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift compacted preferably at a moisture content between 0 to 3% above optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698). A sheepsfoot roller or approved alternative may be used to compact the soil cap provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil cap shall be screened, disked, or prepared using any other approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. After each lift, the surface shall be scarified prior to the placement of the next lift to provide good bonding from one lift to the next.

(f) The cohesive soil cap shall be tested to evaluate the coefficient of permeability. The coefficient of permeability of the soil cap shall be equal to or less than 1.0 x 10^{-5} cm/sec after placement and compaction. The soil cap must be a minimum of 1.5 feet thick.

(g) Laboratory falling head permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 x 10^{-5} cm/sec. Tests shall be performed in accordance with ASTM D5084. All laboratory permeability tests shall be performed at a confining pressure of 10 psi and at a hydraulic gradient of 20.

(h) The soil cap shall be tested a minimum of one soil sample per lift per acre for laboratory permeability. All permeability testing will be on random samples judged by the Engineer to be representative of the most permeable soil conditions for the area being tested. The Engineer shall certify that the materials used in construction were tested according to the Division approved plans. If after placement of the soil cap it fails the required tests, the material will either be reworked or replaced and retested. The soil cap must remain moist at all times, if any section becomes dry, rework the dry area and moisten.

(i) A minimum of two (2) inches of soil shall be removed prior to securing each sample for permeability testing. The sampling tube shall be advanced vertically into the soil with as little soil disturbance as possible and should be pushed using a uniform pressure. The sampling tube (Shelby tube), when extracted, shall be free of dents, and the ends shall not be distorted. A backhoe or approved alternative should be used to advance the sampling tube (Shelby tube) as long as disturbance is minimized. Drive tube samples of the cap may be obtained for permeability testings. If the Engineer judges the sample to be too disturbed, another sample shall be taken. Once an acceptable sample has been secured and properly prepared, all sample excavations or other holes created by survey stakes, etc. shall be backfilled to grade with a 50% mixture of bentonite and similar soils in maximum 3-inch loose lifts and hand tamped with a blunt tool to achieve a tight seal equivalent to the original density.

(j) No additional construction shall proceed on the soil layers at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved.

(k) As a minimum, sufficient visual classifications (ASTM Test Designation D2487) , analyses (ASTM Test Designation D422) and Atterberg limits (ASTM Test Designation D4318) shall be conducted in association with each permeability test to verify that the construction materials meet specifications. The minimum number of tests will be 1 per lift per acre.

(l) If the soil for the cohesive soil cap is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory and mixed in the field using either a pug mill or a soil stabilizer. Where additives are required, the soil shall be placed in maximum 8-inch thick loose lifts and compacted preferably between 0 to +3% optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698) for the soil-additive mixture. All other compaction procedures for the soil apply.

(m) Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil cap shall have no sudden sharp or abrupt changes in grade such as tire ruts.

(n) The Contractor shall protect the cohesive soil cap from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil cap until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions shall be replaced or reworked by the contractor to remove these defects. Areas where the cohesive soil has been replaced, desiccation cracks and/or heaving is deeper than two (2) inches shall be retested.

(o) The thickness and grade of the soil cap will be verified by the surveyor before placement of the geomembrane liner. The soil cap will be surveyed at 50' grid points where the elevations of the top of intermediate cover will be compared with the top of soil cap to verify 1.5 feet of soil cap. The grade will then be verified with the surveyed information. The survey will be performed by a N.C. licensed surveyor.

(p) Surface Acceptance. Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil cap and the surface shall remain the responsibility of the contractor.

4.2.12 Closure Flexible Membrane Liner Method of Deployment

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Flexible Membrane Liner Tests

Test Name	Description	Test Method	Frequency
Air Test	Air Test Seams		Every Seam
Vacuum Test	Every welded area		Where air test impossible
Destructive Tests	Seam Strength	ASTM D4437	Every 500' of seam

Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

The 40 mil. Linear Low Density Polyethylene (LLDPE) is to be placed in direct contact with moist cohesive soil cap. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner and shall meet the following minimum properties:

English Units

Table 2(a) – Linear Low Density Polyethylene (LLDPE) Geomembrane (TEXTURED)

Properties	Test Method	Test Value 20 mils	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	Testing Frequency (minimum)
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	10	10	10	10	10	10	10	10	Every 2nd roll *(2)*
Density g/ml (max.)	D 1505/D 792	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939	200,000 lb
Tensile Properties *(3)* (min. ave.) • break strength – lb/in. • break elongation - %	D 6693 Type IV	30 250	45 250	60 250	75 250	90 250	120 250	150 250	180 250	20,000 lb
2% Modulus – lb/in. (max.)	D 5323	1200	1800	2400	3000	3600	4800	6000	7200	per formulation
Tear Resistance – lb (min. ave.)	D 1004	11	16	22	27	33	44	55	66	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	22	33	44	55	66	88	110	132	45,000 lb
Axi-Symmetric Break Resistance Strain - % (min.)	D 5617	30	30	30	30	30	30	30	30	per formulation
Carbon Black Content - %	D 1603 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	45,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)* (e) Standard OIT — or — (f) High Pressure OIT	D 3895 D 5885	100 400	100 400	100 400	100 400	100 400	100 400	100 400	100 400	200,000 lb
Oven Aging at 85°C *(7)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	35 60	35 60	35 60	35 60	35 60	35 60	35 60	35 60	per formulation
UV Resistance *(8)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 3895 D 5885	N. R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	per formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 9.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

(4) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(1) Preparation for Geomembrane Deployment

(a) Panel Layout

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project.

(b) Identification

Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture.

(c) Verification

The manufacturers certification will be reviewed by the Engineer. If the certification does not meet the requirements of GRI-GM17, the corresponding liner rolls will be rejected.

The Engineer will remove a sample from 1 out of 4 rolls delivered to the site and have a third party lab test for thickness, density, carbon black content, carbon black dispersion and tensile properties. The will have been accredited by the Geosynthetic Accreditation Institute (GAI).

(2) Field Panel Placement

(a) Location

The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing, which will be modified at the completion of the project to reflect actual panel locations.

(b) Weather Conditions

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds.

(c) Method of Deployment shall follow the manufacturer's recommendations and sound, accepted engineering practices.

(1) The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface.

(2) No personnel working on the geomembrane will smoke, wear shoes that can damage the geomembrane, or engage in actions, which could result in damage to the geomembrane.

(3) Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas.

(4) The geomembrane will be deployed in a manner to minimize wrinkles. The geomembrane will have no fold overs.

(5) Any damage to a panel of the geomembrane will be repaired. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed.

(3) Field Seaming

(a) Layout

In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

(b) Personnel

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

(c) Equipment

(1) Fusion Welding

Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels, which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device, which continuously monitors the temperature of the wedge.

(2) Extrusion Fillet Welding

Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

(d) Weather Conditions

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can affect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation, which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will effect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day.

(4) <u>Seam</u> <u>Preparation</u>

(a) Fusion Welding

(1) Overlap the panels of geomembrane approximately four (4) inches.

(2) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind. No grinding is required for fusion welding.

(3) Adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

(4) A movable protective layer may be used, at the discretion of the Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

(b) Extrusion Welding

(1) Overlap the panels of geomembrane a minimum of three (3) inches.

(2) Temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane.

(3) Grind seam overlap prior to welding within one (1) hour of welding operation in a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area.

(4) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.

(5) Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel.

(6) Keep welding rod clean and off the ground.

(5) Test Seams

Test seams shall be performed at the beginning of each seaming period and at approximately every 4-working hour intervals for each seaming apparatus used that day. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams.

(a) Test Seam Length

The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width.

(b) Sample Procedure

(1) Visually inspect the seam for squeeze out, footprint, pressure and general appearance.

(2) Two random samples one (1) inch wide shall be cut from the test seam.

(3) The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer that has a constant separation of 2.0 in/min for peel and shear. The passing destructive test requirements for a 40-mil liner seam is: minimum peel adhesion of 44 ppi for hot wedge and 50 ppi for extrusion fillet seams, minimum shear strength of 60 ppi or hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam. If a specimen fails, the entire procedure shall be repeated.

(4) If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved.

(5) After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained, listing seam identification number, welder's name, temperature control setting, and test results.

(6) Passing test results records shall be maintained.

(6) General Seaming Procedures

(a) Seaming shall extend to the outside edge of panels to be anchored.

(b) While welding a seam, monitor and maintain the proper overlap.

(c) Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind.

(d) While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly.

(e) Align wrinkles at the seam overlap to allow welding through the wrinkle.

(f) Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions.

(g) All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane.

(h) All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind ¼ of an inch minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

4.2.13 Closure Flexible Membrane Liner Tests

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

(a) Air Pressure Testing

The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time.

(1) Equipment for Air Testing

An air pump (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi.

A rubber hose with fittings and connections.

A sharp hollow needle, or other approved pressure feed device with a pressure gauge capable of reading and sustaining a pressure between 25 to 30 psi.

(2) Procedure for Air Testing

Seal both ends of the seam to be tested.

Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld.

Inflate the test channel to a pressure between 25 to 30 psi, in accordance with the following schedule, close valve, and observe initial pressure after approximately 2 minutes.

INITIAL PRESSURE SCHEDULE *

Material (Mil)	Min. Psi	Max. Psi
40	25	30
60	27	30
80	30	30
100	30	30

* Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize.

Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds the following or if the pressure does not stabilize, locate faulty area and repair.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL
AFTER 5 MINUTES - LLDPE

Material (Mil)	Pressure Diff.
40	4 psi
60	3 psi
80	3 psi
100	3 psi

At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected.

Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

(3) In the event of a Non-Complying Air Pressure Test, the following procedure shall be followed:

Check seam end seals and retest seams.

If non-compliance with specified maximum pressure differential re-occurs, repair the seam. Capping or removal/reseam of the non-complying seam are the only two (2) acceptable methods for repairing failed seams. Non-destruct test the entire length of the repaired seam.

(b) Vacuum Testing

This test is used when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

(1) Equipment for Vacuum Testing

Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

Vacuum pump assembly equipped with a pressure controller and pipe connection.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and means to apply a soapy solution.

A soapy solution.

(2) Procedure for Vacuum Testing

Trim excess overlap from seam, if any.

Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi gauge.

Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested.

Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.

Close the bleed valve and open the vacuum valve.

Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box.

Ensure that a leak tight seal is created.

For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process.

(3) Procedure for Non-Complying Test

Mark all areas where soap bubbles appear and repair the marked areas.
Retest repaired areas.

(c) Destructive Testing

(1) Concept

The purpose of destructive testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane.

(2) Procedure for Destructive Testing

All Destructive tests will be done according to GRI test method GM19. Destructive test samples shall be marked and cut out randomly at a minimum average frequency of one test location every 500 feet of seam length.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds at the discretion of the Flexible Membrane Liner Superintendent and Engineer.

Sample Size

The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications.

A one (1) inch sample shall be cut from each end of the test seam for field testing.

The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer that has a constant separation of 2.0 in/min. for peel and shear. The passing destructive test requirements for a 40-mil LLDPE liner seam is: minimum peel strength of 50 ppi for hot wedge and 44 ppi for extrusion fillet seams, minimum shear strength of 60 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam.

(3) Procedure in the event of Destructive Test Failure

Cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.

If the laboratory samples pass then repair the seam between the two (2) passing samples locations.

Capping or removal/reseam of the non-complying seam are the only two (2) acceptable methods for repairing failed seams.

All destructive seam samples sent to the Flexible Membrane Liner System's laboratory shall be numbered.

(d) Quality Assurance Laboratory Testing

(1) Destructive samples sent to the laboratory will be tested for shear/peel strength, elongation, and peel separation according to table 1(a) of GRI Test Method GM19. Five (5) specimens shall be tested for each test method with data recorded. Four (4) out of the five (5) specimens must pass and the fifth specimen must be 80% of the passing test values. The passing test values are as follows:

Hot Wedge Seams
- Shear Strength-60 ppi
- Shear elongation at break – 50%
- Peel Strength- 50 ppi
- Peel separation-25%

Extrusion Fillet Seams
- Shear Strength-60 ppi
- Shear Elongation at break-50%
- Peel Strength- 44 ppi
- Peel separation-25%

(2) Defects and Repairs

(a) The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation.

(b) All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

(c) Repair Procedures

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely manner to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil cap such as a temporary cover. If cohesive soil cap is damaged, it must be reworked. Procedures available for liner repair:

Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded.

Grinding and welding - used to repair sections of extruded seams.

Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws.

Capping - used to repair lengths of failed seams.

Removal of a bad seam and replacement with a strip of new material seamed into place.

(d) Verification of Repairs

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

e) Liner Acceptance

The constructed liner will be accepted when all non-destruct and destruct tests have passed their respective tests and the results have been verified by the Engineer.

4.2.14 Closure Protective Cover

(1) HPDE Geocomposite Drainage Netting manufactured by SKAPS Industries, or approved equal. Q/C testing information/certification for each property on geocomposite will be provided by the contractor/manufacture for the rolls delivered. The thickness, transmissivity and ply adhesion will be tested by the Engineer's third party laboratory for quality assurance. One roll from every 200,000 $ft.^2$ of material delivered to the site will be tested.

SKAPS TRANSNET HDPE GEOCOMPOSITE WITH 250 MIL GEONET

Last Updated on Wednesday, 08 September 2010 07:57

SKAPS TRANSNET™ GeoComposite consists of SKAPS GeoNet made from HDPE resin with non-woven polypropylene GeoTextile fabric heat bonded on both sides of GeoNet.

Property	Test Method	Unit	Required Value		Qualifier
			with 6 oz.	with 8 oz.	
Geonet					
Thickness	ASTM D 5199	mil	250 ±15	250 ±10	Range
Carbon Black	ASTM D 4218	%	2 to 3	2 to 3	Range
Tensile Strength	ASTM D 5035	lb/in	50	50	Minimum
Melt Flow	ASTM D 1238[3]	g/10 min	1	1	Maximum
Density	ASTM D 1505	g/cm^3	0.94	0.94	Minimum
Transmissivity[1]	ASTM D 4716	m^2/sec	$2.5x10^{-3}$	$2.5x10^{-3}$	MARV[2]
Composite					
Ply Adhesion (Minimum)	ASTM D 7005	lb/in	0.5	0.5	MARV
Ply Adhesion (Average)	ASTM D 7005	lb/in	1	1	MARV
Transmissivity[1]	ASTM D 4716	m2/sec	$2x10^{-4}$	$2x10^{-4}$	MARV
GeoTextile					
Fabric Weight	ASTM D 5261	oz/yd^2	6	8	MARV
Grab Strength	ASTM D 4632	lbs	160	225	MARV
Grab Elongation	ASTM D 4632	%	50	50	MARV
Tear Strength	ASTM D 4533	lbs	65	90	MARV
Puncture Resistance	ASTM D 4833	gpm/ft^2	95	130	MARV
CBR Puncture	ASTM D 6241	lbs	475	650	MARV
Water Flow Rate	ASTM D 4491	gpm/ft^2	125	100	MARV
Permittivity	ASTM D 4491	sec^{-1}	1.63	1.26	MARV
Permeability	ASTM D 4491	cm/sec	0.30	0.3	MARV
AOS	ASTM D 4751	US Sieve	70	80	MARV

Notes:

1. Transmissivity measured using water at 21 ± 2 °C (70 ± 4 °F) with a gradient of 0.1 and a confining pressure of 10000 psf between steel plates after 15 minutes. Values may vary between individual labs.

2. MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.

3. Condition 190/2.16

The geocompsite will be handled in such a manner as to ensure the geocomposite are not damaged in any way. On slopes, the geocomposite will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles. Geocomposite can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geocomposite will not be welded to the geomembrane. Geocomposite will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geocomposite that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geocomposite will be overlapped by at least four inches and securely tied. Tying can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one foot intervals. In the corners of the side slopes where overlaps between perpendicular geocomposite strips are required, an extra layer of geocomposite will be unrolled along the slope, on top of the previously installed geocomposite, from the top to bottom of the slope.
Any holes or tears in the geocomposite will be repaired by placing a patch, utilizing the same geocomposite material, extending two feet beyond edges of the hole or tear. The patch will be secured to the original geocomposite by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geocomposite will be joined.

The engineer will visually inspect the drainage layer before placement of the erosive layer, if any defects are detected they will be repaired before placement of erosive layer.

(2) Erosive Layer

The soil for the erosive layers shall consist of suitable site soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension, which has been screened. No permeability, grain size, or other tests are required for this material.

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The erosive layer shall be composed of 24” of select backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

The depth of the erosive layer will be verified based on the 50 ft. grid and the difference in elevation from the top of the cohesive soil to the top of the erosive layer.

(a) A minimum of twelve inches (12") of cover between low ground pressure equipment and the liner is required at all times. Roadways for entering and for transporting material over slopes and capped/lined areas shall have a minimum depth of four feet (4').

(b) Avoid undue stress on the liner at all times. Cover material must be pushed up slopes, never down to help minimize wrinkles. Material must be placed to minimize wrinkles, wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Fold over of the liner will not be allowed. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner.

(c) If damage does occur, report it to the Project Manager immediately so that repairs can be performed without needless delay. All repairs to any component of the liner system will be done and tested according to the required repairs and testing for that component

(d) Do not work wet cover material that cannot support equipment.

(e) Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

(3) Vegetative Layer

Native vegetation will be used as approved by the Erosion Control Plan.

4.2.15 Closure Methane Venting System

NC.D.O.T. No.5 stone, Geotextile fabric, and 8" and 10" plastic pipes will be used in the construction of the gas venting system.

(1) Stone in Trenches and Surrounding Perforated Collection Piping

Stone for methane collection system shall meet the requirements of NC DOT aggregate, standard size No. 5 and shall contain no fines. Stone must pass the sieve analysis test for No. 5 stone performed at the quarry.

(2) Geotextile Fabric

Geotextile fabric surrounding the stone/piping shall be non-woven needle punched fabric with the following minimum properties:

1)	Weight	8.0 oz/yd^2	ASTM D-3776
2)	Grab Strength	205 lbs.	ASTM D-4632
3)	Grab Elongation	50%	ASTM D-4632
4)	Trapezoidal Tear Strength	85 lbs.	ASTM D-4533
5)	Puncture Strength	100 lbs.	ASTM D-4833
6)	Mullen Burst Strength	320 psi	ASTM D-3786
7)	Permittivity	1.4 sec^{-1}	ASTM D-4491

Geotextile fabric shall be manufactured by Polyfelt , TNS Advanced Technologies, or approved equal.

(3) Plastic Pipe

Plastic gravity sewer pipe and fittings used for methane vent shall be unplasticized polyvinyl chloride (PVC) and conform to the requirements of ASTM Designation D-3034 on ASTM F679, Type PSM, Class 12454-B, SDR-35 with elastomeric gasket joints. PVC pipe and fittings shall be as manufactured by J-M Pipe, Certainteed, H&W Industries or equal. The methane riser pipe shall be a 10 inch solid wall PVC pipe.

4.3 Documentation

At the completion of the contract, it is the Engineer's responsibility to provide to the Owner and eventually to the Division of Waste Management the following:

1. All parties involved in the landfill construction including name and contact information and responsibilities'.
2. As-built drawings of the subgrade, liner system, leachate collection, gas vents, etc. provided by NC Professional Land Surveyor.
3. Documentation of all subbase standard Proctor tests.
4. Documentation of all cohesive soil liner tests including test pads, permeability, standard Proctor and Atterberg limits.
5. Documentation of all destructive and non-destructive tests, methods and results and repairs.
6. Geomembrane panel layout with test locations and repairs illustrated.
7. Documentation of all hydrostatic testing of non-perforated leachate collection pipe.
8. Completed and signed meeting minutes including pre-construction, progress and any trouble shooting.
9. Summary of all construction activities from the Engineer.
10. Provide color photographs of major construction features.
11. Any other pertinent documentation.

The CQA report shall be sealed by the Engineer and a certification that construction was completed an accordance with the CQA plan, Conditions of the permit to construct, The requirements of rule .1624 Construction Requirements for MSWLF Facilities, and acceptable engineering practices.

Shop Drawings

Contractor is required to submit to the Engineer a descriptive detail and any shop and setting drawings. On composite liner system, such submission shall include the following:

(1) Flexible Membrane Liner Panel Layout Drawings,
(2) Flexible Membrane Liner Penetration Details,
(3) Flexible Membrane Liner Anchoring Detail,
(4) Flexible Membrane Liner Seaming Detail,
(5) Single Flexible Membrane Liner Anchoring to Structure Detail,
(6) Flexible Membrane Liner Extension Detail, and
(7) Certified experience records for manufacturer, fabricator and installer, listing installations of Flexible Membrane Liners.

SEAM TESTING

Project Name ____________________________Project Number ______________________Superintendent ______________________

NSC FIELD SEAM NO.	SEAM DATE	SHOP DWGN SEAM NO.	WELDER AND SEAMER ID. NO.	TEST DATE	START ______ PRESS.	TIME	END ______ PRESS.	TIME	AIR TEST RESULTS	COMMENTS	REPAIR DATE	WELDER AND GUN ID. NO.	REPAIR VACUUM TEST DATE	SEAM (INITIAL) (DATE)

Page ________ of ________

DESTRUCTIVE TEST SAMPLES

Project Name ______________________________Project Number _____________________________Supervisor _____________________

DATE	WELDER ID.	SEAMER	SEAM NO.	LOCATION	SAMPLE ID.

Page _______ of _______

TEST SEAM RECORDS

Project Name ___________________________Project Number __________________________Supervisor ___________________

TEST DATE	TIME	LBS./IN.	PASS/FAIL	MACHINE NUMBER	TEMP. SETTING	OPERATOR

Page _______ of _________

REPAIR REPORT

Project Name ______________________ Project Number ________________ Supervisor ____________________

FIELD SEAM #	PANEL #	REPAIR DATE	WELDER AND SEAMER ID. #	LOCATION OF REPAIR	REPAIR VACUUM TEST DATE	REPAIR ACCEPTED (INITIAL) (DATE)

Page ______ of _______

SECTION 5.0

OPERATION PLAN

5.1 Introduction

The County Landfill will only accept Municipal Solid Wastes (MSW) from the County. The County will construct a 21 acre Municipal Solid Waste Landfill (Phase 3) according to Subtitle D requirements. The facility will be constructed with 24 inches of cohesive soil (permeability of 1.0 x 10^{-7} cm/sec), or 18 inches of cohesive soil (permeability of 1.0 x 10^{-5} cm/sec) with reinforced geosynthetic clay liner (GCL), 60 mil High Density Polyethylene liner (HDPE), 36 inches of protective cover over the liner and a leachate collection system which flows to the existing leachate lagoon.

The perimeter of the lined area will be marked off by 2 inch PVC pipe at 100' intervals that will be placed in the anchor trenches. Solid waste will not be placed within four (4) feet of this boundary to assure that it is being placed directly above the liner system so that no leachate can flow outside of this area.

All stormwater that comes in contact with solid waste will be handled as leachate. The leachate is collected in the sump area, where it is pumped by force main to the lagoon.

Storm water that has not come in contact with waste can be removed from the landfill by pumping thru a sump pump over the berm prior to waste being placed in the sump basin. A mobile pump can also be used to pump storm water over the berm.

Leachate will be pumped and treated at the Goldsboro Wastewater Treatment Plant. The leachate will have to be tested according to the pretreatment conditions outlined in the pre-treatment agreement.

Leachate will be treated at the Goldsboro Wastewater Treatment Plant. The leachate will have to be tested according to the pretreatment conditions outlined in the pre-treatment agreement. The leachate will be pumped by Forcemain to the Treatment Plant.

The leachate lagoon will be inspected on a monthly basis and a report generated and placed in the landfill records. The report will include the date the liner was inspected, the inspector, general observations since the last inspection, visible abrasions, possible stress cracks, or obvious punctures. Stress cracks can occur in wrinkles that are generated from heat expansion or contraction due to freezing. Also, the HDPE liner may deteriorate due to ultra violet light and this can appear as an abrasion where material can be scraped away with a hard object. If any damage or possible weak spots due to ultra violet exposure has been detected, a qualified HDPE installation company shall be notified immediately so that a repair patch can be installed. The leachate level shall not be allowed to exceed the depth of the damaged liner until it has been repaired and tested by the liner installation company. Once this has been accomplished all testing documentation shall be placed in the operating records.

The County will monitor all areas of MSW filling for possible leachate break-outs. The County will implement a program for corrective actions for leachate break-outs (See Section 5.5-Appendix III).

The County will implement a program at the landfill for detecting and preventing the disposal of hazardous and liquid wastes. The program consists of random inspection of incoming loads at a minimum of 1% of the weekly traffic. Landfill personnel will be trained to recognize hazardous and liquid wastes. Records will be kept on the training and the inspections (See Section 5.3-Appendix I).

The County will monitor for explosive gases at landfill structures and the perimeter of the landfill. There are ten(10) existing methane monitoring probes. Four(4) additional methane monitoring probes will be installed. The concentration of methane gases generated by the landfill cannot exceed 25 percent of the lower explosive limit for methane in the structures, and it cannot exceed 100 percent of the lower explosive limit for methane of the landfill property boundary (See Section 5.4-Appendix II). If methane gas is found to exceed the acceptable limits at either the property boundary or landfill structures, it is the County's responsibility to do the following:

1. Immediately take all necessary steps to ensure protection of human health, i.e. no smoking, temporarily abandon the structure and notify the Division of Waste Management.

2. Within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and

3. Within 60 days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Division of Waste management that the plan has been implemented. The plan will describe the nature and extent of the problem and the proposed remedy.

Off and on site erosion will be controlled through erosion control structures and devices. Provisions for a vegetative ground cover sufficient to restrain erosion will be accomplished within 15 working days or 90 calendar days upon completion of any phase of landfill development.

The County will record and retain at the landfill an operating record of the following information:

(1) Inspection records, waste determination records, and training procedures;
(2) Amounts by weight of solid waste received at the landfill;
(3) Waste determination, Leachate sampling data, leachate levels, meteorological data ;
(4) Gas monitoring results and any remediation plans;
(5) Any demonstration, certification, findings, monitoring, testing or analytical data required for surface and groundwater monitoring;
(6) Any monitoring, testing or analytical data required for closure or post-closure;
(7) Any cost estimates and financial assurance documentation.

All information contained in the operating record will be furnished upon request to the Division of Waste Management or be made available at all reasonable times for inspection by the Division.

Ground and surface water will be sampled and analyzed according to Subtitle D Appendix I detection monitoring requirements. The monitoring frequency for all Subtitle D Appendix I detection monitoring constituents will be at least semi-annually during the life of the facility (including closure) and the post-closure period. A minimum of four independent samples from each well (background and downgradient) will be collected and analyzed for the Subtitle D Appendix I constituents during the first semi-annual sampling event. At least one sample from each well (background and downgradient) will be collected and analyzed during subsequent semiannual sampling events.

If the County determines that there is a statistically significant increase over background for one or more of the constituents listed in Subtitle D Appendix I at any monitoring well at the relevant point of compliance, the County will, within 14 days of the finding, report to the Division of Waste Management and place a notice in the operating record indicating which constituents have shown statistically significant changes from background levels. The County will establish an assessment monitoring program within 90 days. The County may demonstrate that a source other than the landfill caused the contamination or that the statistically significant increase resulted from an error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality. A report documenting these demonstrations will be certified by a Licensed Geologist or Professional Engineer and approved by the Division. A copy of this report will be placed in the operating record. If a successful demonstration is made, documented, and approved by the Division, the County may continue detection monitoring. If after 90 days, a successful demonstration is not made, the County will initiate an assessment monitoring program.

5.2 Operational Requirements

1. Waste Acceptance and Disposal Requirements

   a. The Municipal Solid Waste Landfill (MSWLF) will only accept those solid wastes which it is permitted to receive. The County will notify the Division within 24 hours of attempted disposal of any waste the landfill is not permitted to receive. Signs are placed at the entrance to the Landfill stating that Hazardous and Liquid wastes are not accepted and that random waste screening is performed.

   b. The following wastes are prohibited from disposal at the MSWLF:

      i. Hazardous waste as defined within 15A NCAC 13A, to also include hazardous waste from conditionally exempt small quantity generators.

      ii. Polychlorinated biphenyls (PCB) wastes as defined in 40 CFR 761.

      iii. Bulk or non-containerized liquid waste will not be placed in the landfill unless:

         (i) The waste is household waste other than septic waste and waste oil,
         (ii) The waste is leachate or gas condensate derived from the landfill.

      iv. White Goods, Yard Waste, Tires.

      v. Containers holding liquid wastes will not be placed in the landfill unless:

         (i) The container is a small container similar in size to that normally found in household waste;
         (ii) The container is designed to hold liquids for use other than storage; or
         (iii) The waste is household waste.

      vi. For the purpose of this paragraph:

         (i) Liquid waste means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), S. W. 846.

   c. Spoiled foods, animal carcasses, abattoir waste, hatchery waste, and other animal waste delivered to the disposal site will be covered immediately.

   d. The following are items that are banned in the future from the landfill:

      i. Beverage containers that are required to be recycled under G.S. 18B-1006.1 (Effective January 1, 2008).

      ii. Recyclable rigid plastic containers that are required to be labeled as provided BELOW that have a neck smaller than the body of the container and that accept a screw top, snap cap, or other closure. The prohibition on disposal of recyclable rigid plastic containers in landfills does not apply to rigid plastic containers that are intended for use in the sale or distribution or motor oil. (Effective October 1, 2009)

         (a) For polyethylene terephthalate, the letters "PETE" and the number 1.
         (b) For high density polyethylene, the letters "HDPE" and the number 2.
         (c) For vinyl, the letter "V" and the number 3.
         (d) For low density polyethylene, the letters "LDPE" and the number 4.
         (e) For polypropylene, the letters "PP" and the number 6.
         (f) For polystyrene, the letters "PS" and the number 7.
         (g) For any other, the letters "OTHER" and the number 7.

iii. Motor vehicle oil filters (effective October 1, 2009).

iv. Wooden pallets, except that wooden pallets maybe disposed of in a landfill that is permitted to only accept construction and demolition debris (effective October 1, 2009).

v. Discarded computer equipment (effective April 1, 2011).

e. Asbestos waste will be accepted and managed in accordance with 40 CFR 61. The waste will be covered immediately with soil in a manner that will not cause airborne conditions and must be disposed of separate and apart from other solid wastes:

i. At the bottom of the working face or;
ii. In an area not contiguous with other disposal areas. Separate areas will be clearly designated so that asbestos is not exposed by future land disturbing activities.

f. Wastewater treatment sludges may be accepted either as a soil conditioner incorporated into or applied onto vegetative growth layer but in no case greater than six inches in depth. Or wastewater treatment sludges may be co-disposed in the lined area.

g. The County will continue a program at the Landfill for detecting and preventing the disposal of hazardous and liquid wastes. (Section 5.3-Appendix I) This program will include, at a minimum:

i. Random inspections of incoming loads or other comparable procedures;
ii. Records of any inspections;
iii. Training of facility personnel to recognize hazardous and liquid wastes.
iv. If hazardous wastes are identified by facility personnel, Emergency Management or personnel trained, shall be notified to identify the waste and address removal, storage and final deposition of the waste.

h. Waste placement will be within the areal limits of the base liner system and in a manner consistent with the effective permit.

2. Cover material requirements.

a. Except as in Part (b), The County must cover disposed solid waste with six inches of earthen material at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors blowing litter, and scavenging.

b. Alternative materials such as synthetic cover may be used as daily cover on the working face until it is necessary to cover with earthen material. The alternative material must be approved by the Division and applied according to manufacturers recommendations. At a minimum soil cover will be used once a week.

c. Areas which will not have additional wastes placed on them for 12 months or more, but where final termination of disposal operations has not occurred, will be covered with a minimum of one foot of intermediate cover.

3. Disease vector control

a. The County will prevent or control on-site populations of disease vectors using techniques appropriate for protection of human health and the environment. At the end of every day, waste will be covered either by synthetic cover or 6" of soil cover. At a minimum soil will be used once a week. Any waste that requires immediate cover, will be covered immediately with soil.

b. "Disease vectors" means any rodents, flies, mosquitoes, or other animals, including insects, capable of transmitting disease to humans.

4. Explosive gases control

a. The County must ensure that:

i. The concentration of methane gas generated by the landfill does not exceed 25 percent of the lower explosive limit for methane in landfill structures (excluding gas control or recovery system components); and
ii. The concentration of methane gas does not exceed 100 percent of the lower explosive limit for methane at the landfill property boundary.

b. The County will implement a routine methane monitoring program to ensure that the standards of 4 (a) are met. (Section 5.4-Appendix II)

i. The type and frequency of monitoring must be determined based on the following factors:
(i) Soil conditions;
(ii) The hydrogeologic conditions surrounding the facility;
(iii) The hydraulic conditions surrounding the facility;
(iv) The location of facility structures and property boundaries.

ii. The minimum frequency of monitoring will be quarterly.

c. If methane gas levels exceeding the limits specified in 4 (a) are detected, the owner or operator will:

i. Immediately take all necessary steps to ensure protection of human health, i.e. no smoking, temporarily abandon the structure and notify the Division.
ii. Within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and
iii. Within 60 days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Division of Waste Management that the plan has been implemented. The plan will describe the nature and extent of the problem and the proposed remedy.

d. "Lower explosive limit" means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25° C and atmospheric pressure.

5. Air Criteria

a. The County will ensure that the landfill does not violate any applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the US. EPA Administrator pursuant to Section 110 of the Clean Air Act, as amended.

b. Open burning of solid waste, except for the infrequent burning of land clearing debris generated on site or debris from emergency clean-up operations, is prohibited. Any such infrequent burning will be approved by the Division of Waste Management, Division of Air Quality and the local Fire Marshall.

c. Earth moving equipment will be provided to control accidental fires and leachate tank trucks used for water or leachate that would be recirculated can also be used. Arrangements have been made with the local fire department to provide actual fire protection. This Fire department has access at all times to the landfill to provide fire fighting services when needed. Landfill personnel can use soil to isolate the fire so it will not spread any further but actual fighting of the fire should be the responsibility of the trained fire department.

d. Fires that occur at the landfill will be reported to the Division of Waste Management within 24 hours and written notification will be submitted within 15 days.

6. Access and safety requirements

a. The landfill will be adequately secured by means of gates, chains, beams, fences and other security measures approved by the Division of Waste Management to prevent unauthorized entry.

b. An attendant will be on duty at the site at all times while it is open for public use to ensure compliance with operational requirements.

c. The access road to the site will be of all-weather construction and maintained in good condition.

d. Dust control measures will be implemented when necessary. If dust problems should arise, the County will use any reasonable means necessary to reduce it. At a minimum the County will spray water on necessary areas.

e. Signs providing information on tipping or disposal procedures, the hours during which the site is open for pubic use, the permit number and other pertinent information will be posted at the site entrance.

f. Signs will be posted stating that no hazardous or liquid waste can be received.

g. Traffic signs or markers will be provided as necessary to promote an orderly traffic pattern to and from the discharge area and to maintain efficient operating conditions.

h. The removal of solid waste from the landfill will be prohibited unless the County approves and the removal is not performed on the working face.

i. Barrels and drums will not be disposed of unless they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained therein, except fiber drums containing asbestos.

7. Erosion and Sedimentation Control Requirements

a. Adequate sediment control measures (structures or devices), will be utilized to prevent silt from leaving the landfill.

b. Adequate sediment control measures (structures or devices), will be utilized to prevent excessive on-site erosion.

c. Provisions for a vegetative ground cover sufficient to restrain erosion will be accomplished within <u>15 working days</u> or <u>90 calendar days</u> upon completion of any phase of landfill development.

8. Drainage Control and Water Protection Requirements

a. Surface water will be diverted from the operational area and will not be impounded over waste..

b. Solid waste will not be disposed of in water.

c. Leachate will be contained on site and properly treated prior to discharge.

d. The landfill will not:

(i) Cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements pursuant to Section 402.

(ii) Cause the discharge of a nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirements of an area-wide or state-wide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended.

9. Liquids Restriction

a. Bulk or non-containerized liquid waste will not be placed in the landfill unless:

(i) The waste is household waste other than septic waste and waste oil,

(ii) The waste is leachate or gas condensate derived from the landfill.

b. Containers holding liquid wastes will not be placed in the landfill unless:

(i) The container is a small container similar in size to that normally found in household waste;

(ii) The container is designed to hold liquids for use other than storage; or

(iii) The waste is household waste.

c. For the purpose of this paragraph:

(i) Liquid waste means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), S. W. 846.

d. Test for free liquids:

Sludges or other wastes may be tested for free liquids after previous screening tests have shown that the waste is not hazardous and does not contain PCB's. The specified test to determine whether or not a material is considered to be a liquid is the Paint Filter Test method 9095. The procedure for conducting this test is as follows:

(i) Obtain standard 400- micron paint filter;

(ii) Place a properly-sized, clean, dry funnel in a ring stand or similar device;

(iii) Fold the filter and line the funnel with it;

(iv) Place a 100 ml sample of waste into the funnel;

(v) Place a clean, dry container under the funnel; and,

(vi) Check in exactly 5 minutes to see if any liquid is in the container.

(vii) If any liquid passes through the filter in 5 minutes or less, the waste is considered to be a liquid. The filtrate can be water, oil or any combination of any non-hazardous liquids.

10. Record keeping Requirements

a. The County's MSWLF will record and retain at the facility, or an alternative location near the facility approved by the Division of Waste Management, in an operating record the following information as it becomes available.

(i) Inspection records, waste determination records, and training procedures;

(ii) Amounts by weight of solid waste received at the landfill to include source of generation.

(iii) Waste determination, Leachate sampling data, leachate levels, meteorological data ;

(iv) Gas monitoring results and any remediation plans;

(v) Any demonstration, certification, findings, monitoring, testing or analytical data required for surface and groundwater monitoring;

(vi) Any monitoring, testing or analytical data required for closure or post-closure; and,

(vii) Any cost estimates and financial assurance documentation.

b. All information contained in the operating record will be furnished upon request to the Division of Waste Management or be made available at all reasonable times for inspection by the Division.

c. The County will maintain a copy of the operation plan at the landfill.

11. Spreading and Compacting Requirements

a. The initial lift of solid waste will be placed over cell 1 that is bounded by the leachate collection ditch. This lift will be covered with six (6) inches of daily cover. This lift will absorb the rain water and allow some of it to evaporate prior to reaching the leachate collection system. When a heavy rain does occur, the impact on the leachate collection system will not be immediate. Prior to placement of solid waste over any leachate pipe, the geotextile fabric that is covering the stone will be folded back so that solid waste will be in direct contact with the stone. This method will not allow biological growth to develop on the geotextile which could eventually clog the system.

b. The initial lift of solid waste will be placed loosely at a depth of 4 feet. As this lift is being placed, a spotter should be placed in the landfill to assure that the compactor does not drive any long, sharp objects through the protective cover into the liner system. If an object were to penetrate the liner system, the protective cover must be removed and the penetration repaired. The subsequent lifts can be placed up to final grades. Heavy landfill equipment including articulating dump trucks, and compactor will only be allowed on areas that have a minimum of 4’ of solid waste. Only low pressure equipment such as a D6 LGP Caterpillar will be allowed on the protective cover.

c. The landfill will restrict solid waste into the smallest area feasible, typically 60' x 75' area.

d. Solid waste will be compacted as densely as practical into cells. The compactor should run over an area of solid waste a minimum of 6 times.

e. Appropriate methods such as fencing and diking will be provided within the area to confine solid waste subject to be blown by the wind. At the conclusion of each day of operation, all windblown material resulting from the operation will be collected and returned to the area.

12. Leachate Management Plan

a. The County will record the flows weekly from the sump pumps to the lagoon and the volume pumped from the lagoon to the Waste Water Treatment Plant. Monthly visually inspect the lagoon liner for damage.

b. The County will maintain records for the amount of leachate pumped to the lagoon from the sumps and the amount pumped to the Waste Water Treatment Plant. Records of the visual inspections and any repairs made will also become part of the operating record.

c. The County will quality sample their leachate bi-annually for Subtitle D Appendix I constituents, pH, BOD, COD, TDS, phosphate, nitrate, and sulfate. The sample will be obtained from the lagoon and sampled the same time as the monitoring wells. The results will be part of the operating record and submitted with the semiannual groundwater sampling events.

d. The leachate is being treated by Goldsboro Wastewater Treatment Plant.

e. Under extreme operational conditions, the County has the option of shutting down the flow of leachate to the lagoon by shutting off the pump. The leachate will be temporarily stored within the MSWLF units until such a time the flow of leachate can continue to the lagoon. If any rain or other event requires storage of leachate or storm water in the cell, the Division of Waste Management will be notified immediately followed by written communication.

f. Leachate will not recirculated.

g. The video camera accessible leachate lines shall be videoed at the completion of the construction to assure that no sediment or other material has accumulated in the lines or the pump riser during construction. Thereafter annually, the same lines will be videoed by the County to assure that no blockages have occurred. If a blockage is encountered, the line will be pressured washed until the blockage is removed and re-videoed. The sediment or other material that has been washed to the sump shall be vacuumed from the sump utilizing a vacuum truck. The lines will be videoed annually and cleaned if necessary until the waste in the landfill has reached the height of the surrounding exterior berms. Once the waste has reached the berm height, the videoing and necessary cleaning shall be done every three years.

Records of all videoing and pressurized washing shall become part of the operating record.

h. The County will inspect all areas of fill for leachate break-outs. All fill area slopes shall be maintained to insure that no water is impounded on top of waste.

5.3 <u>Appendix I</u>

A. INTRODUCTION

The municipal solid waste stream is made up of wastes from all sectors of society. The waste is often categorized by its source or its characteristics. Terms used include commercial, industrial, residential, biomedical, hazardous, household, solid, liquid, demolition/construction, sludge, etc. Regardless of how one classifies wastes, the bottom line is that wastes are delivered to the landfill and a management decision must be made to either reject or accept them. This responsibility rests with the manager of the landfill. Wastes which are not authorized to be accepted at the landfill create a number of potential problems including: (1) liability due to future releases of contaminants; (2) bad publicity if media learns of unacceptable waste entering the landfill; (3) potential for worker injury; (4) exposure to civil or criminal penalties; (5) damage to landfill environmental control systems.

B. HAZARDOUS WASTE REGULATIONS AND MANAGEMENT

In the United States, hazardous waste is regulated under RCRA, Subtitle C. A waste is hazardous if it is listed as a hazardous waste by the Administrator of the Environmental Protection Agency (EPA) in the Code of Federal Regulations, Title 40, Part 261, or if it meets one or more of the hazardous waste criteria as defined by EPA. These criteria are:

- Ignitability
- Corrosivity
- Reactivity
- Toxicity

1. Ignitability

Ignitable waste is a waste that burns readily, causes a fire by friction under normal circumstances, or is an oxidizer. Any waste having a flash point of <140F falls in this category. Flash point is that temperature at which a liquid gives off vapors that will ignite when an open flame is applied. Under Department of Transportation (DOT) definitions, a flammable liquid has a flash point of >100 F. A combustible liquid has a flash point between 100 and 200 F. Therefore, a flammable liquid is always hazardous while a combustible liquid may or may not be hazardous depending upon its flash point.

2. Corrosivity

A corrosive waste is one having a very high or a very low pH. The pH of a liquid is a measure of how acidic or basic (alkaline) the material is. The pH scale ranges from 0 to 14. High numbers are basic and low numbers are acidic. A substance having a pH $\leq$2.0 or $\geq$12.5 is defined as hazardous under RCRA.

3. Reactivity

A waste is reactive if it is normally unstable: reacts violently with water; forms an explosive mixture with water; contains quantities of cyanide or sulfur that could be released to the air; or can easily be detonated or exploded. These wastes may fall into any one of several DOT categories.

4. Toxicity Characteristic Leaching Procedure (TCLP)

A waste is TCLP toxic if the concentration of any constituent in Table 1 exceeds the standard assigned to that substance. The TCLP is a methodology, which attempts to simulate the conditions within a landfill. An acidic solution is passed through a sample of waste and the resultant "leachate" is analyzed for contaminants. The TCLP is designed to detect heavy metals, pesticides and a few other organic and inorganic compounds. The purpose of the test is to prevent groundwater contamination by highly toxic materials. TCLP tests the mobility of 40 different elements and compounds.

Except in certain specified circumstances, regulated quantities of hazardous waste must be disposed of at a permitted hazardous waste disposal facility. In accordance with 40 CFR Part 261.3, **any material contaminated by a hazardous waste is also deemed to be a hazardous waste and must be managed as such.** Hazardous waste, from conditionally exempt small quantity generators, are to be disposed of in a Hazardous waste disposal facility. RCRA permits are also required to store, transport, and treat hazardous waste.

C. POLYCHLORINATED BIPHENYL'S (PCBs)

1. Introduction

PCBs are nonflammable and conduct heat without conducting electricity. These compounds were most frequently used as an additive to oil or other liquids in situations where heat was involved. The PCBs enhance the heat conducting properties of the liquid and thereby increase the heat dissipation or cooling effect obtained. They have also been used in lubricants and paint. In the United States one of the most common applications was in electric transformers. The only effective method for destroying PCBs is high Temperature incineration, which is relatively expensive due to a shortage of PCB incineration capacity.

TABLE 1

T.C.L.P. CONSTITUENTS & REGULATORY LEVELS (mg/L)			
CONSTITUENT	REG LEVEL	CONSTITUENT	REG LEVEL
Arsenic	5.0	Hexachlorobenzene	0.13
Barium	100	Hexachloro-1,3-butadiene	0.5
Benzene	0.5	Hexachloroethane	3.0
Cadmium	1.0	Lead	5.0
Carbon Tetrachloride	0.5	Lindane	0.4
Chlordane	0.03	Mercury	0.2
Chlorobenzene	100	Methoxychlor	10.0
Chloroform	6.0	Methyl ethyl ketone	200
Chromium	5.0	Nitrobenzene	2.0
m-Cresol	200	Pentachlorophenol	100
o-Cresol	200	Pyridine	5.0
p-Cresol	200	Selenium	1.0
Cresol	200	Silver	5.0
1,4-Dichlorobenzene	10.0	Tetrachloroethylene	0.7
1,2-Dichloroethane	0.7	Toxaphene	0.5
1,1-Dichloroethylene	0.5	Trichloroethylene	0.5
2,4-Dichlorophenoxyacetic acid	0.7	2,4,5-Trichlorophenol	400
2,4-Dinitrotoluene	0.13	2,4,6-Trichlorophenol	2.0
Endrin	0.02	2,4,5-TP (Silvex)	1.0
Heptachlor (and its hydroxide)	0.008	Vinyl Chloride	0.2

By law PCB's are no longer used as dielectrics in transformers and capacitors manufactured after 1979. There are many millions of pounds of PCBs still in use or in storage. One example is the ballasts used in fluorescent light fixtures. It has been estimated that there are between 0.5 million and 1.5 billion ballasts currently in use in this country. Due to the long life of these units, about half of these may be of pre-1979 manufacture and contain PCBs. Since each ballast contains about one ounce of nearly pure PCB fluid, there are about **20 to 30 million pounds** of PCBs in existing lighting fixtures. These items are <u>not</u> the subject to RCRA Subtitle D Waste Screening!

Commercial or industrial sources of PCB wastes that should be addressed by the program include:

- Mineral oil and dielectric fluids containing PCBs;
- Contaminated soil, dredged material, sewage sludge, rags, and other debris from a release of PCBs;
- Transformers and other electrical equipment containing dielectric fluids; and
- Hydraulic machines.

2. PCB Regulatory Requirements

As contrasted to hazardous wastes, the Toxic Substance Control Act regulates PCBs based on the concentration of PCBs in the waste rather than the source or characteristic of the waste. The regulations concerning PCB disposal are spelled out in 40 CFR Part 761. Subtitle D of RCRA merely requires that PCB waste not be disposed in a MSW landfill. PCB management requirements include:

Waste containing more than 500 ppm of PCBs must be incinerated. Waste containing from 50 to 500 ppm must be disposed of by incineration, approved burning, or in chemical waste landfill permitted to receive such wastes. The regulations are silent concerning wastes containing less than 50 ppm of PCBs; however, the regulations cannot be circumvented by diluting stronger wastes.

D. FUNDAMENTALS OF WASTE SCREENING

1. Know Your Generators and Haulers

Since the level of sophistication of your waste screening program will be a reflection of the likelihood of hazardous waste and PCB waste being in your incoming waste, **<u>knowledge of the commercial industrial base of your service area is critical.</u>** Some examples are the automotive industry, which generates solvents, paint wastes, lead acid batteries, grease and oil; the dry cleaning industry, which may generate filters containing dry cleaning solvents; metal platers which generate heavy metal wastes; and other industries which generate a variety of undesirable wastes; e.g. chemical and related products, petroleum refining, primary metals, electrical and electronic machinery, etc.

Landfill managers should also know the haulers and trucks serving the businesses in their community, which are likely to carry unacceptable wastes.

Some local governments and solid waste management agencies have enacted legislation requiring haulers to provide a manifest showing the customers whose wastes make up that particular load. Such a manifest is an extremely useful tool when a load is found to contain prohibited wastes. It is unwise to accept wastes from unknown, unlicensed, or otherwise questionable haulers.

2. Inspections

An inspection is typically a visual observation of the incoming waste loads by an individual who is trained to identify regulated hazardous or PCB wastes that would not be acceptable for disposal at the MSWLF unit. The training of landfill personnel will be conducted by a local EMS official or a SWANA certification. An inspection is considered satisfactory if the inspector knows the nature of all materials received in the load and is able to discern whether the materials are potentially regulated hazardous wastes or PCB wastes.

Ideally, all loads should be screened; however, it is generally not practical to inspect in detail all incoming loads. Random inspections, therefore, can be used to provide a reasonable means to adequately control the receipt of inappropriate wastes. Random inspections are simply inspections made on less than every load. At a minimum the inspection frequency will not be less than one percent of the waste stream.

The frequency of random inspections may be based on the type and quantity of wastes received daily, and the accuracy and confidence desired in conclusions drawn from inspection observations. Because statistical parameters are not provided in the regulation, a reasoned, knowledge-based approach may be taken. A random inspection program may take many forms such as inspecting every incoming load one day out of every month or inspecting one or more loads from transporters of wastes of unidentifiable nature each day. If these inspections indicate that unauthorized wastes are being brought to the MSWLF site, the random inspection program should be modified to increase the frequency of inspections.

Inspection priority also can be given to haulers with unknown service areas, to loads brought to the facility in vehicles not typically used for disposal of municipal solid waste, and to loads transported by previous would-be offenders. For wastes of unidentifiable nature received from sources other than households (e.g., industrial or commercial establishments), the inspector should question the transporter about the source/composition of the materials.

An inspection flow chart to identify, accept, or refuse solid waste is provided as Figure 1.

Inspections of materials may be accomplished by discharging the vehicle load in an area designed to contain potentially hazardous wastes that may arrive at the facility. The waste should be carefully spread for observation using a front end loader or other piece of equipment. The Division of Waste recommends that waste should be hand raked to spread the load. Personnel should be trained to identify suspicious wastes. Some indications of suspicious wastes are:

- Hazardous placards or markings;
- Liquids;
- Powders or dusts;
- Sludges;
- Bright or unusual colors;
- Drums or commercial size containers; or
- Chemical odors.

The County will follow these procedures when suspicious wastes are discovered.

- Segregate the wastes;
- Question the driver;
- Review the manifest (if applicable);
- Contact possible source;
- Call the State Solid Waste Management Department;
- Use appropriate protective equipment;
- Contact laboratory support if required; and
- Notify the local Hazardous Material Response Team.

Containers, with contents that are not easily identifiable, such as unmarked 55-gallon drums, should be opened only by properly trained personnel. Because these drums could contain hazardous waste, they should be refused whenever possible. Upon verifying that the solid waste is acceptable, it may then be transferred to the working face for disposal.

Testing typically would include the Toxicity Characteristic Leaching Procedure (TCLP) and other tests for characteristics of hazardous wastes including corrositivity, ignitability, and reactivity. Wastes that are suspected of being hazardous should be handled and stored as a hazardous waste until a determination is made.

If the wastes temporarily stored at the site are determined to be hazardous, Wayne County is responsible for the management of the waste. If the wastes are to be transported from the facility, the waste must be: (1) stored at the MSWLF facility in accordance with requirements of a hazardous waste generator, (2) manifested, (3) transported by a licensed Treatment, Storage, or Disposal (TSD) facility for disposal.

E. RECORD KEEPING AND NOTIFICATION REQUIREMENTS

Records must be kept pursuant to an incident where regulated hazardous waste or prohibited waste is found at the landfill. It is also recommended that records be kept of all screening activities and incidents, whether or not, regulated or prohibited wastes are found. This will help prove that the landfill owner/operator has acted in a prudent and reasonable manner.

The best way to prove compliance with this requirement is to document each inspection including:

Date and time of waste detection
Hauler name (company and driver)
Waste(s) detected
Waste generator(s) if able to identify
Action(s) taken to manage or return material(s)
Efforts taken if extreme toxicity or hazard was discovered
Landfill employee in responsible charge

40 CFR Part 258 requires that records should be maintained at or near the landfill site during its active life and as long after as may be required by the appropriate state or local regulations.

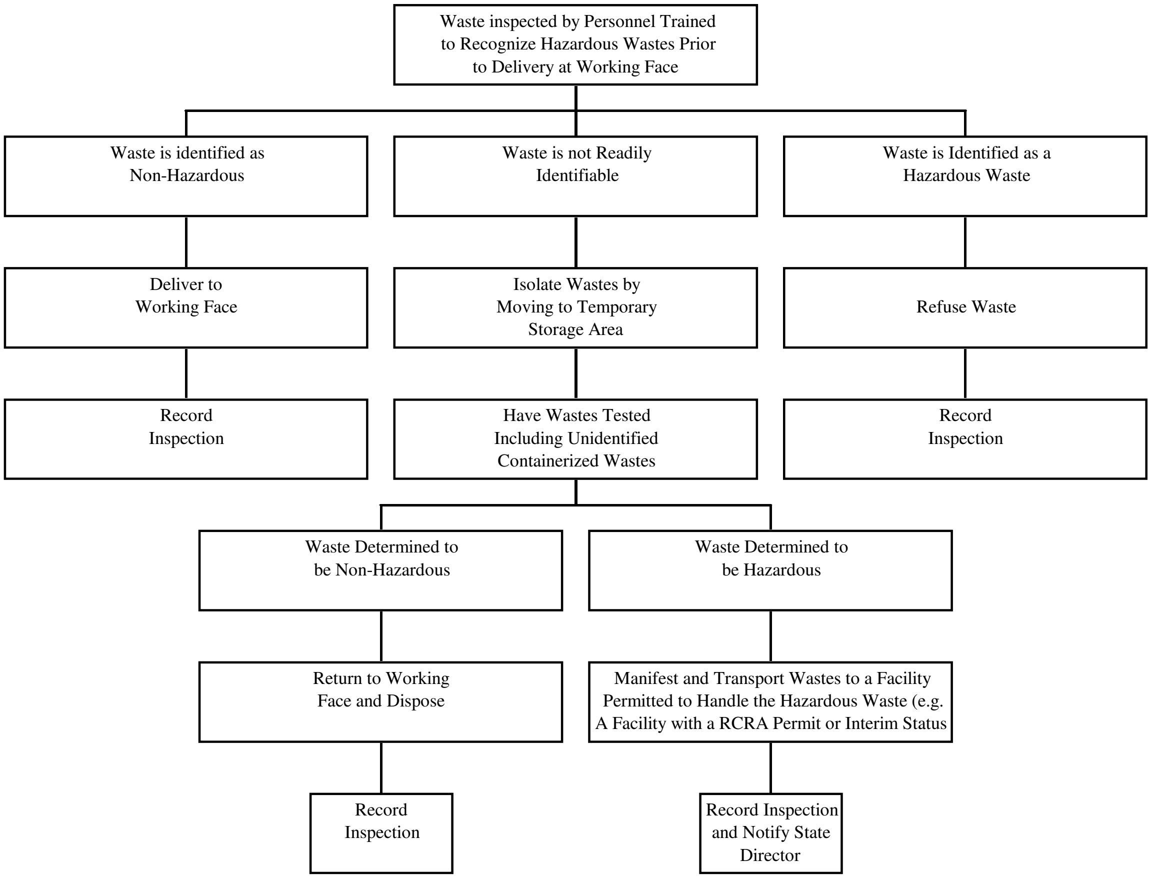

FIGURE 1
Hazardous Waste Inspection Decision Tree
Inspection Prior to Working Face

WASTE SCREENING CHECK LIST

	YES	NO
CONTAINERS		
FULL………………………………………………………..	______	______
PARTIALLY FULL……………………………………..	______	______
EMPTY……………………………………………………..	______	______
CRUSHED………………………………………………….	______	______
PUNCTURED………………………………………………	______	______
POWDERS/DUSTS		
IDENTIFIED………………………………………………	______	______
UNKNOWN……………………………………………….	______	______
SATURATION……………………………………………	______	______
LABEL/HAZARDOUS…………………………………	______	______
ODOR/FUMES		
STRONG…………………………………………………..	______	______
FAINT…………………………………………………….	______	______
HEAT……………………………………………………..	______	______
ITEMS FOUND		
BATTERIES………………………………………………	______	______
OIL………………………………………………………..	______	______
BIOMEDICAL……………………………………………	______	______
RADIOACTIVE…………………………………………..	______	______
ASHES/RESIDUE………………………………………..	______	______
SOD/SOIL………………………………………………..	______	______
LIQUID……………………………………………………	______	______
HAZARDOUS…………………………………………….	______	______
PCB'S……………………………………………………..	______	______

CHECK ALL THAT APPLY

DETAILED SCREENING REPORT

WASTE SOURCE____

ADDRESS____

PROBABLE [ ] SUSPECTED [ ] CONFIRMED [ ]

WASTE

HAULER____

ADDRESS____

DRIVER'S NAME____

DETAIL____

NOTIFIED:

WASTE SOURCE [ ] HAULING MANAGEMENT [ ] SITE MANAGEMENT [ ]

STATE [ ] FEDERAL [ ]

NAME____

WITNESS (IF ANY)____

DATE________________________TIME_________________________ AM PM

ACTION REQUIRED

5.4 Appendix II

WAYNE COUNTY - EXPLOSIVE GAS CONTROL PLAN

Quarterly, Wayne County Landfill will monitor the explosive gas at the landfill structures and at or near the landfill boundary. . The permanent probes will consist of a plastic stand pipe similar to a piezometer used for groundwater detection. A typical permanent methane probe is detailed in the operation drawings. The permanent probe will be constructed at a depth of six (6) feet. A 6" diameter hole will contain a one (1) inch slotted PVC pipe. The bottom two (2) feet will be backfilled with non-carbonate pea gravel with a bentonite seal one (1) foot thick above it. The remaining three (3) feet will be backfilled with *in situ* soils. The one (1) inch PVC pipe will be approximately three (3) feet above the existing grade. The PVC pipe will be capped with a one (1) inch PVC cap, one quarter (1/4) inch NPT hose barb, and 1" tubing, plugged or capped.

The location and spacing of the methane monitoring probes is somewhat arbitrary. The locations were determined by the relationship of solid waste with property lines and landfill structures. The spacing of the monitoring probes is between 200 and 400 feet. The migration of methane gas is induced by pressure gradients. The methane will move from areas of high pressure to those of low pressure following the path of least resistance. The methane will migrate vertically until it reaches the landfill cap, where it will begin to flow horizontally. This occurs until it finds a pathway out, either by the installed methane collection trenches or migration through the permeable *in situ* soils. Since methane is lighter than air, it wants to escape into the atmosphere. It has been our experience that whenever gas is migrating no matter what the spacing or depth of the monitoring probes, the gas will fill the void created by the monitoring point and an explosive meter will monitor the level. The various depths of the monitoring probes are to ensure a stable monitoring points. The only time a shallow monitoring point has not worked is in a very heavy, impermeable clay layer that acts as a seal to the migration of the gas. If a clay layer is encountered during the construction of the monitoring points, it will either be moved beyond the clay or excavated to a depth that is in the conductive zone below the clay.

The permanent probes will surround Phase 3. Wayne County's landfill is designed with a base liner system and cap system, there should be no migration of methane in the permeable *in situ* soils.

The gas can be detected by use of an instrument that reports the percent of lower explosive limit. The instrument being used is the Gas Tech GP 204.

Based on current conditions, there are ten (10) existing monitoring points and four(4) proposed monitoring points that will be installed at the facility prior to waste activities commencing at Phase 3. Quarterly, a County employee will visit each monitoring point either the temporary or permanent. The monitoring points consist of all methane probes and leachate collection system cleanouts. Using the detection instrument, he will determine if methane gas has filled the probes. If the probe is near the property line and methane gas is detected at or beyond the lower explosive limit (100% LEL), it must then be determined if the gas is migrating across the landfill boundary. If the probe is on the boundary or methane gas has migrated beyond the boundary, a remediation plan must be completed by Wayne County.

Other points of monitoring will be the landfill structures. Each structure will be monitored for methane using the following methods:

1. All crawl spaces will be monitored;
2. All corners in the structure will be monitored;
3. Any holes, cracks and pipes through the foundation will be monitored

If methane gas is detected beyond 25% of its lower explosive limit in any structure, check the calibration of the monitor and resample. If the reading is still above 25%, evacuate the building and try to find the source of gas. If the source is found try to remove the source. If this fails a remediation plan is stated in the operational requirements.

5.5 **Appendix III**

WAYNE COUNTY –CORRECTIVE ACTION FOR LEACHATE BREAK-OUTS

Leachate breakouts can be prevalent during and after any wet weather period. These breakouts are created by standing water on a landfill that drains through the cover into the waste. Once the water is in the waste, it moves through it both vertically and horizontally until it reaches a less permeable layer. Once it reaches this layer, it will move horizontally along it until it pools up or finds a less permeable area to flow vertically through that layer. If it pools up, it will eventually work through the layer to also flow vertically. If the less permeable layer is on a slope, the leachate will never pool up but flow horizontally along this slope until it "breaks out" the side of the landfill.

The best solution to breakouts is to avoid any standing water on top of the landfill. If waste is placed down a slope, provide trench excavations perpendicular to the flow direction into the intermediate cover so that the leachate flow is directed downward instead of along the plane between the waste and the intermediate cover.

If a breakout occurs, first and foremost contain it on the landfill foot print. In the case of the lined landfill, it needs to be within the lined area. Containment on the surface cannot be the only solution. The breakout must be repaired so that the flow of the leachate is downward and does not continue along the plane between any cover and the waste. Containment of leachate breakouts by berming along the edge is not a permanent fix for two reasons. First, storm water is being impounded behind the berms and impoundment of storm water over waste is a violation of the NC Solid Waste Rules. Second, if storm water continues to be impounded behind the berms, it has the potential eventually to pond up higher than the berm and erode the berm releasing all contained leachate with the storm water. The storm water cannot flow downward into the waste as fast as it is flows down the slopes; consequently, a pond will form and all of the above can and will happen.

The liquid that is impounded behind any berm has to be removed by pumping into a tank and hauling it either to the leachate lagoon or the waste water treatment plant. It cannot be allowed accumulate because it will break through the containment berm.

All leachate breakouts need to be repaired immediately. The repair consists of vertically excavating above (uphill) of the actual breakout. The leachate is flowing down hill from the ponding on top of the landfill; consequently, it needs to be intercepted by the excavation. Vertically excavate down through the waste until the intermediate or cover soils have been penetrated so waste below these layers of soil has been exposed. Immediately remove all excavated waste to the working face of the landfill.

Place a more permeable material in the excavation. The best material is rock because it is the most permeable material. The rock can be either on site or purchased from a quarry. The only criteria is that it be relatively free of soil. The excavation needs to be filled with this material up to and including the soil layers where the leachate is flowing. This allows the leachate to move vertically instead of horizontally. Once the material has been filled above the soil layers, re-cover the area with soil cover material.

If the outbreak is at the edge of the landfill (MSW or C&D), do not excavate at his point. Step into the landfill at least 20 feet to excavate. In the lined landfill, do this with extreme caution. In the lined landfill, the excavation should be no deeper than 6 feet. Within 6 feet, the intermediate soil layers should have been penetrated. Do not excavate into the initial waste placement.

In the C&D landfill, the vertical excavation may have to penetrate the final cap of the MSWLF. The cap was supposed to be two feet but may be thicker. Whatever the thickness, the excavation needs to penetrate this cap until the MSW is exposed. Fill the excavation with the more permeable material up to the top of the excavation and place the methane vent pipe in the material and re-cover with intermediate cover. However, unlike the MSWLF, place at least two feet of intermediate soil cover over the surface at the breakout. Also, unlike the MSWLF, the leachate may be following the final cap of the closed MSW landfill and a considerable amount of leachate may be seeking the low point along the landfill cap. If the low point happens to be at the edge of the landfill, the excavation into the landfill may have to be considerable in order to allow the amount of leachate to flow vertically. The additional soil cover will have a damming effect so that the water is forced vertically into the trench that has been excavated and filled with rock, preferably.

Also, the top of the C&D landfill needs to be graded so that there is very little standing water. The water that is accumulating on the top is the source of the breakouts. The less there is on top, the less the potential of a breakout.

If leachate has been impounded behind a berm, immediately obtain a water sample for laboratory testing for Appendix I constituents. If leachate from a breakout has left the foot print of the landfill, obtain a water sample from a sediment basin or other areas that the leachate may have been ponding. Once the sample has been obtained, remove the ponding water by pumping it into a tank and disposing of it in either the leachate lagoon or the waste water treatment plant. Once the water has been removed, remove the top one foot of soil in the pond and dispose of it in the lined MSW landfill. Once the top one foot of soil has been removed, test the remaining soil to assure that there are no Appendix I constituents in the surface of the soil that is in the pond area.

5.6 **Appendix IV**

WAYNE COUNTY - SYNTHETIC COVER OPERATION PLAN

1. Determine the size of the area to be covered. Be sure to allow for five to ten feet extra on each measurement to ensure that the refuse is completely covered.

2. The synthetic cover is shipped to the landfill site with panels folded accordion-type, then rolled up. Unroll the cover along the working face (depending upon operations), and attach the leading edge of the unrolled panel to existing landfill equipment with ropes(i.e., to the top of the blade).

3. Pull the sewn panels of cover across the compacted trash. The synthetic cover maybe pulled from any direction, which may vary from day to day. Keep the leading edge between the two machines (or people) as high as possible to eliminate drag.

4. Anchor the edges of synthetic cover every 20 feet with tires or sandbags to hold the synthetic cover in place. If it is windy, more anchoring may be required. Make sure a large enough panel has been ordered to completely cover the refuse (base this on the heaviest day to the week). If complete coverage is not possible, cover the exposed refuse with soil; but take care not to place too much dirt on the synthetic cover if it is to be re-used.

5. On the next day of operations, remove the tires and/or sandbags. Simply pull the synthetic cover across itself (to reduce drag) and off the refuse to an area that is inactive. Anchor the edges again to prevent wind from lifting the blanket. At the end of the day, pull the synthetic cover back across the refuse by repeating steps 3 and 4 until a new panel is needed.

Synthetic Cover is designed to be used as landfill daily cover on a working face. For best results, it is recommended that the area to be covered be kept as close to a square shape as possible not to exceed 75' X 75' in size. Not only does this procedure allow for easier coverage, it allows for better management of the working face and saves time at the end of the working day.

The County will use a panel of synthetic cover that is pulled over the working face on a daily basis by two pieces of landfill equipment. At the end of the working day, the panel will be secured in place. This is attained by one of two methods : the panel may be heavy enough to hold itself in place due to accumulation of soil and is left in that manner; or tires are placed on the panel to secure it in place.

The working face is operated in this manner, brought to an intermediate grade and then covered with the required six (6) inches of soil. The process will continue until a lift is completed. The process is then started over on the next lift until the landfill is filled to final grade and a section is closed. At a minimum six (6) inches of soil cover will be used once a week.

TIPS TO REMEMBER

1. Always pull the fabric across itself during installation and removal to make each panel last as long as possible.

2. Avoid driving on the panel(s); this may cause punctures and tears.
3. Tie the panel(s) to the top of the dozer blade and raise the blade to minimize dragging on refuse.

4. Use tires or sandbags to hold the panel(s) down overnight. Soil can be used if you plan to leave panel(s) in place and cover with refuse.

5. Minimize stress between dozer/compactors while pulling on the panel(s).

5.7 Operation Drawings

5.7.1 Title Sheet
5.7.2 Index Sheet
5.7.3 Facility Operations
5.7.4 Initial Placement of Waste
5.7.5 1st Year Fill Plan
5.7.6 2nd Year Fill Plan
5.7.7 3rd Year Fill Plan
5.7.8 4th Year Fill Plan
5.7.9 Final Fill with Intermediate Cover
5.7.10 Final Fill with Exist. And Prop. Gas Collection Wells
5.7.11 Miscellaneous Details

WAYNE COUNTY MUNICIPAL SOLID WASTE LANDFILL FACILITY

OPERATION PLAN - PHASE 3

Permit Number: 96-06

Site Location: 460 B South Landfill Road
Dudley, NC 28333

Applicant: Wayne County

Applicant's Address: 224 E. Walnut St., 3rd Floor
Goldsboro, NC 27530

BOARD OF COMMISSIONERS

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Engineer

Municipal Engineering Services Company, P.A.
Garner, NC - Morehead City, NC - Boone, NC

NORTH CAROLINA PROFESSIONAL SEAL 8282 ENGINEER JIMMY D. WOODIE

4/1/2011

by ______________
Professional Engineer
(Garner Office)

LICENSE NUMBER: C-0281
Municipal Services
Engineering Company, P.A.
P.O. BOX 97 GARNER, N.C. 27529 (919) 772-5393
P.O. BOX 349 BOONE, N.C. 28607 (828) 262-1767
P.O. BOX 828 MOREHEAD CITY, N.C. 28557 (252) 726-9481

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	1	NO REVISIONS TO THIS SHEET

SCALE:	1:1
DATE:	4/7/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	T1
SHEET NO.	1 OF 11

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9	P7	FINAL FILL PLAN
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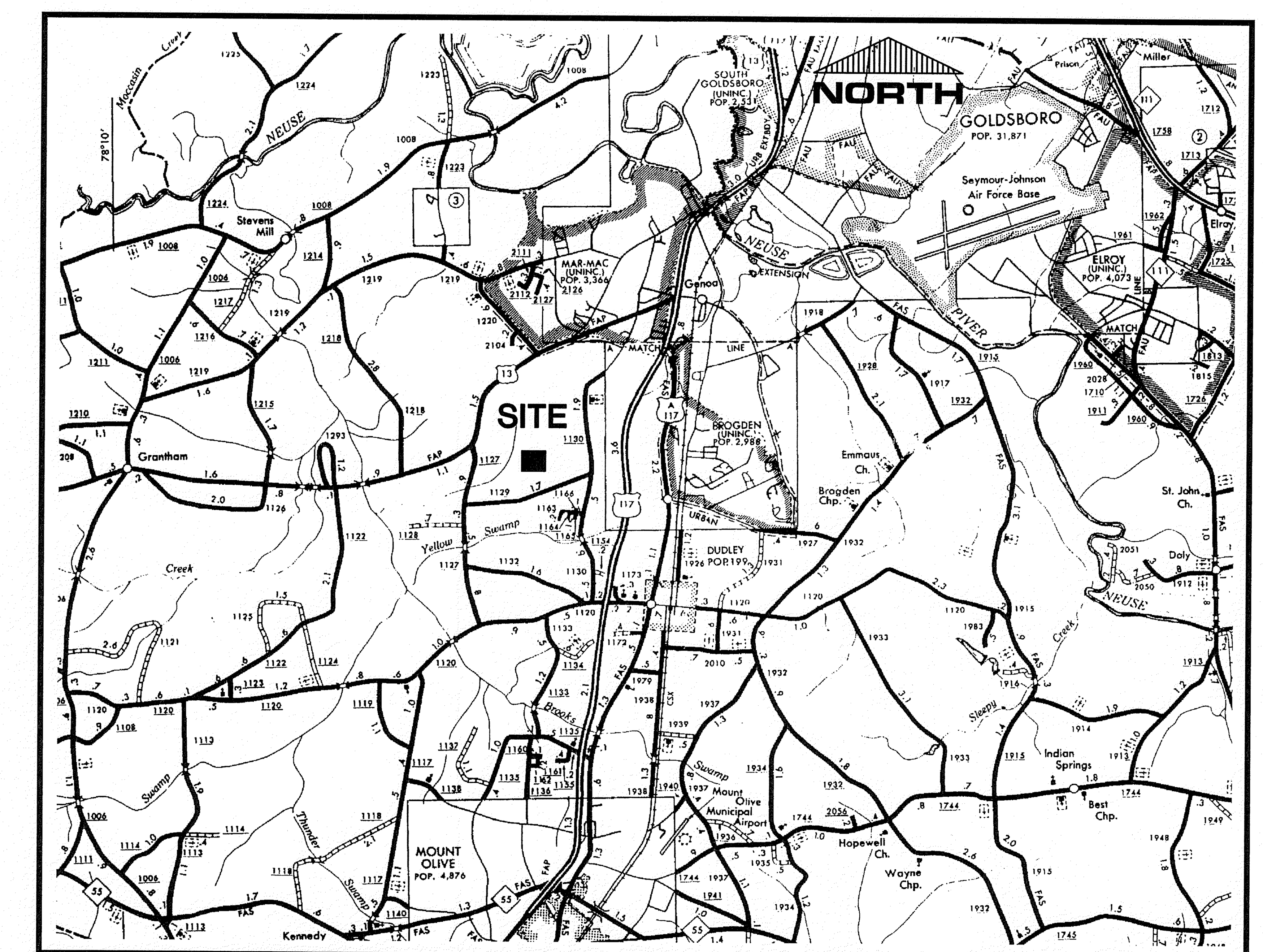

VICINITY MAP

LICENSE NUMBER: C-0281
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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	NO REVISIONS THIS SHEET
11/1/2010	LCH	1	REVISED INDEX

OPERATION PLAN - PHASE 3
INDEX AND VICINITY MAP

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE

SCALE:	1:1
DATE:	4/7/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. T2	SHEET NO. 2 OF 11

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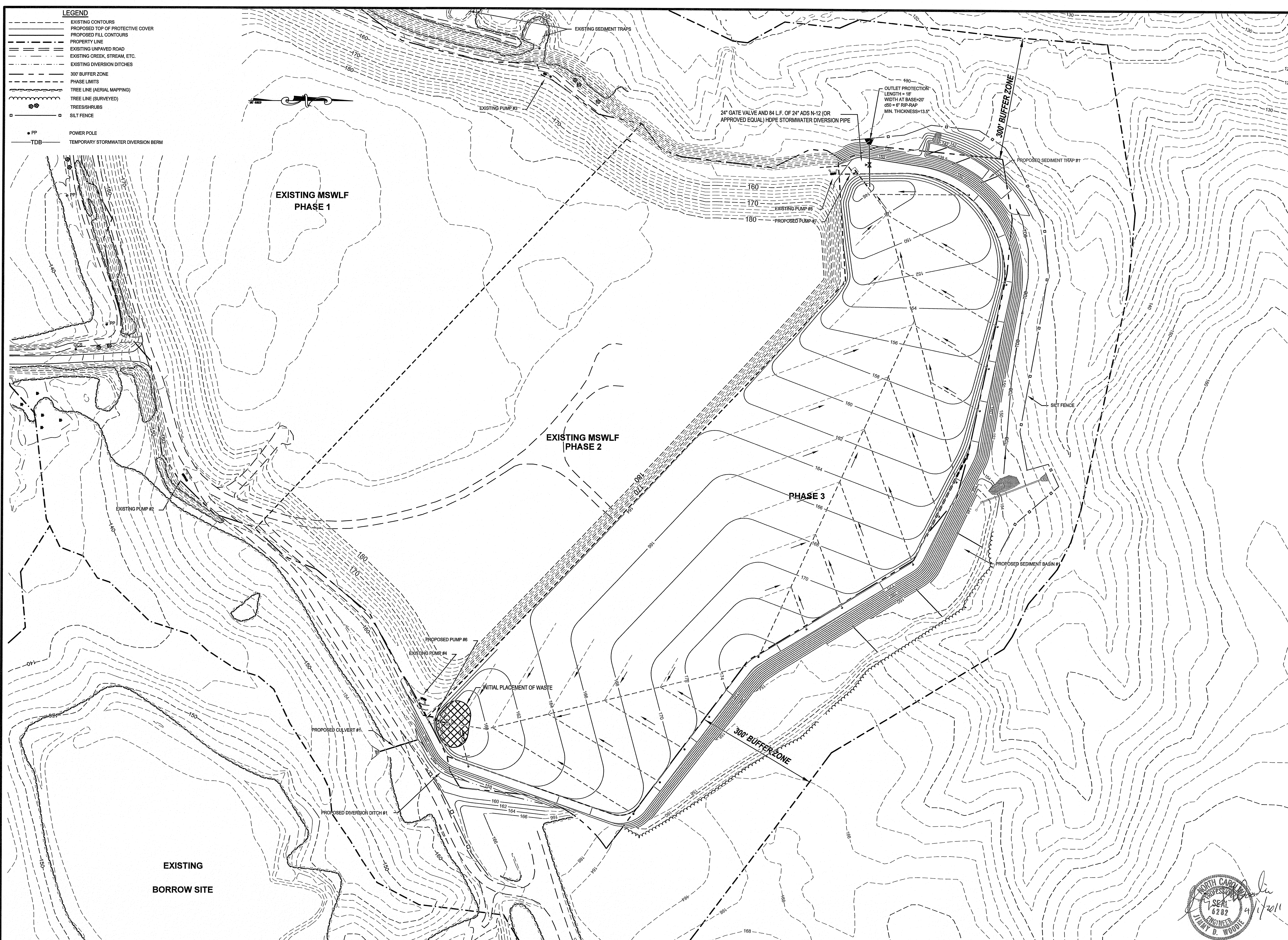

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	REVISED PROTECTIVE COVER AND LEACHATE SYSTEM
11/1/2010	LCH	1	REVISED GRADING AT PROPSED PUMP #7 AREA

OPERATION PLAN - PHASE 3
INITIAL PLACEMENT OF WASTE AND STORMWATER DIVERSION PIPE

SCALE:	1" = 100'
DATE:	4/7/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	P2
SHEET NO.	4 OF 11

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE

4/1/2011

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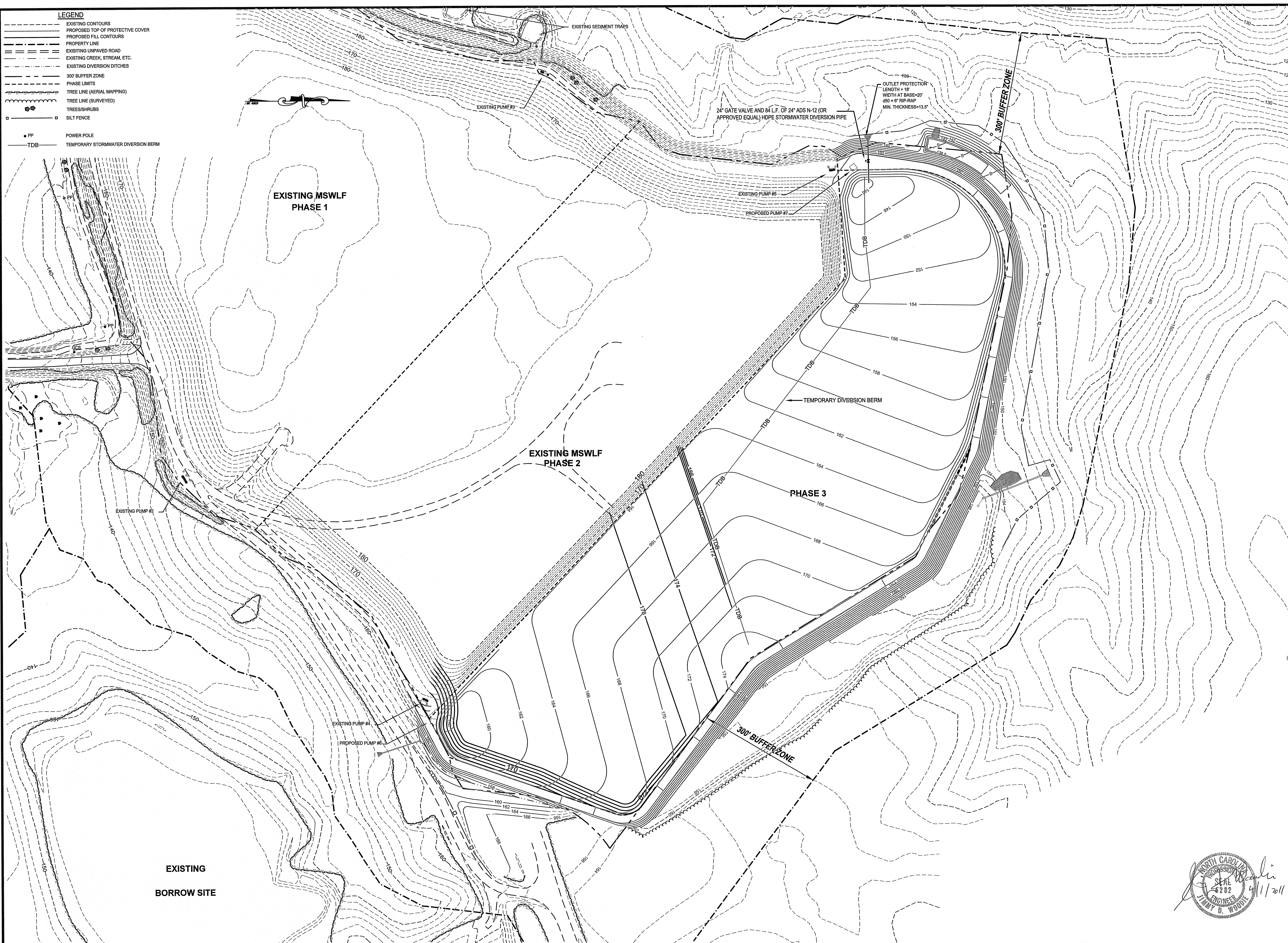

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	REVISED PROTECTIVE COVER AND FILL PLAN
11/1/2010	LCH	1	REVISED GRADING AT PROPOSED PUMP#7 AREA

OPERATION PLAN - PHASE 3
1st YEAR FILL PLAN

NORTH CAROLINA PROFESSIONAL SEAL 6282 ENGINEER JIMMY D. WOODIE
4/1/2011

SCALE:	1" = 100'
DATE:	4/7/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE

PROJECT NUMBER G06096

DRAWING NO. P3 | SHEET NO. 5 OF 11

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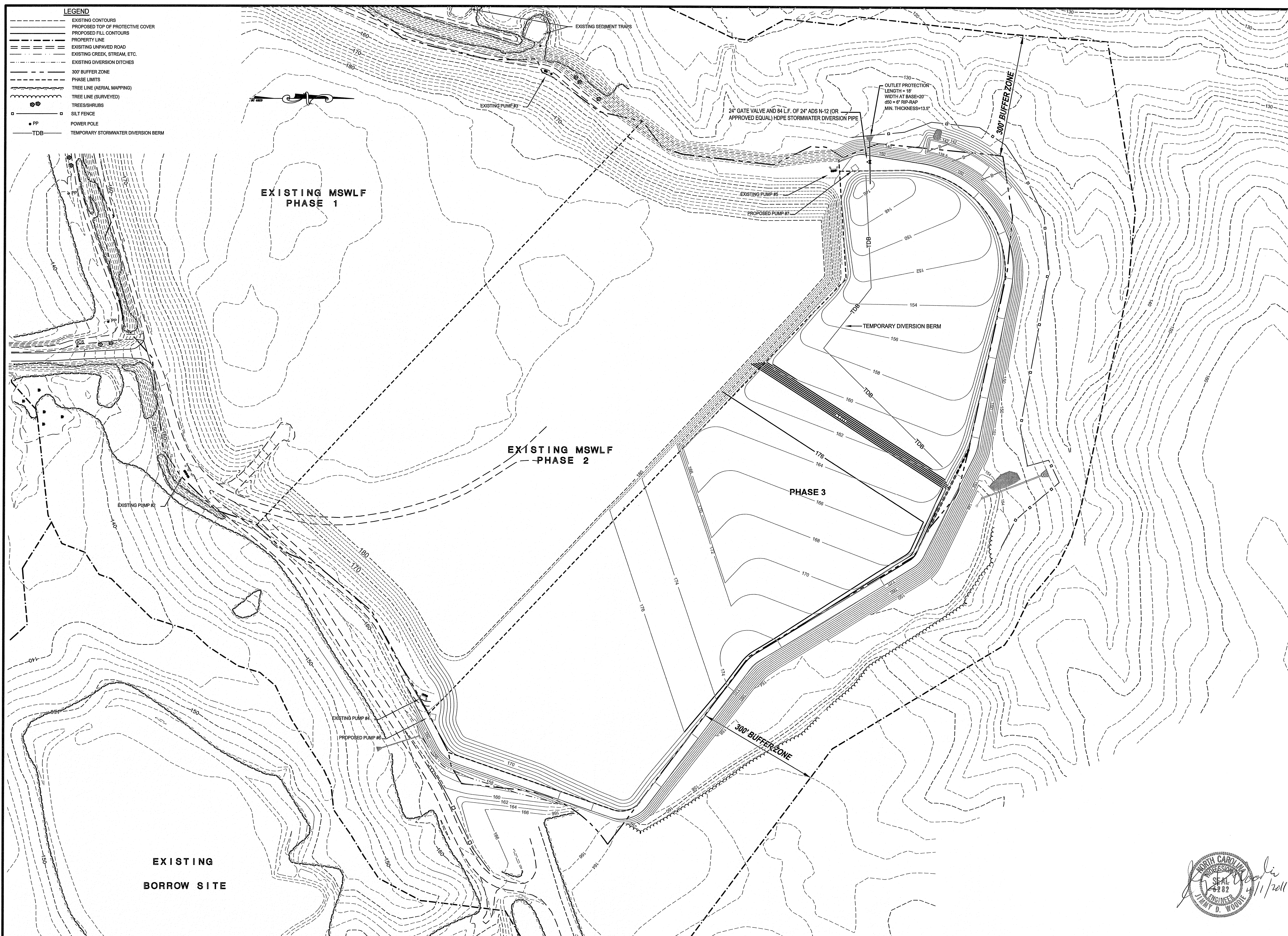

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	REVISED PROTECTIVE COVER AND FILL PLAN
11/1/2010	LCH	1	REVISED GRADING AT PUMP #7 AREA

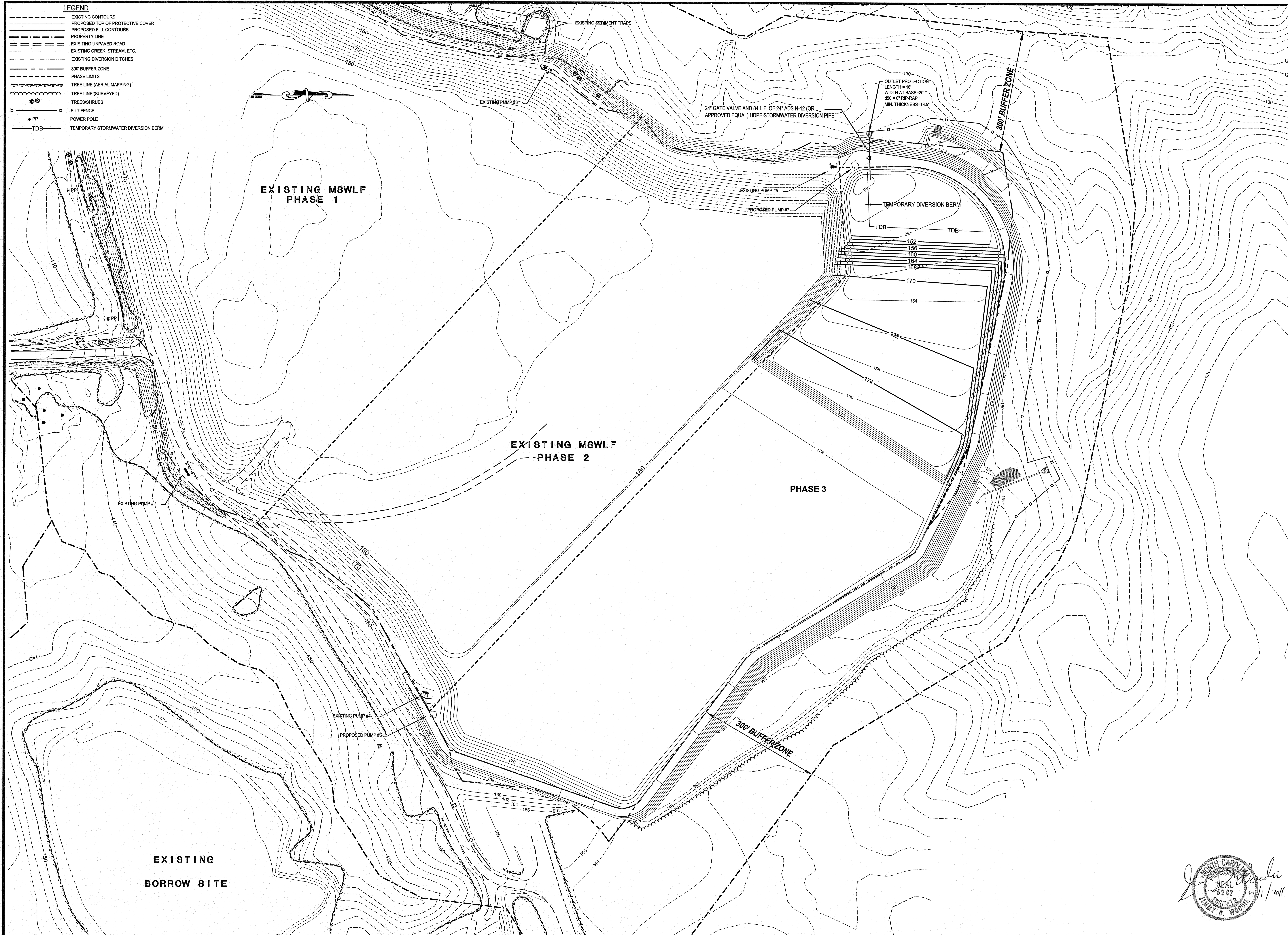
OPERATION PLAN - PHASE 3
2nd YEAR FILL PLAN

NORTH CAROLINA PROFESSIONAL SEAL 28262 ENGINEER JIMMY D. WOODIE
4/1/2011

SCALE:	1" = 100'
DATE:	4/7/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE

PROJECT NUMBER G06096

DRAWING NO.	SHEET NO.
P4	6 OF 11



LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	REVISED PROTECTIVE COVER AND FILL PLAN
11/1/2010	LCH	1	REVISED GRADING AT PUMP #7 AREA

OPERATION PLAN - PHASE 3
3rd YEAR FILL PLAN

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 6282 JIMMY D. WOODIE
4/1/2011

SCALE:	1" = 100'
DATE:	4/7/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO.	SHEET NO.
P5	7 OF 11

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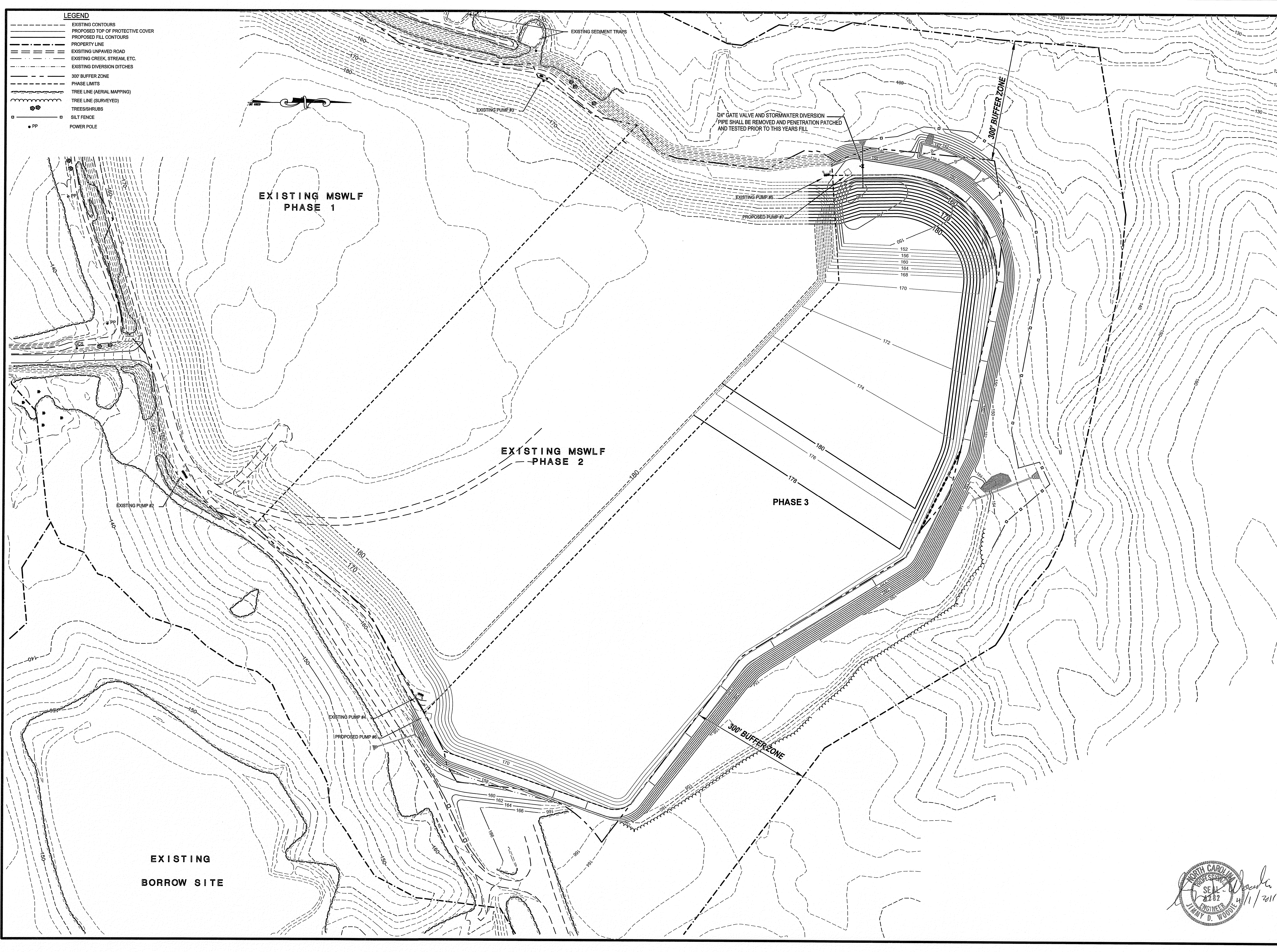

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	REVISED PROTECTIVE COVER AND FILL PLAN
11/1/2010	LCH	1	REVISED GRADING AT PUMP #7 AREA

OPERATION PLAN - PHASE 3
4th YEAR FILL PLAN

SCALE: 1" = 100'
DATE: 4/7/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE

PROJECT NUMBER: G06096

DRAWING NO.: P6

SHEET NO.: 8 OF 11

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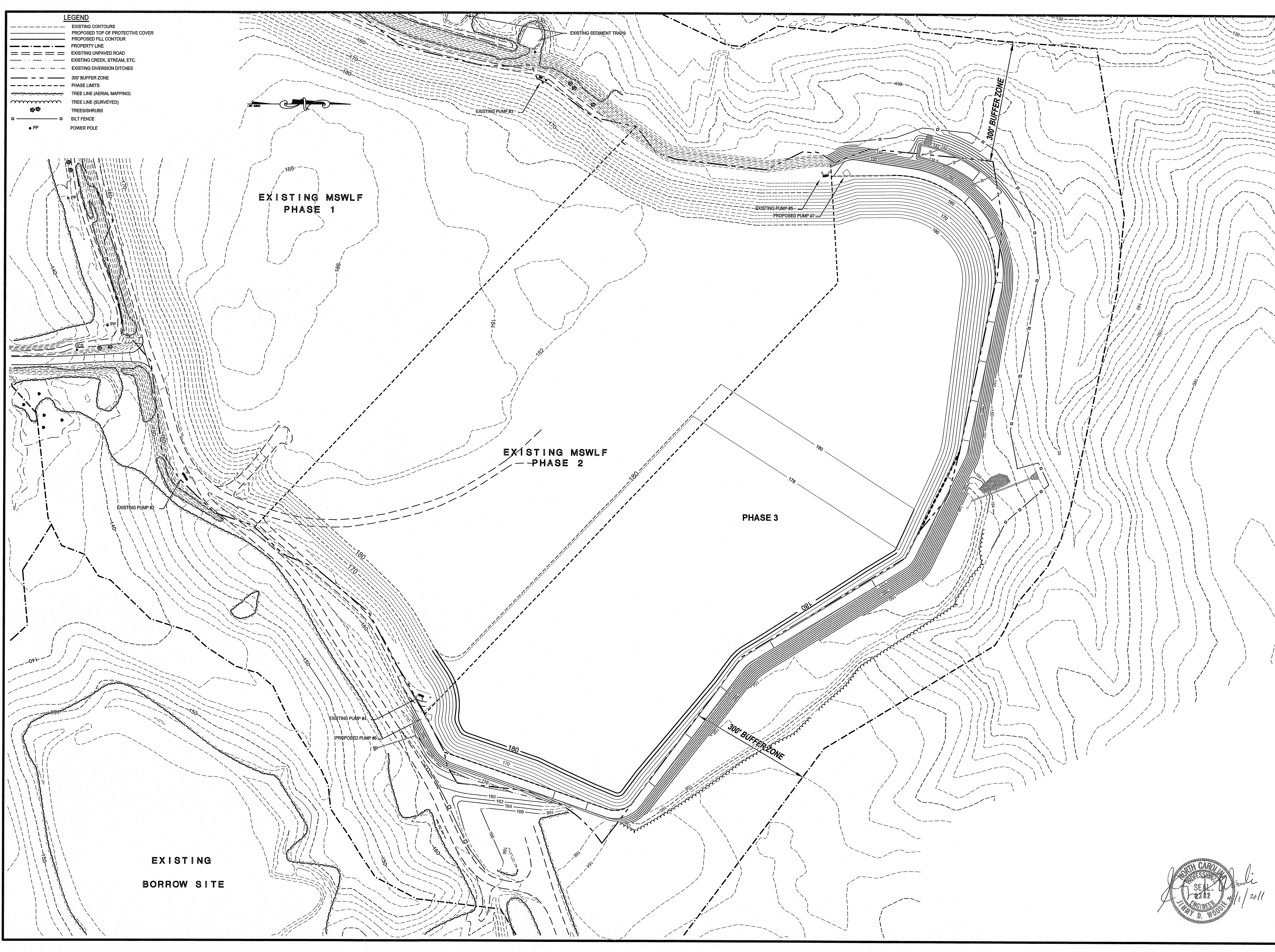

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	REVISED PROTECTIVE COVER AND FILL PLAN
11/1/2010	LCH	1	REVISED GRADING AT PUMP #7 AREA

OPERATION PLAN - PHASE 3
FINAL FILL PLAN

SCALE:	1" = 100'
DATE:	4/7/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE

PROJECT NUMBER
G06096

DRAWING NO.	SHEET NO.
P7	9 OF 11

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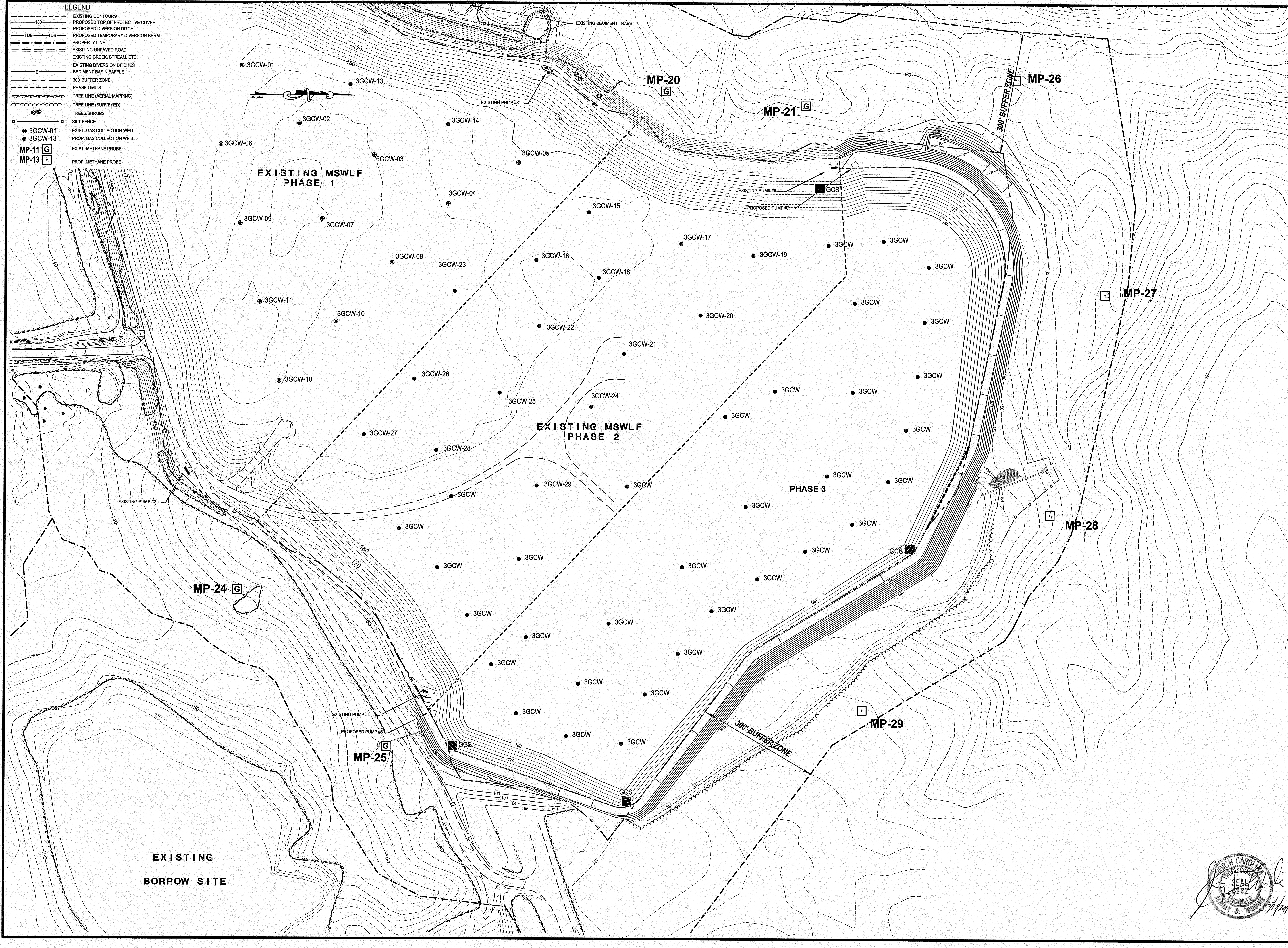

LICENSE NUMBER: C-0281

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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
5/13/2011	LHC	3	REVISED EXISTING AND PROPOSED METHANE PROBES
3/17/2011	LHC	2	REVISED FILL PLAN
11/1/2010	LCH	1	REVISED TITLE AND EXIST. / PROP. GAS COLLECTION WELLS

OPERATION PLAN - PHASE 3
FINAL FILL WITH EXISTING AND PROPOSED GAS COLLECTION WELLS AND METHANE MONITORING PROBE LOCATIONS

SCALE: 1" = 100'
DATE: 4/7/09
DRWN. BY: L. HAMPTON
CHKD. BY: J. WOODIE

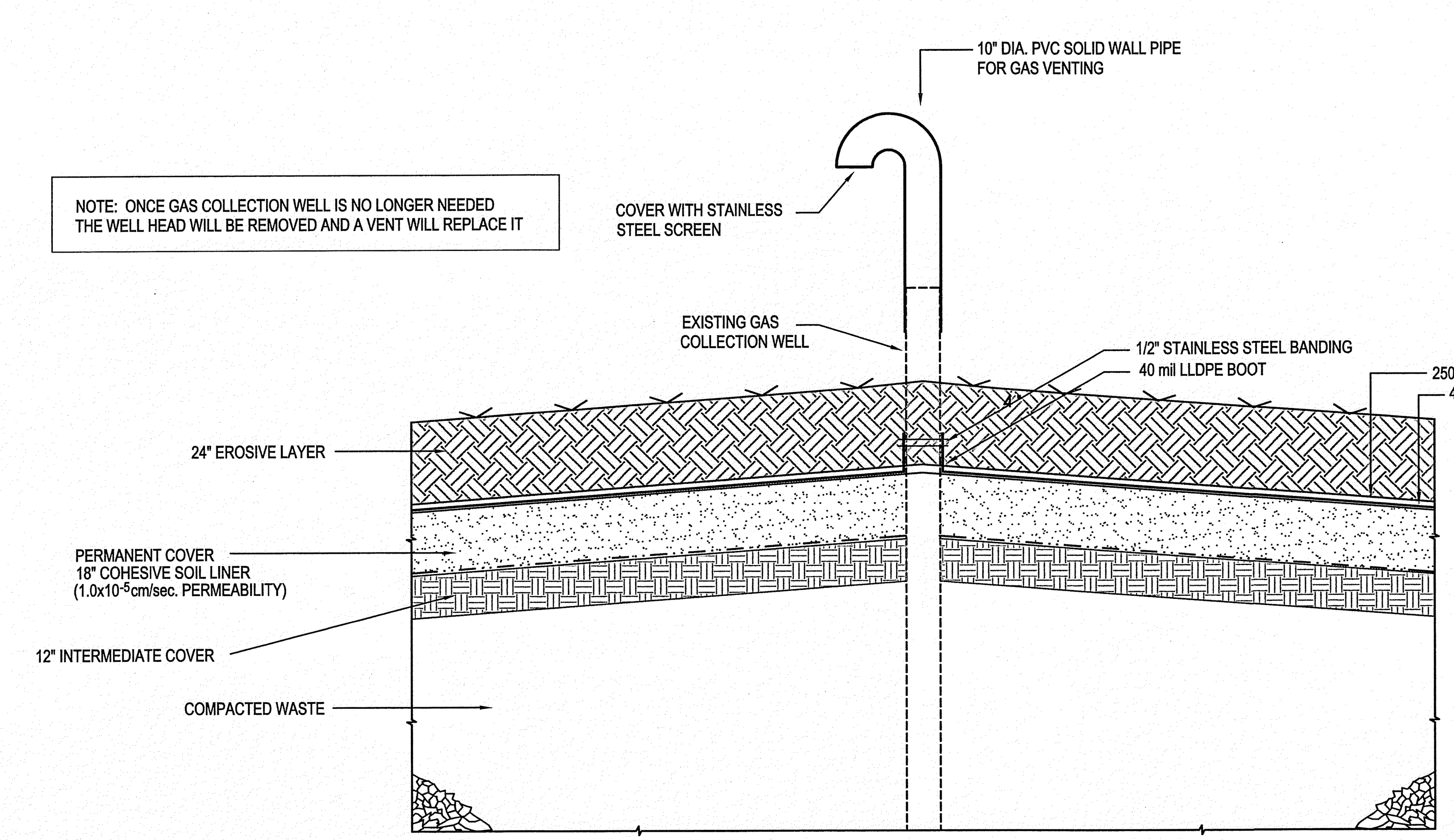
PROJECT NUMBER G06096

DRAWING NO. P8

SHEET NO. 10 OF 11

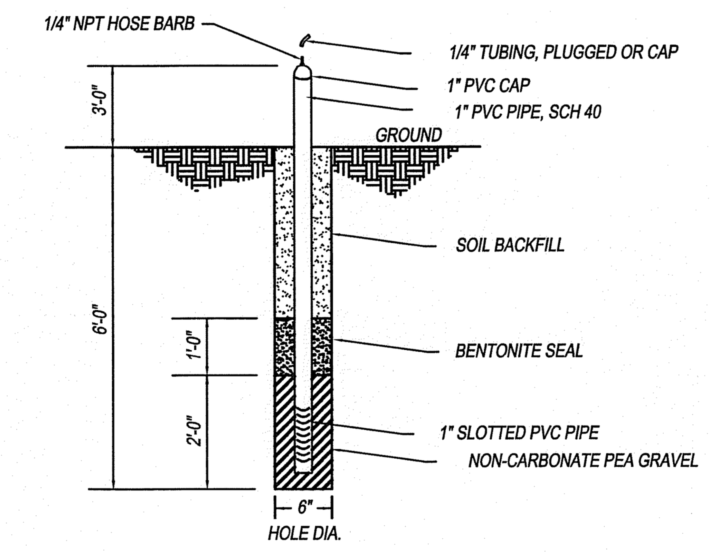
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL JAMMY D. WOODIE

5/13/2011



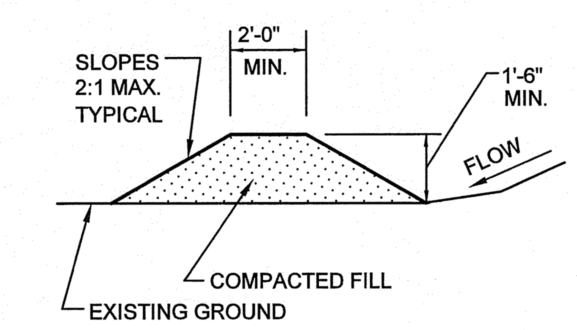
TYPICAL METHANE GAS COLLECTION WELL TO VENT CONVERSION DETAIL

N.T.S.



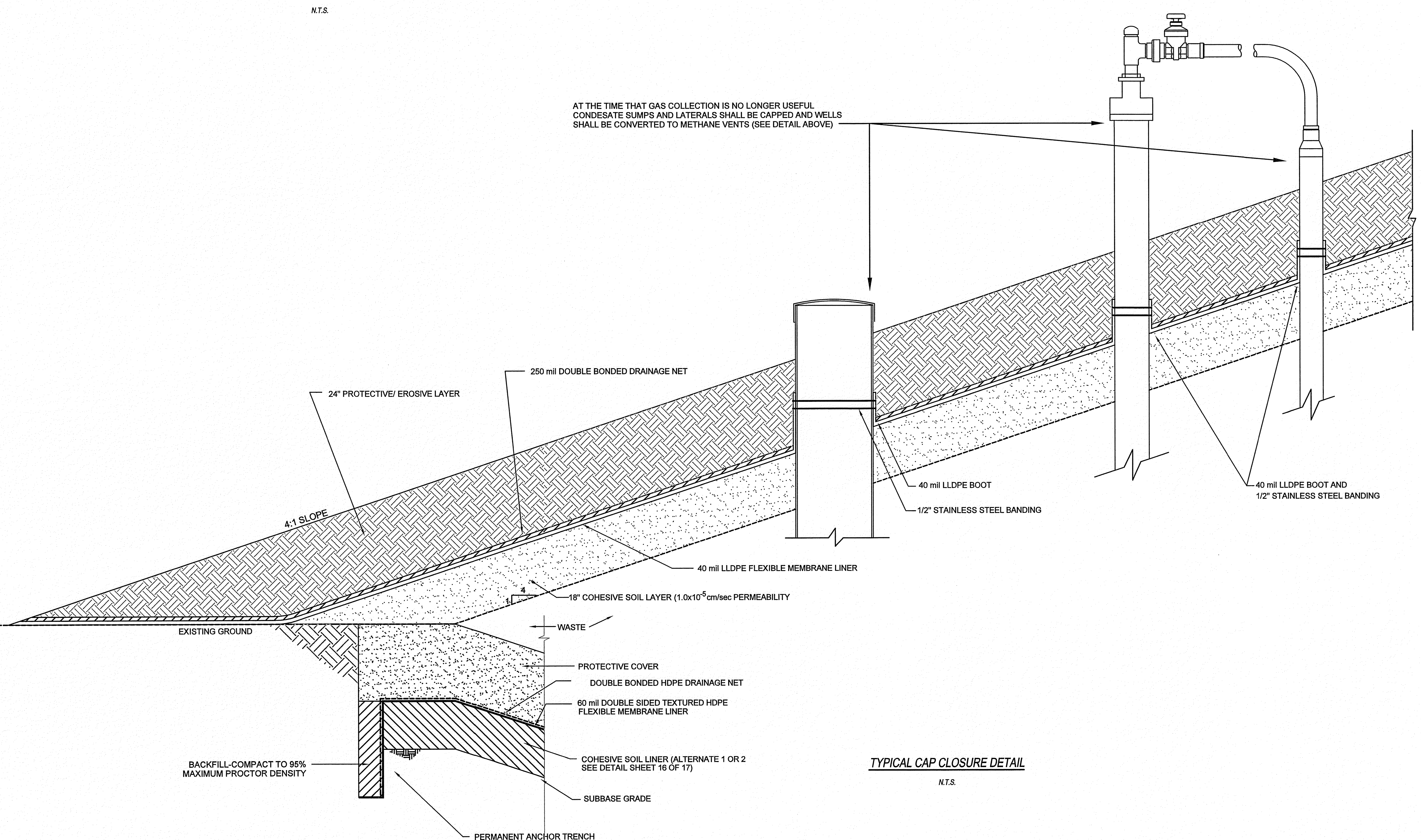
METHANE GAS MONITORING PROBE

N.T.S.



STORMWATER DIVERSION BERM DETAIL

NOT TO SCALE



TYPICAL CAP CLOSURE DETAIL

N.T.S.

LICENSE NUMBER: C-0281
Municipal Engineering Services Company, P.A.
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MUNICIPAL SOLID WASTE LANDFILL FACILITY
WAYNE COUNTY
NORTH CAROLINA

DATE	BY	REV.	DESCRIPTION
3/17/2011	LHC	2	REVISED LABELS ON CLOSURE DETAIL
11/1/2010	LCH	1	REVISED DETAILS

OPERATION PLAN-PHASE 3
OPERATION DETAILS

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 22282 JIMMY D. WOODIE
4/1/2011

SCALE:	1:1
DATE:	4/6/09
DRWN. BY:	L. HAMPTON
CHKD. BY:	J. WOODIE
PROJECT NUMBER	G06096
DRAWING NO. P9	SHEET NO. 11 OF 11

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SECTION 6.0

CLOSURE PLAN

6.1 Introduction

Wayne County will cap their landfill within 180 days after the final receipt of solid waste. The cap system will consist of 12 inches bridging material (temporary cover), 18 inches of cohesive soil liner with a permeability no greater than 1.0 x 10^{-5} cm/sec, 40 mil Linear Low Density Polyethylene (LLDPE), drainage layer, 24 inches of protective/erosive layer. The post-settlement surface slopes on the cap system will be a minimum of 5 percent and a maximum of 25 percent. The cap contains gas venting system consisting of a series of washed stone trenches below the soil liner that will be vented through 10" diameter PVC pipes that penetrate the cap. The cap system will also include the proper seeding and mulching of the erosive layer and other erosion control devices.

The largest area to be closed within the permitted life will be 65 acres.

The estimate of the maximum inventory of wastes ever on-site, over the active life to date of the landfill facility is 1,539,760 cubic yards.

Prior to beginning closure, Wayne County shall notify the Division that a notice of the intent to close the unit has been placed in the operating record. The County shall begin closure activities no later than thirty (30) days after the date on which the landfill receives the final wastes or if the landfill has remaining capacity and there is a reasonable likelihood that the landfill will receive additional wastes, no later than one year after the most recent receipt of wastes. Extensions beyond the one-year deadline for beginning closure may be granted by the Division, if the County demonstrates that the landfill has the capacity to receive additional waste and the County has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the closed landfill.

The County shall complete closure activities in accordance with the closure plan within 180 days following the final receipt of waste. Extensions of the closure period may be granted by the Division if the County demonstrates that closure will, of necessity, take longer than one hundred eighty (180) days and the County has taken and will continue to take all steps to prevent threats of human health and environment from the enclosed landfill.

Estimated schedule of closure will be approximately 31 years.

Following closure of the landfill, the County shall notify the Division that a certification, signed by the Engineer verifying that closure has been completed in accordance with the closure plan, and has been placed in the operating record. The County shall record a notation on the deed to the landfill property and notify the Division that the notation has been recorded and a copy has been placed in the operating record. The notation on the deed shall in perpetuity notify any potential purchaser of the property that the land has been used as a landfill and its use is restricted under the closure plan approved by the Division. The County may request permission from the Division to remove the notation from the deed if all waste are removed from the landfill.

6.2 Cap System

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

6.3 Cohesive Soil Cap

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Cohesive Soil Cap Borrow Material

Test Name	Test Method	Contractor/Engineer Frequency
Moisture/Density	ASTM D698/D1557	1 per 5000 c.y.
Remolded Permeability	ASTM D5084	1 per 5000 c.y.
Atterberg Limits	ASTM D4318	1 per 5000 c.y.
Visual Classification	ASTM D2487	1 per 5000 c.y.
Grain Size Distribution	ASTM D422	1 per 5000 c.y.

Cohesive Soil Cap Test Pad

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	3 per lift
Permeability	ASTM D5084	1 per lift
Remolded Permeability	ASTM D5084	1 per lift
Atterberg Limits	ASTM D4318	1 per lift
Visual Classification	ASTM D2487	1 per lift
Grain Size Distribution	ASTM D422	1 per lift

In-Place Cohesive Soil Cap

Test Name	Test Method	Contractor/Engineer Frequency
Field Moisture/Density	ASTM D1556 (sand cone) ASTM D2922/D3017 (nuclear gauge) ASTM D2937 (drive cylinder)	1 per lift per acre
Permeability	ASTM D5084	1 per lift per acre
Atterberg Limits	ASTM D4318	1 per lift per acre
Visual Classification	ASTM D2487	1 per lift per acre
Grain Size Distribution	ASTM D422	1 per lift per acre

(a) Suitable on-site and/or off-site soils may be used as cohesive soil cap if it can achieve an in-place permeability of 1.0 x 10^{-5} cm/sec or less and meets all testing requirements indicated in the material testing paragraph in this section. Wyoming bentonite or an approved equivalent may be blended with the soil to lower the soil's permeability.

(b) A permeability "window" shall be developed for each type of soil from the borrow material that will be used for construction of the cohesive soil cap. The window shall be plotted on a semi-log plot with moisture content versus density. Laboratory testing to develop the window shall include a series of remolded samples compacted to various dry densities and moisture contents utilizing the same compactive effort (ASTM D 698 or D 1557). The remolded samples shall be tested for permeability to determine whether or not the particular soil type will provide the maximum permeability (1.0 x 10^{-5} cm/sec) at various dry densities and moisture contents. The window is then developed from the accepted remolded samples and moisture contents from the semi-log plot. A straight line is typically drawn between the acceptable points on the moisture-density curve to indicate a range of probable acceptable permeability results. The window will be used in the construction of the test strip to verify the laboratory remolded permeability results.

(c) Atterberg limits and grain size distribution shall also be conducted on the bulk samples used to prepare the permeability window ASTM D2487, D4318, D422. These tests can be used as indices on random samples collected from the borrow site during construction to verify the soil type is the same as was used to develop the "window". As a minimum, sufficient visual classifications and Atterberg limits shall be conducted in association with each permeability test to verify that the construction materials meet specifications.

(d) A test strip of compacted cohesive soil cap shall be prepared to verify the permeability “window” prior to general installation of the cohesive soil cap. The test strip will be used to verify the results from the remolded permeabilities from the borrow site utilizing the permeability window(s) for each soil type that is going to be used for construction of the cohesive soil cap. At a minimum, the verification will consist of three moisture density tests, one Atterberg limits test, one grain size distribution test (ASTM D2487 D4318, and D422), and one Shelby Tube sample for each lift constructed in the test pad. Laboratory permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 x10^{-5}cm/sec. Tests shall be performed in accordance with the ASTM D5084. The test strip shall be approximately 2,500 sq. ft. in surface area and constructed to conform geometrically to the site topography with a minimum lateral dimension in any direction of 25 ft. The test strip shall consist of at least three compacted 6 inch lifts of cohesive soil cap. Placement and testing of the test strip shall be in conformance with the construction specifications and requirements for general installation of the cohesive soil cap. Test results from the test strip shall be used to guide placement and achievement of the required maximum permeability of 1.0 x 10^{-5} cm/sec of the cohesive soil cap. The test strip may be used as an integral part of the overall cohesive soil cap if it meets the required specification for the cap. All results shall be given to the Construction Observer.

(e) The soils shall be placed to the total thickness shown on the plans in maximum 8-inch thick loose lifts with a maximum 6" compacted lift compacted preferably at a moisture content between 0 to 3% above optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698). A sheepsfoot roller or approved alternative may be used to compact the soil cap provided the compaction and permeability requirements can be achieved. Each lift shall be tested for permeability, moisture content, particle size distribution analysis, Atterberg limits, moisture-density-permeability relation, and if needed percent bentonite admixed with soil, prior to the placement of the succeeding lift and visually inspected to confirm that all soil clods have been broken and that the surface is sufficiently scarified so that adequate bonding can be achieved. Soils for cohesive soil cap shall be screened, disked, or prepared using any other approved method as necessary to obtain a homogeneous cohesive soil with clod sizes in a soil matrix no larger than about 1.5 inches in maximum diameter. After each lift, the surface shall be scarified prior to the placement of the next lift to provide good bonding from one lift to the next.

(f) The cohesive soil cap shall be tested to evaluate the coefficient of permeability. The coefficient of permeability of the soil cap shall be equal to or less than 1.0 x 10^{-5} cm/sec after placement and compaction. The soil cap must be a minimum of 1.5 feet thick.

(g) Laboratory falling head permeability tests shall be performed on tube (Shelby or drive tubes) samples of the cohesive soil cap after placement and compaction. The permeability must be a maximum of 1.0 x 10^{-5} cm/sec. Tests shall be performed in accordance with ASTM D5084. All laboratory permeability tests shall be performed at a confining pressure of 10 psi and at a hydraulic gradient of 20.

(h) The soil cap shall be tested a minimum of one soil sample per lift per acre for laboratory permeability. All permeability testing will be on random samples judged by the Engineer to be representative of the most permeable soil conditions for the area being tested. The Engineer shall certify that the materials used in construction were tested according to the Division approved plans. If after placement of the soil cap it fails the required tests, the material will either be reworked or replaced, and retested. The soil cap must remain moist at all times, if any section becomes dry, rework the dry area and moisten.

(i) A minimum of two (2) inches of soil shall be removed prior to securing each sample for permeability testing. The sampling tube shall be advanced vertically into the soil with as little soil disturbance as possible and should be pushed using a uniform pressure. The sampling tube (Shelby tube), when extracted, shall be free of dents, and the ends shall not be distorted. A backhoe or approved alternative should be used to advance the sampling tube (Shelby tube) as long as disturbance is minimized. Drive tube samples of the cap may be obtained for permeability testings. If the Engineer judges the sample to be too disturbed, another sample shall be taken. Once an acceptable sample has been secured and properly prepared, all sample excavations Once an acceptable sample has been secured and properly prepared, all sample excavations or other holes created by survey stakes, etc. shall be backfilled to grade with a 50% mixture of bentonite and similar soils in maximum 3-inch loose lifts and hand tamped with a blunt tool to achieve a tight seal equivalent to the original density.

(j) No additional construction shall proceed on the soil layers at the area being tested until the Engineer has reviewed the results of the tests and judged the desired permeability is being achieved.

(k) As a minimum, sufficient visual classifications (ASTM Test Designation D2487) , analyses (ASTM Test Designation D422) and Atterberg limits (ASTM Test Designation D4318) shall be conducted in association with each permeability test to verify that the construction materials meet specifications. The minimum number of tests will be 1 per lift per acre.

(l) If the soil for the cohesive soil cap is incapable of achieving the required permeability when compacted, bentonite or approved alternative may be mixed with the soils to decrease the permeability. The amount of additive required must be determined in the laboratory. Where additives are required, the soil shall be placed in maximum 8-inch thick loose lifts and compacted preferably between 0 to +3% optimum moisture content to 95% standard Proctor maximum dry density (ASTM Test Designation D698) for the soil-additive mixture. All other compaction procedures for the soil apply.

(m) Surfaces to be lined shall be smooth and free of debris, roots, and angular or sharp rocks larger than three-eight (3/8) inches in diameter to a depth of six (6) inches. The cohesive soil cap shall have no sudden sharp or abrupt changes in grade.

(n) The Contractor shall protect the cohesive soil cap from desiccation, flooding and freezing. Protection, if required, may consists of a thin plastic protective cover, (or other material as approved by the engineer) installed over the completed cohesive soil cap until such time as the placement of flexible membrane liner begins. Areas found to have any desiccation cracks or which exhibit swelling, heaving or other similar conditions shall be replaced or reworked by the contractor to remove these defects. Areas where the cohesive soil has been replaced, desiccation cracks and/or heaving is deeper than two (2) inches shall be retested.

(o) The thickness and grade of the soil cap will be verified by the surveyor before placement of the geomembrane liner. The soil cap will be surveyed at 50' grid points where the elevations of the top of intermediate cover will be compared to the top of soil cap to verify 1.5 feet of soil cap. The grade will then be verified with the surveyed information. The survey will be performed by N.C. licensed surveyors.

(p) Surface Acceptance. Upon request, the Flexible Membrane Liner manufacturer installer shall provide the Engineer with a written acceptance of the surface prior to commencing installation. Subsequent repairs to the cohesive soil cap and the surface shall remain the responsibility of the contractor.

6.4 <u>Flexible Membrane Liner Method of Deployment</u>

All materials and equipment shall be furnished by an established and reputable manufacturer or supplier. All materials and equipment shall be new and shall be of first class ingredients and construction, designed and guaranteed to perform the service required and shall conform with the following standard specifications or shall be the product of the listed manufacturers or similar and equal thereto as approved by the Engineer.

Flexible Membrane Liner Tests

Test Name	Description	Test Method	Frequency
Air Test	Air Test Seams		Every Seam
Vacuum Test	Every welded area		Where air test impossible
Destructive Tests	Seam Strength	ASTM D4437	Every 500' of seam

Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.
40 mil Linear Low Density Polyethylene (LLDPE) is to be placed in direct contact with moist cohesive soil cap. The extrusion rods and/or brads used in seaming the rolls together shall be derived from the same base resin as the liner and shall meet the following minimum properties:

English Units

Table 2(a) – Linear Low Density Polyethylene (LLDPE) Geomembrane (TEXTURED)

Properties	Test Method	Test Value 20 mils	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	Testing Frequency (minimum)
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) *(1)*	D 7466	10	10	10	10	10	10	10	10	Every 2nd roll *(2)*
Density g/ml (max.)	D 1505/D 792	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939	200,000 lb
Tensile Properties *(3)* (min. ave.) • break strength – lb/in. • break elongation - %	D 6693 Type IV	30 250	45 250	60 250	75 250	90 250	120 250	150 250	180 250	20,000 lb
2% Modulus – lb/in. (max.)	D 5323	1200	1800	2400	3000	3600	4800	6000	7200	per formulation
Tear Resistance – lb (min. ave.)	D 1004	11	16	22	27	33	44	55	66	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	22	33	44	55	66	88	110	132	45,000 lb
Axi-Symmetric Break Resistance Strain - % (min.)	D 5617	30	30	30	30	30	30	30	30	per formulation
Carbon Black Content - %	D 1603 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	45,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)* (e) Standard OIT — or — (f) High Pressure OIT	D 3895 D 5885	100 400	100 400	100 400	100 400	100 400	100 400	100 400	100 400	200,000 lb
Oven Aging at 85°C *(7)* (a) Standard OIT (min. ave.) - % retained after 90 days — or — (b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5721 D 3895 D 5885	35 60	35 60	35 60	35 60	35 60	35 60	35 60	35 60	per formulation
UV Resistance *(8)* (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 3895 D 5885	N. R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	N.R. *(9)* 35	per formulation

(1) Of 10 readings; 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils; also see Note 9.
(2) Alternate the measurement side for double sided textured sheet
(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

(4) Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.
(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

(1) Preparation for Geomembrane Deployment

(a) Panel Layout

Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and location of seams for the project.

(b) Identification

Each panel used for the installation shall be given a numeric or alpha-numeric identification number consistent with the layout drawing. This identification number shall be related to manufacturing roll number that identifies the resin type, batch number and date of manufacture.

(c) Verification

The manufacturers certification will be reviewed by the Engineer. If the certification does not meet the requirements of GRI-GM17, the corresponding liner rolls will be rejected.

(2) Field Panel Placement

(a) Location

The Flexible Membrane Liner Manufacturer/Installer shall install field panels at the location indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the field on a layout drawing which will be modified at the completion of the project to reflect actual panel locations.

(b) Weather Conditions

Geomembrane deployment shall not be carried out during any precipitation, nor in the presence of excessive moisture (i.e. fog, dew), in an area of standing water, or during high winds.

(c) Method of Deployment shall follow the manufacturer's recommendations and sound, accepted engineering practices.

(1) The method and equipment used to deploy the panels must not damage the geomembrane or the supporting subgrade surface.

(2) No personnel working on the geomembrane: will smoke, wear shoes that can damage the geomembrane, or engage in actions, which could result in damage to the geomembrane.

(3) Adequate temporary loading and/or anchoring, (i.e. sandbags, tires), which will not damage the geomembrane, will be placed to prevent uplift of the geomembrane by wind. If uplift occurs, additional sandbags will be placed in necessary areas.

(4) The geomembrane will be deployed in a manner to minimize wrinkles. The geomembrane will have no fold overs.

(5) Any damage to a panel of the geomembrane will be repaired. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked, cut out and removed from the work area with resulting seaming and/or repairs performed.

(3) Field Seaming

(a) Layout

In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Whenever possible, horizontal seams should be located not less than five (5) feet from the toe of the slope. Each seam made in the field shall be numbered in a manner that is compatible with the panel layout drawing for documentation of seam testing results.

(b) Personnel

All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used and will qualify by successfully welding a test seam. The project foreman will provide direct supervision of all personnel seaming to verify proper welding procedures are followed. Qualified liner installers, seamers, and the liner foreman shall meet a minimum requirement of 1,000,000 square feet of geomembrane installation. There are no other minimum qualifications needed by other parties.

(c) Equipment

(1) Fusion Welding

Fusion Welding consists of placing a heated wedge, mounted on a self propelled vehicular unit, between two (2) overlapped sheets such that the surface of both sheets are heated above the polyethylene's melting point. After being heated by the wedge, the overlapped panels pass through a set of preset pressure wheels which compress the two (2) panels together so that a continuous homogeneous fusion weld is formed. The fusion welder is equipped with a temperature readout device which continuously monitors the temperature of the wedge.

(2) Extrusion Fillet Welding

Extrusion fillet welding consists of introducing a ribbon of molten resin along the edge of the seam overlap of the two (2) sheets to be welded. The molten polymer causes some of the material of each sheet to be liquefied resulting in a homogeneous bond between the molten weld bead and the surfaces of the sheets. The extrusion welder is equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

(d) Weather Conditions

The Flexible Membrane Liner Manufacturer/Installer will rely on the experience of the Flexible Membrane Liner Superintendent and the results of test seams to determine seaming restrictions by weather. Many factors, such as ambient temperature, humidity, wind, sunshine, etc., can effect the integrity of field seams and must be taken into account when deciding whether or not seaming should proceed. Responsibility for monitoring these conditions shall lie with the Flexible Membrane Liner Superintendent; however, the Engineer may suspend any seaming operation which is, in his opinion, at the risk of providing the Owner with a quality product. Test seams are required prior to daily production seaming to determine if the weather conditions will effect the Flexible Membrane Liner System's ability to produce quality seams. Additional non-destructive and destructive testing of production seams substantiate the decision made by the Flexible Membrane Liner Superintendent to seam on any given day.

(4) Seam Preparation

(a) Fusion Welding

(1) Overlap the panels of geomembrane approximately four (4) inches.

(2) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, debris of any kind. No grinding is required for fusion welding.

(3) Adjust the panels so that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

(4) A movable protective layer may be used, at the discretion of the Flexible Membrane Liner Superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

(b) Extrusion Welding

(1) Overlap the panels of geomembrane a minimum of three (3) inches.

(2) Temporarily bond the panels of geomembrane to be welded taking care not to damage the geomembrane.

(3) Grind seam overlap prior to welding within one (1) hour of welding operation In a manner that does not damage the geomembrane. Limit grinding to ¼" outside of the extrusion weld area.

(4) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.

(5) Purge the extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel.

(6) Keep welding rod clean and off the ground.

(5) Test Seams

Test seams shall be performed at the beginning of each seaming period and at least once each four (4) hours for each seaming apparatus used that day. Test seams shall be made on fragment pieces of the geomembrane liner and under the same conditions as actual seams.

(a) Test Seam Length

The test seam shall be at least three (3) feet long and should be made by joining two (2) pieces of geomembrane at least 9" in width.

(b) Sample Procedure

(1) Visually inspect the seam for squeeze out, footprint, pressure and general appearance.

(2) Two random samples one (1) inch wide shall be cut from the test seam. The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer that has a constant separation of 2.0 in/min for peel and shear. The passing destructive test requirements for a 40-mil LLDPE liner seam is: minimum peel strength of 50 ppi for hot wedge and 44 ppi for extrusion fillet seams, minimum shear strength of 60 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam.

If a specimen fails the entire procedure shall be repeated.

(3) If any of the second set of specimens fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved.

(4) After completion of these tests, the remaining portion of test seam can be discarded. Documentation of the test seams will be maintained listing seam identification number, welder's name, temperature control setting, and test results.

(5) Passing test results records shall be maintained.

(6) General Seaming Procedures

(a) Seaming shall extend to the outside edge of panels to be anchored.
While welding a seam, monitor and maintain the proper overlap.

(b) Inspect seam area to assure area is clean and free of moisture, dust, dirt, debris of any kind.

(c) While welding a seam, monitor temperature gauges to assure proper settings are maintained and that the seaming apparatus is operating properly.

(d) Align wrinkles at the seam overlap to allow welding through the wrinkle.

(e) Fishmouths or wrinkles at seam and overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut fishmouth or wrinkle shall be seamed. Any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane extending a minimum of six (6) inches beyond the cut in all directions.

(f) All cross/butt seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane.

(g) All "T" joints shall have the overlap from the wedge welder seam trimmed back to allow an extrusion fillet weld. Then grind ¼ of an inch minimum on either side of the wedge seam, then extrusion weld all of the area prepared by grinding.

6.5 Flexible Membrane Liner Tests

The installation crews will non-destructively test all field seams over their full length using air pressure testing, vacuum testing or other approved methods, to verify the continuity and integrity of the seams.

(a) Air Pressure Testing

The welded seam created by double hot-wedge fusion welding process is composed of two distinct welded seams separated by an unwelded channel approximately 3/8 of an inch between the two welded seams permits the double hot-wedge fusion seams to be tested by inflating the sealed channel with air to a predetermined pressure, and observing the stability of the pressurized channel over time.

(1) Equipment for Air Testing

An air pump (manual or motor driven) capable of generating and sustaining a pressure between 25 to 30 psi.

A rubber hose with fittings and connections.

A sharp hollow needle, or other approved pressure feed device with a pressure gauge capable of reading and sustaining a pressure between 25 to 30 psi.

(2) Procedure for Air Testing

Seal both ends of the seam to be tested.

Insert needle or other approved pressure feed device into the sealed channel created by the fusion weld.

Inflate the test channel to a pressure between 25 to 30 psi, in accordance with the following schedule, close valve, and observe initial pressure after approximately 2 minutes.

INITIAL PRESSURE SCHEDULE *

Material (Mil)	Min. Psi	Max. Psi
40	25	30
60	27	30
80	30	30
100	30	30

* Initial pressure settings are read after a two minute "relaxing period". The purpose of this "relaxing period" is to permit the air temperature and pressure to stabilize.

Observe and record the air pressure five (5) minutes after "relaxing period" ends and when initial pressure setting is used. If loss of pressure exceeds the following or if the pressure does not stabilize, locate faulty area and repair.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL AFTER 5 MINUTES - LLDPE

Material (Mil)	Pressure Diff.
40	4 psi
60	3 psi
80	3 psi
100	3 psi

At the conclusion of the pressure test the end of the seam opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated after the blockage is corrected.

Remove needle or other approved pressure feed device and seal resulting hole by extrusion welding.

(3) In the event of a Non-Complying Air Pressure Test, the following procedure shall be followed:

Check seam end seals and retest seams.

If non-compliance with specified maximum pressure differential re-occurs, repair the seam. Capping or removal/reseam of the non-complying seam are the only two (2) acceptable methods of repairing failed seams.

Non-destruct test the entire length of the repaired seam

(b) Vacuum Testing

This test is used when the geometry of the weld makes air pressure testing impossible or impractical or when attempting to locate the precise location of a defect believed to exist after air pressure testing. The penetration will be tested using this method.

(1) Equipment for Vacuum Testing

Vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

Vacuum pump assembly equipped with a pressure controller and pipe connection.

A rubber pressure/vacuum hose with fittings and connections.

A bucket and means to apply a soapy solution.

A soapy solution.

(2) Procedure for Vacuum Testing

Trim excess overlap from seam, if any.

Turn on the vacuum pump to reduce the vacuum box to approximately 5 inch of mercury, i.e., 5 psi gauge.

Apply a generous amount of a solution of strong liquid detergent and water to the area to be tested.

Place the vacuum box over the area to be tested and apply sufficient downward pressure to "seat" the seal strip against the liner.

Close the bleed valve and open the vacuum valve.

Apply a minimum of 5 in. Hg vacuum to the area as indicated by the gauge on the vacuum box.

Ensure that a leak tight seal is created.

For a period of not less than 30 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

If no bubbles appear after 30 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 in. overlap, and repeat the process.

(3) Procedure for Non-Complying Test

Mark all areas where soap bubbles appear and repair the marked areas.

Retest repaired areas.

(c) Destructive Testing

(1) Concept

The purpose of destructive testing is to determine and evaluate seam strength. These tests require direct sampling and thus subsequent patching. Therefore destructive testing should be held to a minimum to reduce the amount of repairs to the geomembrane.

(2) Procedure for Destructive Testing

All Destructive tests will be done according to GRI test method GM19. Destructive test samples shall be marked and cut out randomly at a minimum average frequency of one test location every 500 feet of seam length.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds at the discretion of the Flexible Membrane Liner Superintendent and Engineer.

Sample Size

The sample should be twelve (12) inches wide with a seam fourteen (14) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the owner at the owner's request or by specific project specifications.

A one (1) inch sample shall be cut from each end of the test seam for field testing.

The two (2), one (1) inch wide samples shall be tested in the field in a tensiometer for peel and shear. The passing destructive test requirements for a 40-mil LLDPE liner seam is: minimum peel strength of 50 ppi for hot wedge and 44 ppi for extrusion fillet seams, minimum shear strength of 60 ppi for hot wedge and extrusion fillet seams, and a maximum of 25% peel separation of the seam.

(3) Procedure in the event of Destructive Test Failure

Cut additional field samples for testing. In the case of a field production seam, the samples must lie a minimum of ten (10) feet in each direction from the location of the failed sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.

If the laboratory samples pass then reconstruct the seam between the two (2) passing samples locations.

Heat tack the overlap along the length of the seam to be reconstructed and extrusion weld.

Vacuum test the extrusion weld.

If either of the samples fail, then additional samples are taken in accordance with the above procedure until two (2) passing samples are found to establish the zone in which the seam should be reconstructed.

All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken.

In cases of reconstructed seams exceeding 150 feet, a destructive sample must be taken and pass destructive testing from within the zone in which the seam has been reconstructed.

All destructive seam samples sent to the Engineer's laboratory shall be numbered.

(d) Quality Assurance Laboratory Testing

(1) Destructive samples sent to the laboratory will be tested for shear/peel strength, elongation, and peel separation according to table 1(a) of GRI Test Method GM19. Five (5) specimens shall be tested for each test method with data recorded. Four (4) out of the five (5) specimens must pass and the fifth specimen must be 80% of the passing test values. The passing test values are as follows:

Hot Wedge Seams
Shear Strength-60 ppi
Shear elongation at break – 50%
Peel Strength- 50 ppi
Peel separation-25%
Extrusion Fillet Seams
Shear Strength-60 ppi
Shear Elongation at break-50%
Peel Strength- 44 ppi
Peel separation-25%

(2) Defects and Repairs

(a) The Flexible Membrane Liner Superintendent shall conduct a detailed walk through and visually check all seams and non-seam areas of the geomembrane for defects, holes, blisters and signs of damage during installation.

(b) All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

(c) Repair Procedures

Any portion of the geomembrane showing a flaw or failing a destructive or non-destructive test shall be repaired. Several procedures exist for repair and the decision as to the appropriate repair procedure shall be made by the Flexible Membrane Liner Superintendent. Repairs need to be made in a timely manner to protect the moist cohesive soil liner and flexible membrane liner. If inclement weather is approaching, steps need to be made to protect the cohesive soil cap such as a temporary cover. If cohesive soil cap is damaged, it must be reworked. Procedures available for liner repair:

Patching - used to repair large holes, tears and destructive sample locations. All patches shall extend at least six (6) inches beyond the edges of the defect and all corners of patches shall be rounded.

Reconstruction - used to repair seams bounded by passing destruct samples.

Grinding and welding - used to repair sections of extruded seams.

Spot welding or seaming - used to repair small tears, pinholes or other minor localized flaws.

Capping - used to repair lengths of failed extruded seams.

Removal of a bad seam and replacement with a strip of new material seamed into place.

(d) Verification of Repairs

Every repair shall be non-destructively tested. Repairs which pass the non-destructive test shall be deemed adequate. Large repairs may require a destructive test. Repair test results shall be logged. The repair location shall be recorded on an as-built drawing.

e) Liner Acceptance

The constructed liner will be accepted when all non-destruct and destruct tests have passed their respective tests and the results have been verified by the Engineer.

6.6 Protective Cover

(1) HPDE Geocomposite Drainage Netting manufactured by SKAPS Industries, or approved equal. Q/C testing information/certification for each property on geocomposite will be provided by the contractor/manufacture for the rolls delivered. The thickness, transmissivity and ply adhesion will be tested by the Engineer's third party laboratory for quality assurance. One roll from every 200,000 $ft.^2$ of material delivered to the site will be tested.

SKAPS TRANSNET HDPE GEOCOMPOSITE WITH 250 MIL GEONET

Last Updated on Wednesday, 08 September 2010 07:57

SKAPS TRANSNET™ GeoComposite consists of SKAPS GeoNet made from HDPE resin with non-woven polypropylene GeoTextile fabric heat bonded on both sides of GeoNet.

Property	Test Method	Unit	Required Value		Qualifier
				with 8 oz.	
Geonet					
Thickness	ASTM D 5199	mil		250 ±10	Range
Carbon Black	ASTM D 4218	%		2 to 3	Range
Tensile Strength	ASTM D 5035	lb/in		50	Minimum
Melt Flow	ASTM D 1238[3]	g/10 min		1	Maximum
Density	ASTM D 1505	g/cm^3		0.94	Minimum
Transmissivity[1]	ASTM D 4716	m^2/sec		$2.5x10^{-3}$	MARV[2]
Composite					
Ply Adhesion (Minimum)	ASTM D 7005	lb/in		0.5	MARV
Ply Adhesion (Average)	ASTM D 7005	lb/in		1	MARV
Transmissivity[1]	ASTM D 4716	m2/sec		$2x10^{-4}$	MARV
GeoTextile					
Fabric Weight	ASTM D 5261	oz/yd^2		8	MARV
Grab Strength	ASTM D 4632	lbs		225	MARV
Grab Elongation	ASTM D 4632	%		50	MARV
Tear Strength	ASTM D 4533	lbs		90	MARV
Puncture Resistance	ASTM D 4833	gpm/ft^2		130	MARV
CBR Puncture	ASTM D 6241	lbs		650	MARV
Water Flow Rate	ASTM D 4491	gpm/ft^2		100	MARV
Permittivity	ASTM D 4491	sec^{-1}		1.26	MARV
Permeability	ASTM D 4491	cm/sec		0.3	MARV
AOS	ASTM D 4751	US Sieve		80	MARV

Notes:

1. Transmissivity measured using water at 21 ± 2 °C (70 ± 4 °F) with a gradient of 0.1 and a confining pressure of 10000 psf between steel plates after 15 minutes. Values may vary between individual labs.

2. MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.

3. Condition 190/2.16

The geocomposite will be handled in such a manner as to ensure the geocomposite are not damaged in any way. On slopes, the geocomposite will be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite sheet in tension. If necessary, the geocomposite will be positioned by hand after being unrolled to minimize wrinkles. Geocomposite can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., where extra layers are required or where slope is less than 10:1).

Geocomposite will not be welded to the geomembrane. Geocomposite will be cut using approved cutters,(i.e., hook blade, scissors, etc.) Care should be taken to prevent damage to underlying layers. Care must be taken not to entrap dirt in the geocomposite that could cause clogging of the drainage system, and or stones that could damage the adjacent geomembrane.

Adjacent rolls of geocomposite will be overlapped by at least four inches and securely tied. Tying can be achieved by plastic fasteners. Tying devices will be white or yellow for easy inspection. Metallic devices are not allowed. Tying will be five to ten feet along the bottom of the slope. Tying will be every five feet along the slope, every two feet across the slope and at the top of the berm. Tying in the anchor trench will be done in one foot intervals. In the corners of the side slopes where overlaps between perpendicular geocomposite strips are required, an extra layer of geocomposite will be unrolled along the slope, on top of the previously installed geocomposite, from the top to bottom of the slope.

Any holes or tears in the geocomposite will be repaired by placing a patch, utilizing the same geocomposite material, extending two feet beyond edges of the hole or tear. The patch will be secured to the original geocomposite by tying every twelve inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area will be cut out and the two portions of the geocomposite will be joined.

The engineer will visually inspect the drainage layer before placement of the erosive layer, if any defects are detected they will be repaired before placement of erosive layer.

(2) Erosive Layer

The soil for the erosive layers shall consist of suitable site soil free of debris, roots, rocks and organics. The soil shall contain no particles or objects greater than 3/4 inch in largest dimension, which has been screened. No permeability, grain size, or other tests are required for this material.

Installation of the protective cover shall be the responsibility of the contractor. Before proceeding with placement of the protective cover over the liner, the Contractor shall furnish to the Engineer with the manufacturer's certification that the lining has been satisfactorily installed in accordance with the manufacturer's recommendations.

The erosive layer shall be composed of 24” of select backfill. The cover shall be installed using low ground pressure equipment such as a Caterpillar D6H LGP, or approved equal, with ground pressure not exceeding 4.71 psi until the depth of cover exceeds three feet.

The depth of the erosive layer will be verified based on the 50 ft. grid and the difference in elevation from the top of the cohesive soil to the top of the erosive layer.

(a) A minimum of twelve inches (12") of cover between low ground pressure equipment and the liner is required at all times. Roadways for entering and for transporting material over slopes and capped/lined areas shall have a minimum depth of four feet (4').

(b) Avoid undue stress on the liner at all times. Cover material must be pushed up slopes, never down to help minimize wrinkles. Material must be placed to minimize wrinkles, wrinkles in excess of two feet in height are unacceptable. If a wrinkle is more than two feet in height, soil will be placed on top of the wrinkle to decrease the height. Fold over of the liner will not be allowed. A worker must walk along side earth moving equipment and remove all rocks, stones, roots or other debris that could cause damage to the liner. Equipment operators must avoid sharp turns or quick stops that could pinch and tear the liner.

(c) If damage does occur, report it to the Project Manager immediately so that repairs can be performed without needless delay. All repairs to any component of the liner system will be done and tested according to the required repairs and testing for that component.

(d) Do not work wet cover material that cannot support equipment.

(e) Equipment operators and all other personnel must be qualified and must exercise good judgment and common sense at all times.

(3) Vegetative Layer

Native vegetation will be used as approved by the Erosion Control Plan.

6.7 Methane Venting System

Gas Venting System

The existing gas collection system and any future expansions of the system, shall remain in service until collection of gas is no longer functional. The wells will then be converted to methane vents and the gas collection laterals shall remain in place and be capped.

The well heads shall be removed and replaced with a methane vent turndown and the opening shall be covered with a stainless steel screen.

Plastic Pipe

Plastic gravity sewer pipe and fittings used for methane vent shall be unplasticized polyvinyl chloride (PVC) and conform to the requirements of ASTM Designation D-3034 on ASTM F679, Type PSM, Class 12454-B, SDR-35 with elastomeric gasket joints. PVC pipe and fittings shall be as manufactured by J-M Pipe, Certainteed, H&W Industries or equal. The methane riser pipe shall be a 10 inch solid wall PVC pipe.

6.8 **Closure Costs**

The largest area to be closed within the permitted life will be Phase 1, 2, and 3 (65 Ac.). The estimated costs shown below are only for Phase 1, 2 and 3. Post Closure will be 30 years after closure.

Closure Costs:
Closure will consist of the following which costs are estimated as being done by a third party.

1. 18" of $1x10^{-5}$ cm/sec. soil cover;
2. 40 Mil LLDPE Liner and Drainage net;
3. Erosion Control Devices;
4. 24" Erosive layer;
5. Seeding and Mulching;
6. Mobilization/Demobilization;
7. Labor Costs; and
8. Stone for methane gas collection.
9. Geotextile for methane gas collection.
10. Vent pipes for methane gas collection.
11. Engineering Costs and QA/QC of the Composite liner and certification of closure.

Estimate of Probable Costs:

1. 18" of $1x10^{-5}$ cm/sec. soil cover for 65 acres:

   Total yardage + 15% = 180,895 yd^3 @ a cost of $6.90/$yd^3$
   ∴ Cost = $1,248,176

2. 40 Mil LLDPE Liner and Drainage net for 65 acres

   Total Footage + 15% = 3,256,110 ft^2 @ a cost of $0.85/$ft^2$
   ∴ Cost = $2,767,694

3. Erosion Control devices

   Estimated costs @ $75,000
   ∴ Cost = $75,000

4. 24" Erosive soil layer for 65 acres.

   Total yardage + 15% = 241,194 yd^3 @ a cost of $4.05/$yd^3$
   ∴ Cost = $976,836

5. Seeding and Mulching for 65 acres.

   Estimated cost of $2,000/acre
   ∴ Cost = $130,000

6. Mobilization/Demobilization.

   Estimated cost of $175,000

7. Labor Costs.

   Estimated cost of $650,000

8. Vent pipes for methane gas collection.

Estimated cost @ $600.00 each (62).

∴ Cost = $37,500

9. Engineering Costs and QA/QC of the Composite liner and certification of closure.

Estimated cost = $650,000

Total of Estimated Phase 1, 2 and 3 Closure Costs:

	1.	$ 1,248,176
	2.	$ 2,767,694
	3.	$ 75,000
	4.	$ 976,836
	5.	$ 130,000
	6.	$ 175,000
	7.	$ 650,000
	8.	$ 37,500
	9.	$ 650,000
Total:		$ 6,710,206

SECTION 7.0

POST-CLOSURE PLAN

7.1 Introduction

CONTACTS:

Name:	W. Lee Smith, III
Title:	County Manager
Phone No.:	(919) 731-1435
Address:	P.O. Box 227 Goldsboro, NC 27530

DESCRIPTION OF USE:

The County has no future use planned for their landfill at this time.

DESCRIPTION OF MAINTENANCE ACTIVITIES:

The landfill will be monitored quarterly for evidence of settlement, subsidence, ponding in the cap system, leachate seepages, and any erosion. The quarterly inspection will also include observation and necessary repair of the security fence, entrance sign, access roads to the methane and groundwater monitoring points, the actual ground water monitoring wells and methane probes, accumulated silt in the sediment basins, leachate lagoon, pumps and edge of waste markers. Annually in the spring, the vegetative cover will be monitored to assure a good stand of vegetation, and where needed, it will be reseeded. Semi-annually the cap vegetation will be mowed and any saplings removed. These maintenance activities will take place over the entire post closure period of thirty years.

The pumps in the sumps will be monitored quarterly to assure that they are operating properly by manually operating each pump. The flow pumped from each sump for the quarter will be documented. The pumps at the lagoon will also be manually operated to assure that they are working properly and the flow to the Waste Water Treatment Plant documented for the quarter. If for any reason a pump is not operating, it will be repaired or replaced within two weeks of the inspection.

Any repairs to the cap system will be done according to the approved closure plan and documented according to the approved quality assurance plan. Damages that require repairs shall be reported to the NC Solid Waste Section within 3 days of inspection/observation.

The leachate collection system will be videoed every five years and power washed if necessary. The pump risers will be vacuum cleaned every five years. Leachate will be collected and treated until the generation of leachate has stopped due to capping.

All quarterly inspections/observations will be documented and become part of the landfill's operating record. All repairs/maintenance will be documented and also become part of the landfill's operating record. Data collected from all pumps will also become part of the operating record.

DESCRIPTION OF MONITORING ACTIVITIES:

The County will monitor and analyze ground and surface water semi-annually according to the approved monitoring plan for a period of thirty years. The County will also monitor methane gas at landfill structures and the boundary quarterly according to the approved methane monitoring plan for the thirty-year period. All reports and records required by the approved monitoring plans will become part of the landfill's operating record.

COMPLETION OF POST-CLOSURE CARE

Following completion of the post-closure care period for each MSWLF unit, the owner or operator will notify the Division that a certification, signed by a registered professional engineer, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record.

CLOSURE OF LEACHATE STORAGE FACILITIES

The County will close the leachate lagoon within 180 days after liquid collection has ceased. The plan for closure of the lagoon shall be approved by the Division of Waste Management prior to commencing closure activities.

All solid waste will be removed from the leachate lagoon, connecting sewer lines, and manholes. All solid waste removed will be properly handled and disposed of according to federal and State requirements. All connecting lines will be disconnected and securely capped or plugged.

All waste residues, contaminated system components (composite liner system), contaminated subsoils, structures and equipment contaminated with waste will be removed and appropriately disposed. If the groundwater surrounding the impoundment is contaminated, other corrective actions to remediate a contaminant plume may be required by the Department. If the groundwater surrounding the lagoon is found not to be contaminated, the liner system may remain in place if drained, cleaned to remove all traces of waste, and both liners punctured so that drainage is allowed. The lagoon is to be backfilled and regraded to the surrounding topography.

7.2 Post Closure Costs

The largest closed area to be monitored within the post closure life will be Phase 1,2 and 3 (65 Ac.).

Post Closure Costs:

Methane gas, ground water and surface water will be monitored for 30 years after closure. The cap will also have to be monitored for the 30 year period. All costs include reports, data analysis, and certifications.

1. Closure of sedimentation and erosion control devices.
   Estimate $24,000.00 for closure

   ∴ Cost = $24,000

2. Leachate Management including pumping data.
   Estimate $400,000.00 for the 30 years.

   ∴ Cost = $400,000

3. Closure of leachate lagoon.
   Estimate $30,000 for Closure.

4. Maintenance of gas vents, monitoring wells, pumps, access roads, fencing, signage, EOW markers, vegetation and mowing, etc.
   Estimate $520,000

5. Cap Monitoring and repairing any problems.
   Estimate $100,000 for the 30 years.

   ∴ Cost = $100,000

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Total of Estimated Phase 1, 2 and 3 Post Closure Costs:

	1. $ 24,000
	2. $ 400,000
	3. $ 30,000
	4. $ 520,000
	5. $ 100,000
Total:	$1,074,000

Total for Potential Assessment and Corrective Action: $3,000,000

SECTION 8.0

FINANCIAL ASSURANCES

TO BE SUBMITTED AT A LATER DATE