Fac/Perm/Co ID #	Date	Doc ID#
41-16	8/6/08	5472

Golder Associates

LETTER OF TRANSMITTAL

TO:	DATE:	8/4/08
NCDENR	PROJECT NO.:	
2090 US Highway 70	ATTENTION:	Mr. Allen Gaither
Swannanoa, NC 28778	RE:	WCA of High Point Phase 2 App for
828.296.4703		Permit to Construct

WE ARE SENDING YOU [X] ATTACHED [ ] VIA:

[ ] Shop Drawings [ ] Prints [ ] Plans [ ] Samples [ ] Specifications

[ ] Copy of letter [ ] Change Order [ ] As described

COPIES	DATE	NO.	DESCRIPTION
1			Disc with PDF copy of the Application for Permit to Construct, WCA of High Point Proposed Phase 2 Expansion

THESE ARE TRANSMITTED as checked below:

[ ] For approval [ ] Approved as submitted [ ] Resubmit ___ Copies for approval

[X] For your use [ ] Approved as noted [ ] Submit ___ Copies for distribution

[ ] As requested [ ] Returned for corrections [ ] Return ___ Corrected copies

[ ] For review and comment [ ] ________

[ ] For bids due: ________ [ ] ________

REMARKS

Allen,

Enclosed please find a CD with a PDF copy of the Application for Permit to Construct, WCA of High Point Proposed Phase 2 Expansion. The disc includes the entire text of the Application and the drawings.

If you have any questions or need other electronic files, please contact me at 336.852.4903.

Thanks for your help with this project!

COPY TO File

SIGNED Chr

If enclosures are not as noted, kindly notify us at once.

RECEIVED

AUG 5 2008

SOLID WASTE SECTION
ASHEVILLE REGIONAL OFFICE

Golder Associates NC, Inc.

4900 Koger Boulevard, Suite 140
Greensboro, NC 27407
Telephone (336) 852-4903
Fax (336) 852-4904

April 17, 2007

Project No. 063-6507

Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
401 Oberlin Road, Suite 150
Raleigh, North Carolina 27605
919-508-8507

Received
APR 2007
Solid Waste Section

Attention: Mr. Ed Mussler
Branch Head

**Re: WCA of High Point C&DLandfill,
Permit No. 41-16
Guilford County, North Carolina**

Dear Ed,

On behalf of WCA of High Point, LLC, Golder Associates NC, Inc., (Golder) is submitting three copies of the Application for Permit to Construct for Phase 2 of the WCA of High Point C&D Landfill, Permit No. 41-16. The Application was prepared on behalf of WCA of High Point, LLC, in accordance with the North Carolina Solid Waste Management Rules, 15A NCAC 13B, Section .0531, et seq. The purpose of the Application is to demonstrate compliance with the applicable permit application requirements so that a Permit to Construct may be issued for the proposed Phase 2 Expansion at the WCA of High Point C&D Landfill.

The Application contains information pertinent to the design and construction of an unlined landfill expansion immediately north and east of the active unit, as well as information related to operations and closure of the facility. Information related to landfill siting requirements was submitted and approved previously, and is therefore not included in the scope of this report except as may be necessary to clarify or support the design. This permit application is intended to provide the information necessary to allow the Solid Waste Section to issue a Permit to Construct for the 9.4 acre phase (Phase 2) of the expansion. The estimated operating life for Phase 2 is five years.

The application contains five sections including an Introduction, Engineering Plan, Construction Quality Assurance Plan, Operation Plan and a Closure and Post-Closure Care Plan. The Design Hydrogeologic Report is being submitted to the Department under a separate cover.

We respectfully request your thoughts and comments on this Application for Permit to Construct. If you have any questions, or need any further information, please do not hesitate to contact me at 336.852.4903.

Sincerely,
GOLDER ASSOCIATES NC, INC.

Charles Hiner, P.E.
Senior Consultant

Attachments (3)

C: Mr. Michael McFeeley, WCA

G:\Projects\WCA\High Point\Phase 2 Expansion\Application for Permit to Construct\wca phase 2 transmittal Ed Mussler.doc

APPLICATION FOR PERMIT TO CONSTRUCT WCA OF HIGH POINT CONSTRUCTION AND DEMOLITION LANDFILL PHASE 2 EXPANSION

WCA OF HIGH POINT CONSTRUCTION AND DEMOLITION LANDFILL, PERMIT NO. 41-16 GUILFORD COUNTY, NORTH CAROLINA

MARCH 2007

PREPARED FOR:

WCA

WCA OF HIGH POINT
5830 RIVERDALE DRIVE
JAMESTOWN, NORTH CAROLINA 27282

NORTH CAROLINA PROFESSIONAL SEAL 029089 ENGINEER CHARLES D. MINER

PREPARED BY:

Golder Associates

GOLDER ASSOCIATES NC INC.
4900 KOGER BOULEVARD, SUITE 140
GREENSBORO, NC 27407
PROJECT NO. 053-6526

INTRODUCTION

WCA OF HIGH POINT C&D LANDFILL
PERMIT NO 41-16
APPLICATION FOR PERMIT TO CONSTRUCT
PHASE 2 EXPANSION

INTRODUCTION

This report was prepared on behalf of WCA of High Point, LLC, in accordance with the North Carolina Solid Waste Management Rules, 15A NCAC 13B, Section .0531, et seq. The purpose of this report is to demonstrate compliance with the applicable permit application requirements so that a Permit to Construct may be issued for the proposed Phase 2 Expansion at the WCA of High Point C&D Landfill.

The WCA of High Point C&D Landfill is owned and operated by WCA of High Point, LLC. The facility is currently operating under North Carolina Solid Waste Permit No. 41-16. Based on the current waste stream and a capacity analysis performed by WCA in November 2006 the life of the existing Phase 1 area is projected to extend into 2008. In order for WCA of High Point to continue operating, a new permitted area within the facility is needed for waste disposal.

This report contains information pertinent to the design and construction of an unlined landfill expansion immediately north and east of the active unit, as well as information related to operations and closure of the facility. Information related to landfill siting requirements was submitted and approved previously, and is therefore not included in the scope of this report except as may be necessary to clarify or support the design. This permit application is intended to provide the information necessary to allow the Solid Waste Section to issue a Permit to Construct for the 9.4 acre phase (Phase 2) of the expansion. The estimated operating life for Phase 2 is five years.

This application contains six sections as follows:

- **Introduction**
- **Engineering Plan**
- **Construction Quality Assurance Plan**
- **Operation Plan**
- **Closure and Post-Closure Care Plan and**
- **Design Hydrogeologic Report**

Each section contains tables, figures, drawings and appendices specific to its content. These are provided at the end of each of the six sections behind identifying tabs. There are three sets of drawings referenced in the report: the Engineering Plan drawings (EP-1, EP-2, etc.); Operation Plan drawings (OP-1, OP-2, etc.); and Design Hydrogeologic Report drawings (DH-1, DH-2, etc.). These drawings are included in pockets in the binder.

WCA of High Point C&D Landfill
Application for Permit to Construct
Phase 2 Expansion

TABLE OF CONTENTS

WCA of High Point C&D Landfill
Application for Permit to Construct
Phase 2 Expansion

CONSTRUCTION QUALITY ASSURANCE PLAN

OPERATION PLAN

CLOSURE AND POST-CLOSURE CARE PLAN

ENGINEERING PLAN

ENGINEERING PLAN

WCA OF HIGH POINT
CONSTRUCTION AND DEMOLITION LANDFILL
PHASE 2 EXPANSION
PERMIT NO. 41-16
GUILFORD COUNTY, NORTH CAROLINA

Prepared for:

WCA of High Point, LLC
5830 Riverdale Drive
Jamestown, North Carolina 27282

Prepared by:

Golder Associates NC Inc.
4900 Koger Boulevard, Suite 140
Greensboro, North Carolina 27407

March 2007

Project No.: 063-6562

TABLE OF CONTENTS

STATEMENT OF COMPLIANCE WITH ENGINEERING PLAN REQUIREMENTS

This Engineering Plan has been prepared by a Professional Engineer licensed to practice engineering in accordance with N.C.G.S. 89C and the Administrative Rules developed there under. It is our opinion that the design described in this Engineering Plan meets the intent of the requirements of 15A NCAC 13B .0539 of the Solid Waste Management Rules.

Respectfully Submitted
GOLDER ASSOCIATES NC, INC

NORTH CAROLINA
PROFESSIONAL
SEAL
029089
ENGINEER
CHARLES D. HINER

Charles Hiner, P.E.
Senior Engineer

1.0 INTRODUCTION

This Engineering Plan incorporates the detailed plans and specifications relative to the design and performance of the Phase 2 Expansion of the WCA of High Point C&D Landfill. The facility is located along the eastern border of the City of High Point, along the west side of Riverdale Drive, SR 1145, in southern Guilford County, North Carolina. The C&D landfill facility property consists of approximately 154 acres, of which 49.2 acres will be used for C&D waste disposal. The proposed Phase 2 Expansion is located immediately adjacent to the northern and eastern limits of the first five year phase developed at the site and includes a 9.4 acre disposal cell.

2.0 OVERVIEW OF THE FACILITY DESIGN

This Engineering Plan is submitted in accordance with Rules .0535 and .0539 of the North Carolina Solid Waste Management Rules, 15A NCAC 13B, and contains detailed design information for the Phase 2 Expansion of the WCA of High Point C&D Landfill. The design has been prepared in accordance with the applicable Solid Waste Management Rules. Base grades proposed for the Phase 2 Expansion include in-situ soils and structural fill. No liner or leachate collection system is proposed for the expansion. The facility will be capped with a soil vegetative/protective layer; a gas collection layer; and either a minimum 18 inch soil cap or an alternate 40 mil FML geomembrane cap with an overlying drainage collection layer. As part of the facility closure, passive gas vents will be installed at a minimum of one vent per two acres of waste footprint.

The proposed design is detailed in the following sections of this report and is illustrated by a set of drawings that accompany this report. The drawings include the following:

Drawing No.	Drawing Name
Drawing No. EP-0	Cover Sheet
Drawing No. EP-1	Existing Conditions Plan
Drawing No. EP-2	Grading Plan: Top of Subgrade
Drawing No. EP-3	Grading Plan: Final Grading Plan
Drawing No. EP-4	Erosion and Sediment Control
Drawing No. EP-5	Environmental Monitoring Plan
Drawing No. EP-6	Cross Sections
Drawing No. EP-7	Final Cover and Miscellaneous Details
Drawing No. EP-8	Erosion and Sediment Control Details, Sheet 1 of 3
Drawing No. EP-9	Erosion and Sediment Control Details, Sheet 2 of 3
Drawing No. EP-10	Erosion and Sediment Control Details, Sheet 3 of 3

The drawings and this text describe the proposed design for the purpose of obtaining a Permit to Construct. Prior to construction, detailed construction drawings, technical specifications, and contract documents will be prepared to solicit construction bids.

3.0 ANALYSIS OF FACILITY DESIGN

3.1 Base Grade and Foundation

The subgrade of the proposed landfill consists of the underlying native soils and controlled fill components (berms and embankments). The underlying in-situ materials that will serve as the foundation for the landfill include saprolitic silty sands and clayey sands. Structural fill will be placed in uniform lifts and compacted to within 95% of the soil's maximum dry density as determined by a Standard Proctor Test. The proposed base grades are shown on Drawing No. EP-2. The density and moisture content of any structural fill placed will be tested in accordance with the requirements of the Construction Quality Assurance (CQA) Plan. A land surveyor licensed in the State of North Carolina will verify that the dimensions and elevations of the base grades are in accordance with the approved plans. Technical specifications, included in Appendix EP-1, provide more detailed information about subgrade and base grade preparation and earthwork, along with other aspects of landfill construction.

Settlement and bearing capacity analyses have been conducted to demonstrate that the subgrade will support the loads of the landfill and maintain the integrity of the landfill's structural components. The anticipated maximum total settlement is estimated to be 0.09 feet, and the maximum differential settlement is estimated to be 0.06%. Base grades have been designed to account for anticipated settlements and still maintain acceptable slopes. Supporting calculations are included in Appendix EP-2.

The bearing capacity of the subgrade was evaluated by determining the factor of safety for a deep rotational failure through the underlying subgrade. The results of the stability analysis indicate a minimum factor of safety of 2.35 in the static condition. The facility is located in a seismic zone; the maximum horizontal acceleration in bedrock (90% probability of not being exceeded in 250 years) was estimated to be 0.11 g. The results of the dynamic stability analysis indicate a minimum factor of safety of 1.66. Therefore, we anticipate that the subgrade will support the proposed landfill. Supporting calculations are in Appendix EP-2.

3.2 Vertical Separation

Phase 2 is designed to maintain a minimum four foot separation between the post-settlement bottom elevation of waste and either the seasonal high ground-water table or the bedrock datum plane contours established in the Design Hydrogeological Report prepared in accordance with Paragraph (b) of Rule .0538, whichever is higher. Insitu soils making up the separation are typically silty SAND (SM) or sandy SILT (MH). The design vertical separation is illustrated on cross sections detailing proposed base grades, the seasonal high groundwater table, and the top of bedrock (see Drawing No EP-6).

3.3 Final Cover System

Final grading contours are shown on Drawing No. EP-3. These contours have been designed with post-settlement surface slopes of at least five percent on the top of the cell. Areas that are at final grades (out board side slope areas), may be capped prior to the completion of filling the landfill. Cross-sectional details of the proposed closure cap and an alternative cap design are provided on

Drawing No. EP-7. The following components are proposed from bottom to top as shown on the details (Drawing No. EP-7):

a. Intermediate Cover and Leveling Course – Local soil will be placed over the monthly cover soil to provide at least 12 inches of intermediate cover and a uniform base for construction of the cap.

b. Gas Migration Layer – A geonet composite will be installed between the intermediate cover and the overlying infiltration layer. The geonet composite will provide a pathway for accumulated gas to move laterally and then upward through the vents at the landfill surface.

c. Infiltration Layer: Clay Component – The infiltration layer will consist of 18 inches of compacted soil with a permeability no greater than 1.0×10^{-5} cm/sec. The permeability requirement will be achieved using laboratory test data for borrow soil material and construction specifications developed prior to construction. Installation and testing requirements for the cap are provided in the technical specifications (Appendix EP-1) and the CQA Plan.

d. Alternate Cap Infiltration Layer: Geomembrane Component – A geomembrane cap is proposed as an alternate to a soil cap. Equivalency of the proposed geosynthetic cap to the regulatory minimum soil cap is included in Appendix EP-3. The demonstration is intended to show equivalency to the standard cap design, as required by Rule .0543(c)(3)(A).

   If this alternate is used to cap the facility, the geomembrane component of the infiltration layer will consist of a dual textured 40 mil flexible geomembrane (LLDPE). The geomembrane will be in direct contact with the underlying layer. The testing program and quality assurance requirements for the geomembrane are described in the CQA Plan.

e. Alternate Cap Drainage Layer – A geomembrane cap is proposed as an alternate to a soil cap. If the geosynthetic alternate is used, a geosynthetic drainage layer consisting of a geonet and geotextile composite will be placed over the geomembrane to promote drainage.

f. Protective Layer – A layer consisting of at least 12 inches of local soil will be placed above the compacted soil infiltration barrier or, if an alternate cap is constructed, the drainage layer to provide a protective cover for the underlying cap components. Compaction of the protective layer will be limited to about 90 percent of the Standard Proctor maximum dry density so that the vegetation can develop a strong root system, and to avoid damage to the synthetic components below.

g. Erosion/Vegetative Layer – A layer of topsoil material or organically amended local soil will be placed above the protective layer. This soil layer will be at least 6 inches in thickness. The topsoil material will be lightly compacted so that a good stand of vegetation can be established. Soil tests may be conducted prior to seeding to determine if soil additives are needed to establish and maintain the vegetation.

h. Vegetation – After placement of the erosion layer, the area will be seeded. Seeding will be accomplished in accordance with the "North Carolina Erosion and Sediment Control Planning and Design Manual," and recommendations from the Guilford County Agricultural Extension Office. Mulch and erosion matting will be used, as needed, to control erosion and promote vegetative growth. The vegetative cover will be inspected regularly during the post-closure period. Areas found during inspections to be sparsely covered will be revegetated and mulched.

The stability of the cap system was evaluated under static conditions by examining potential rotational failure surfaces through the exterior slopes, and, when appropriate, veneer failure, and tension in the geosynthetic cap components. Calculations for these analyses are found in Appendix EP-2. These analyses indicate that the proposed cap systems will be stable under design static conditions.

The results of the stability analyses indicate that the proposed landfill cap will be stable under the design static loadings. Certain minimum physical properties were assumed, including interface friction angles and soil properties. Laboratory testing of actual materials proposed for use in constructing the cap will be completed prior to their use to verify that the materials meet the specified parameters for stability.

Additional information on the design, construction, maintenance, and probable cost of the final cover system can be found in the Closure and Post-Closure Plan.

3.4 Erosion and Sediment Control

The storm water management plan detailing the erosion and sediment control features is shown on Drawing No. EP-4. Supporting calculations are provided in Appendix EP-4. A project specific erosion and sediment control plan will be submitted to the North Carolina Department of Environment and Natural Resources, Division of Land Quality for approval prior to construction.

4.0 TECHNICAL REFERENCES

American Society of Civil Engineers. Seminar on Waste Containment and Final Closure Systems Reference Manual (1995).

Joyce Engineering. Site Application, MRR of High Point, LLC, Construction and Demolition Debris. Last Revised April 2003

Joyce Engineering. Construction Plan Application, MRR of High Point, LLC, Construction and Demolition Debris. Last Revised April 2003

Koerner, Robert M., Designing with Geosynthetics. Third Edition, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1994.

Koerner, Robert M. and Hwu, B.L., "Stability and Tension considerations Regarding Cover Soils and Geomembrane Lined Slopes," Journal of Geotextiles and Geomembranes, 1991.

Landva, A.O., et. al, Geotechnics of Waste Fills - Theory and Practice; ASTM STP 1070, American Society for Testing and Materials, 1990.

McBean, Edward A. et al, Solid Waste Landfill Engineering and Design, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1995.

North Carolina Sedimentation Control Commission, North Carolina Department of Environmental and Natural Resources, and the Division of Land Resources – Land Quality Section, Erosion and Sediment Control Planning and Design Manual. June 1, 2006.

Richardson, G.N, et al., RCRA Subtitle D (258) Seismic Guidance for Municipal Solid Waste Landfill Facilities, EPA Publication EPA/600/R-95/051, 1995.

Schroeder, P. R., Aziz, N. M., Lloyd, C. M. and Zappi, P. A. (1994). "The Hydrologic Evaluation of Landfill Performance (HELP) Model: User's Guide for Version 3," EPA/600/R-94/168a, September 1994, U.S. Environmental Protection Agency Office of Research and Development, Washington, DC.

Soil Mechanics, Design Manual 7.01 Revalidated by Change 1, Naval Facilities Engineering Command, Alexandria, Virginia, September 1986.

Tan, Chia K. et al, Engineering Manual for Shallow Foundations, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1991.

United States Soil Conservation Service, Technical Release 55: Urban Hydrology for Small Watersheds, June 1986.

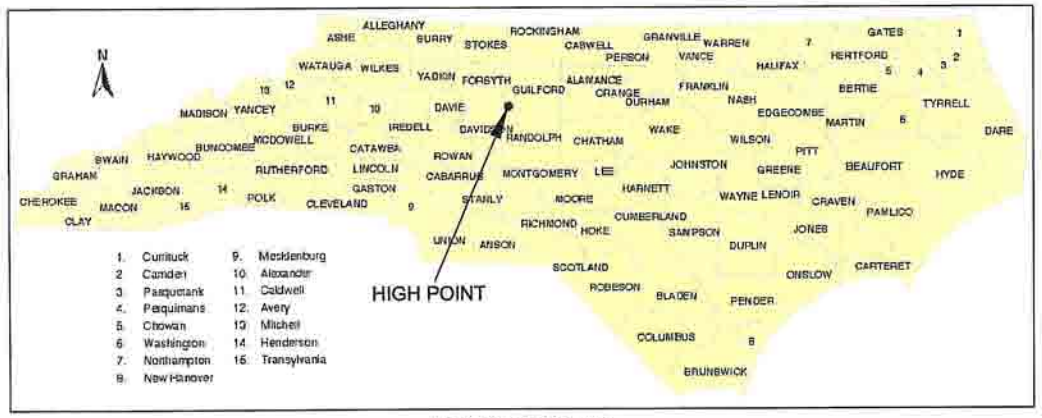
DRAWINGS

WCA OF HIGH POINT C&D LANDFILL

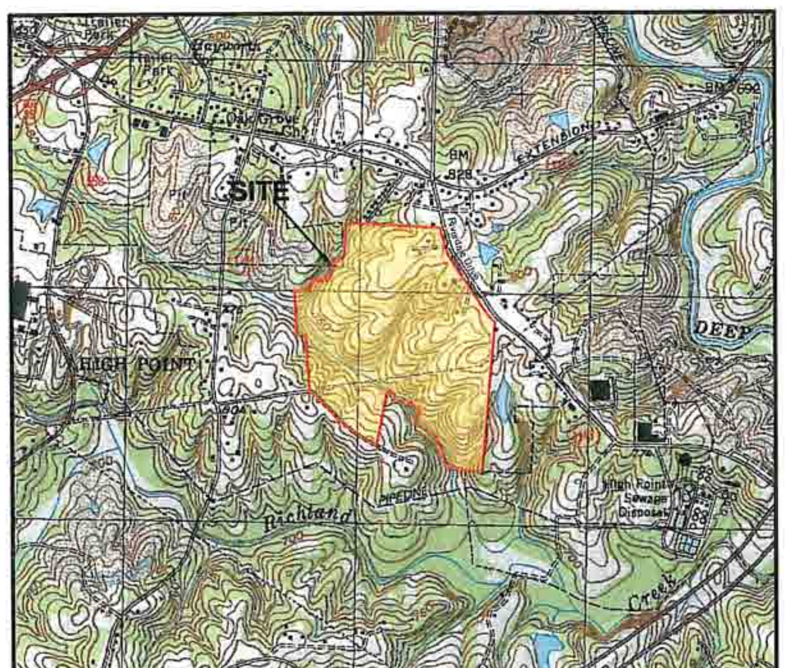
GUILFORD COUNTY, NORTH CAROLINA

APPLICATION FOR PERMIT TO CONSTRUCT PHASE 2 EXPANSION

ENGINEERING PLAN

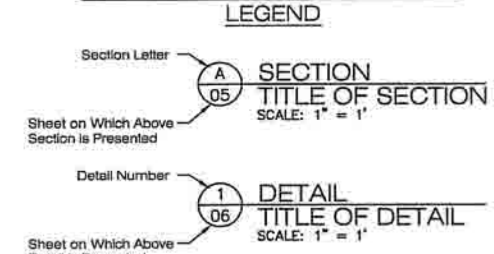


NORTH CAROLINA
COUNTY LOCATION MAP



VICINITY MAP
NOT TO SCALE

SATELLITE IMAGE
1" = 500'



NOTES: ABOVE REFERENCING SYSTEM ALSO APPLIES TO PLAN IDENTIFICATIONS.

DRAWING NO.	DESCRIPTION
EP-0	COVER SHEET
EP-1	EXISTING CONDITIONS PLAN
EP-2	GRADING PLAN: TOP OF SUBGRADE
EP-3	GRADING PLAN: FINAL GRADING PLAN
EP-4	EROSION AND SEDIMENT CONTROL
EP-5	ENVIRONMENTAL MONITORING PLAN
EP-6	CROSS SECTIONS
EP-7	FINAL COVER AND MISCELLANEOUS DETAILS
EP-8	EROSION AND SEDIMENT CONTROL DETAILS SHEET 1 OF 3
EP-9	EROSION AND SEDIMENT CONTROL DETAILS SHEET 2 OF 3
EP-10	EROSION AND SEDIMENT CONTROL DETAILS SHEET 3 OF 3

PREPARED BY:

Golder Associates
Greensboro, NC

Golder Associates
Greensboro, NC

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE
COVER SHEET

PROJECT No.		063-6526
FILE No.		
REV. 1	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. EP-0

LEGEND

EXISTING 10 FT. CONTOUR	
EXISTING 2 FT. CONTOUR	
PROPERTY LINE	
STREAM	
TREELINE	
EXISTING ROAD	
LIMIT OF WASTE (PERMITTED)	
MONITORING WELL LOCATION IDENTIFICATION	MW-3
SPRINGHEAD LOCATION AND IDENTIFICATION	SPRINGHEAD
BENCH MARK	BM-1
SEDIMENT BASIN	SB-1

NOTE:

1. DRAWING BASED ON SITE PLAN PREPARED BY JOYCE ENGINEERING, INC. DATED JULY 7, 2004.
2. BASE DIGITAL MAPPING WITHIN THE BOUNDARY SHOWN BY SPATIAL DATA CONSULTANTS INC. DATE OF AERIAL FLYOVER 3/27/01.
3. DIGITAL MAPPING OUTSIDE BOUNDARY PROVIDED BY THE CITY OF HIGH POINT DEPARTMENT OF PLANNING AND DEVELOPMENT. DATE OF AERIAL FLYOVER 1998.
4. EXISTING CONDITIONS SHOW PHASE 1 FILLED TO PERMITTED GRADES.

Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE
EXISTING CONDITIONS PLAN

PROJECT No.		063-6526
FILE No.		
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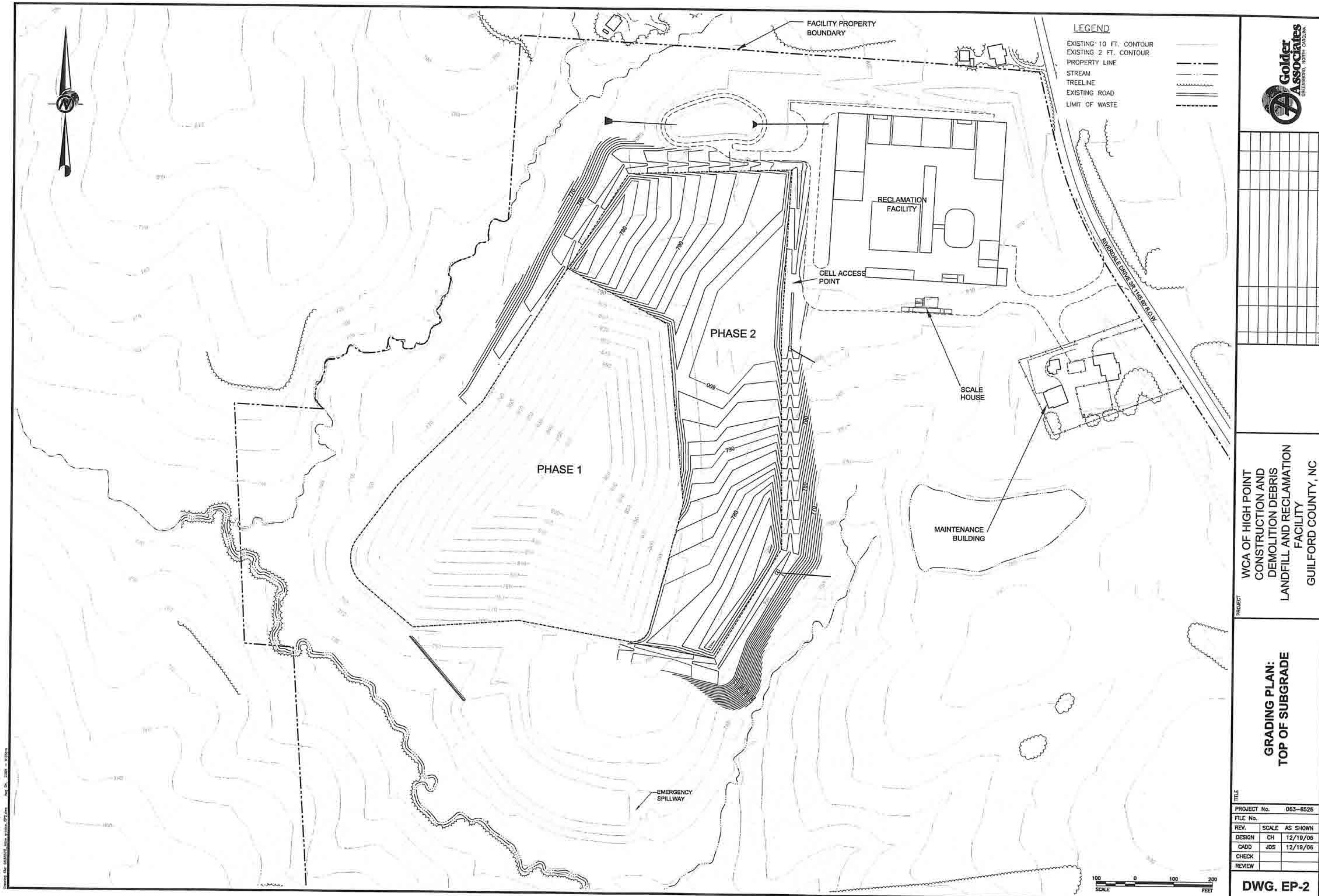
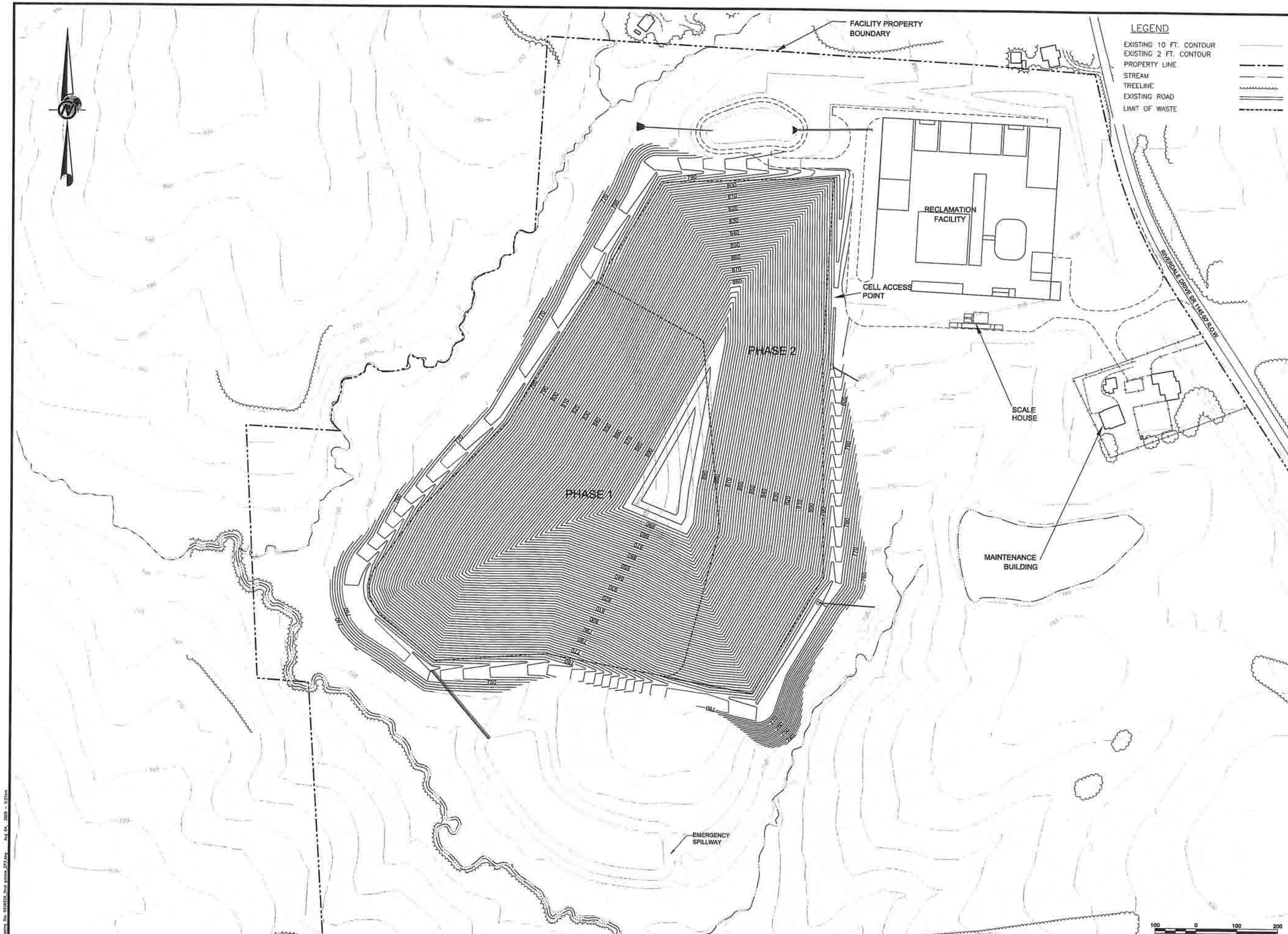
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. EP-1


FACILITY PROPERTY BOUNDARY
LEGEND
EXISTING 10 FT. CONTOUR
EXISTING 2 FT. CONTOUR
PROPERTY LINE
STREAM
TREELINE
EXISTING ROAD
LIMIT OF WASTE
Golder Associates
GREENSBORO, NORTH CAROLINA
REV
DATE
DES
REVISION DESCRIPTION
CADD
CHK
RVW
RECLAMATION FACILITY
CELL ACCESS POINT
SCALE HOUSE
RIVERDALE DRIVE SR 1145 60' R.O.W.
PHASE 2
PHASE 1
MAINTENANCE BUILDING
EMERGENCY SPILLWAY
PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC
TITLE
GRADING PLAN:
TOP OF SUBGRADE
PROJECT No. 063-6526
FILE No.
REV.
SCALE AS SHOWN
DESIGN CH 12/19/06
CADD JDS 12/19/06
CHECK
REVIEW
100 0 100 200
SCALE FEET
DWG. EP-2



GRADING PLAN:
FINAL GRADING PLAN

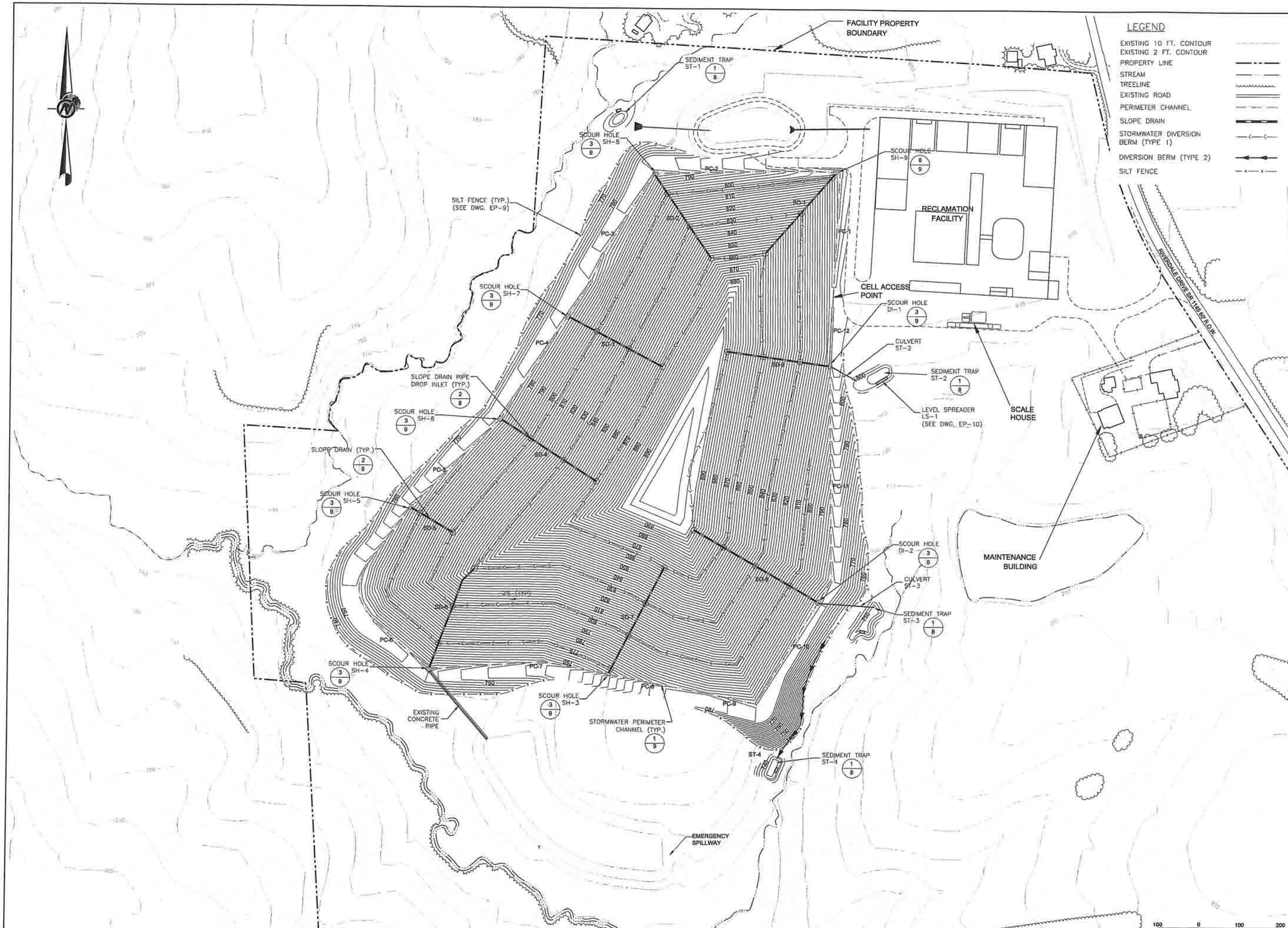
PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT No.		063-6526
FILE No.		
REV.	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. EP-3



Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE
EROSION AND SEDIMENT
CONTROL

PROJECT No.		063-6526
FILE No.		
REV.	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. EP-4

LEGEND

EXISTING 10 FT. CONTOUR	
EXISTING 2 FT. CONTOUR	
PROPERTY LINE	
STREAM	
TREELINE	
EXISTING ROAD	
LIMIT OF WASTE (PERMITTED)	
MONITORING WELL LOCATION IDENTIFICATION	MW-3
SPRINGHEAD LOCATION AND IDENTIFICATION	SPRINGHEAD
PROPOSED LFG MONITORING WELL LOCATION	MM-1
BENCH MARK	BM-1
SEDIMENT BASIN	SB-1

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4. EXISTING CONDITIONS SHOW PHASE 1 FILLED TO PERMITTED GRADES.

Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

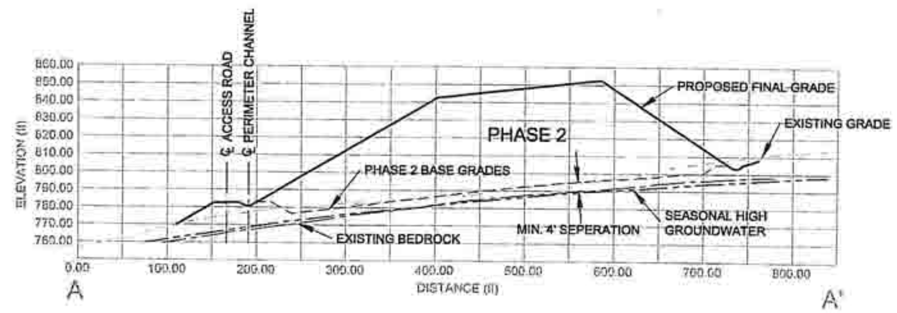
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE

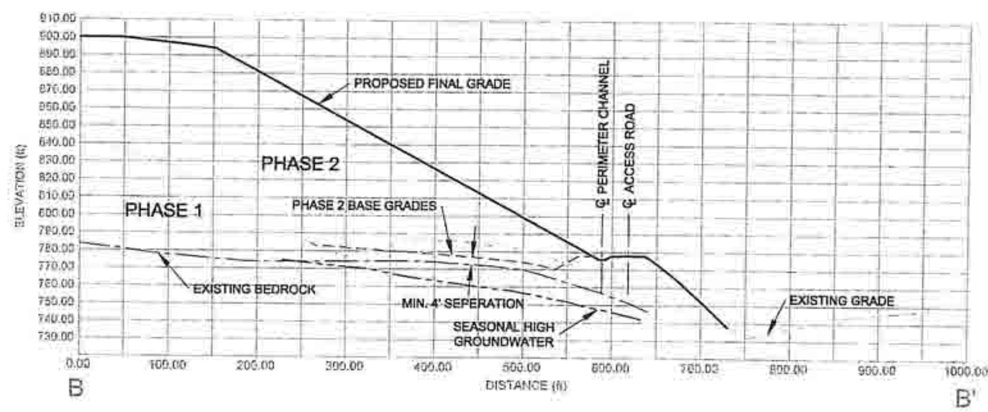
ENVIRONMENTAL MONITORING PLAN

PROJECT No.		063-6526
FILE No.		
REV.	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. EP-5



A CROSS SECTION A-A'



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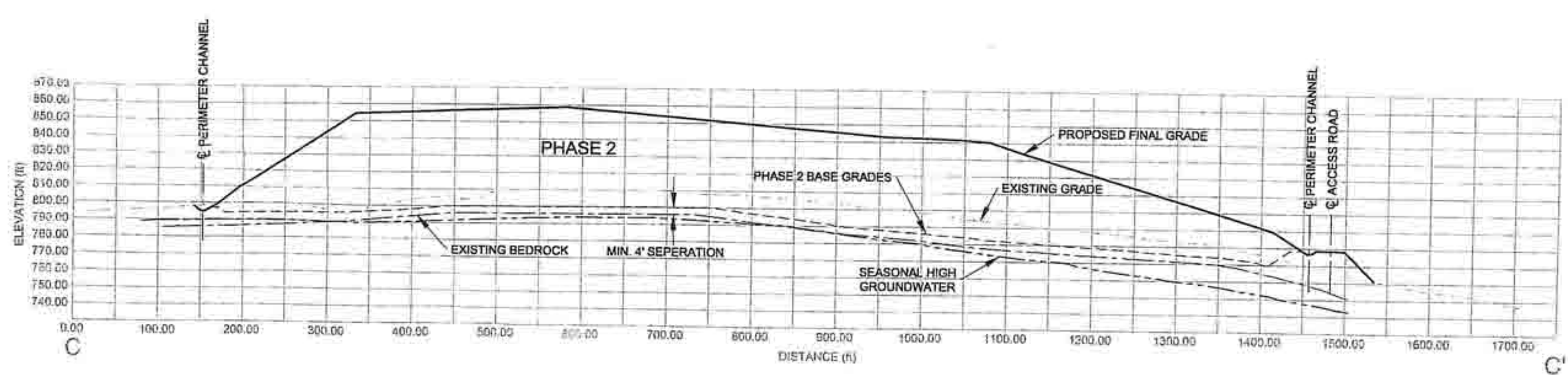
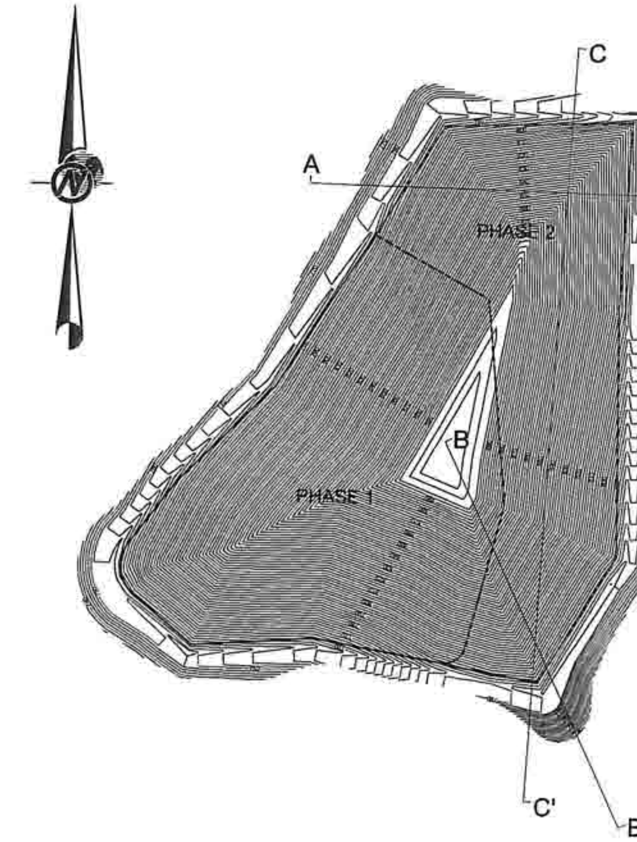


C CROSS SECTION C-C'



200 0 200 400
SCALE FEET

VERTICAL SCALE 50 0 50 100 FEET

HORIZONTAL SCALE 100 0 100 200 FEET

Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

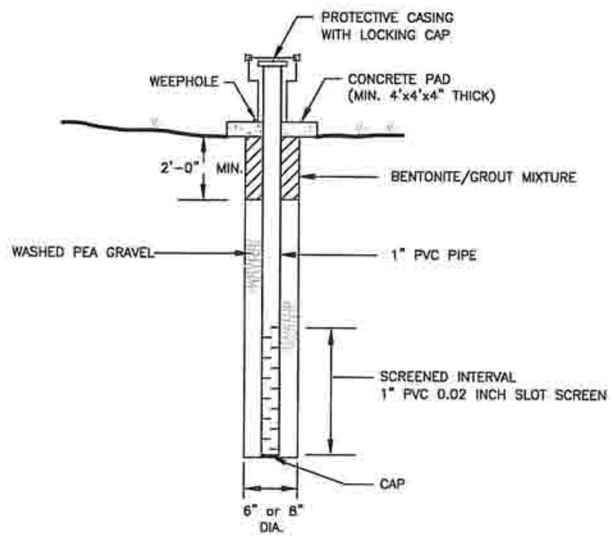
WCA OF HIGH POINT CONSTRUCTION AND DEMOLITION DEBRIS LANDFILL AND RECLAMATION FACILITY
GUILFORD COUNTY, NC

TITLE

CROSS SECTIONS

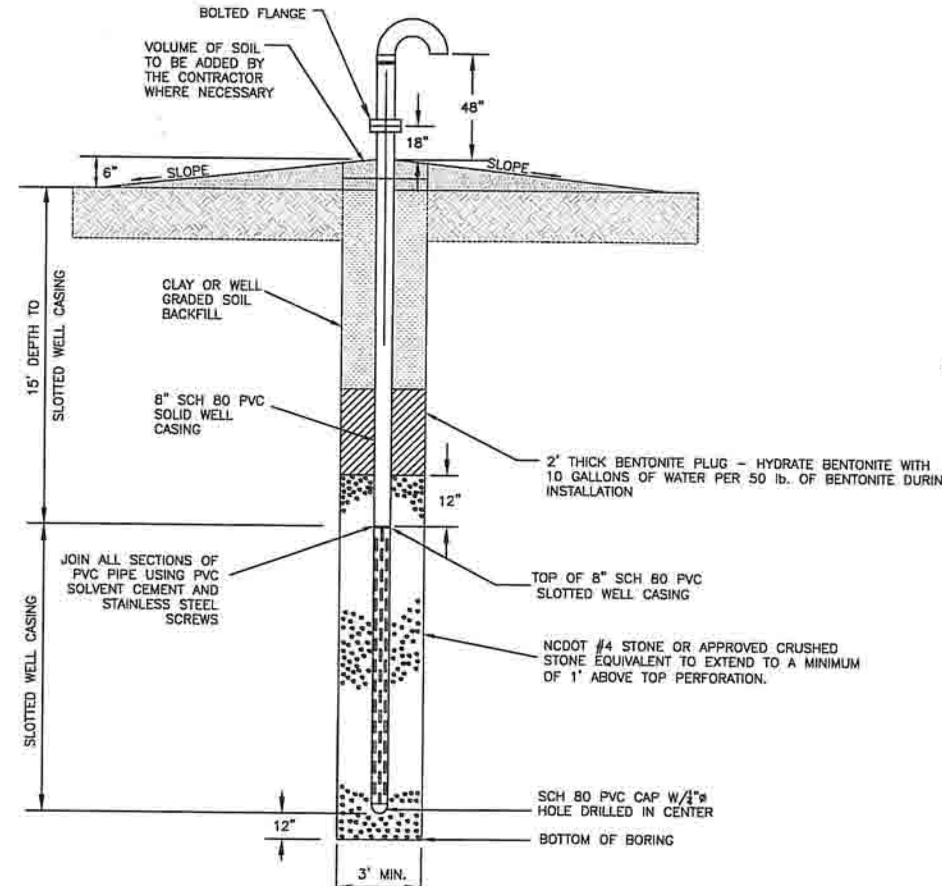
PROJECT No.		063-6526
FILE No.		
REV.	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. EP-6



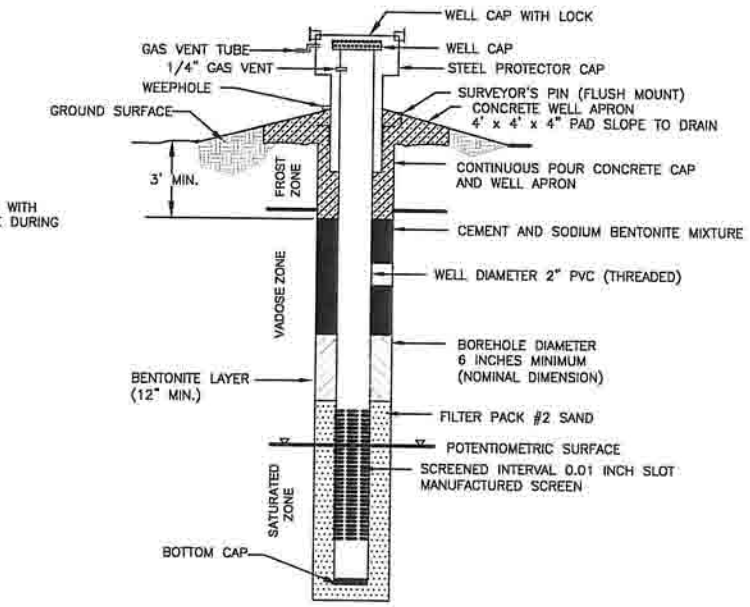
METHANE GAS MONITORING WELL (TYPICAL)

NOT TO SCALE



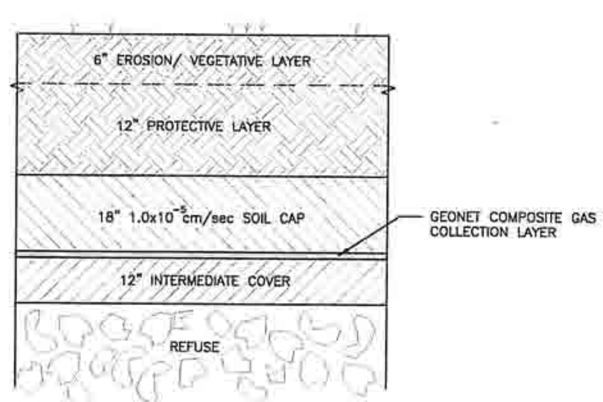
PASSIVE GAS VENT (TYPICAL)

NOT TO SCALE



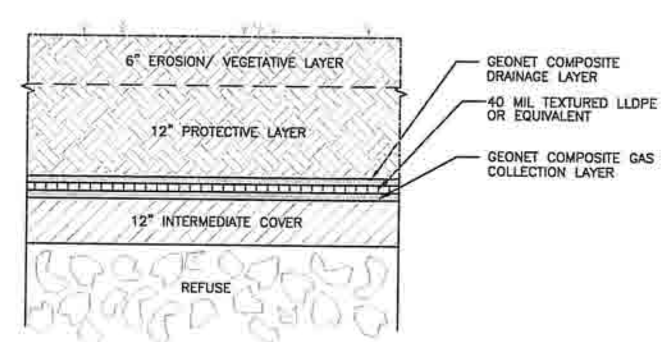
GROUND WATER MONITORING WELL (TYPICAL)

NOT TO SCALE



FINAL COVER SYSTEM (TYPICAL)

NOT TO SCALE



ALTERNATE FINAL COVER SYSTEM (TYPICAL)

NOT TO SCALE

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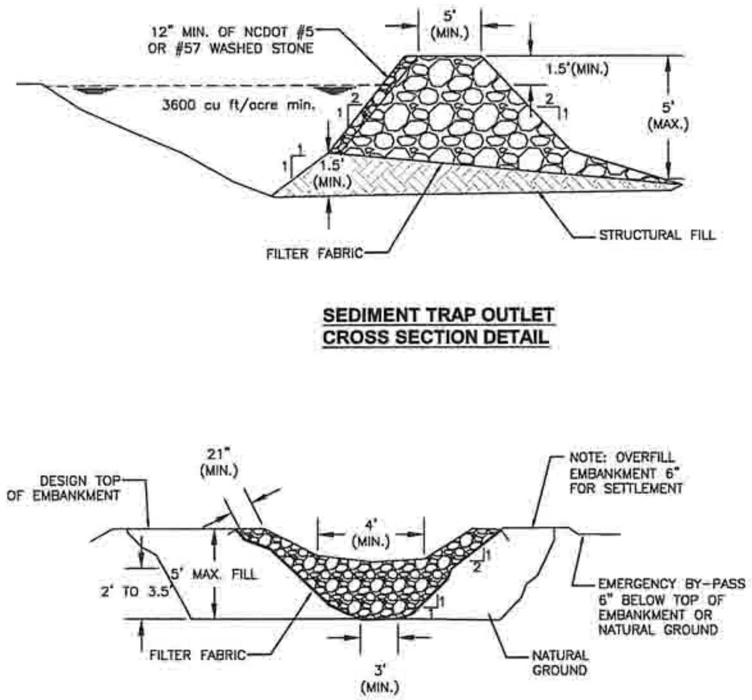
REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE
FINAL COVER AND
MISCELLANEOUS DETAILS

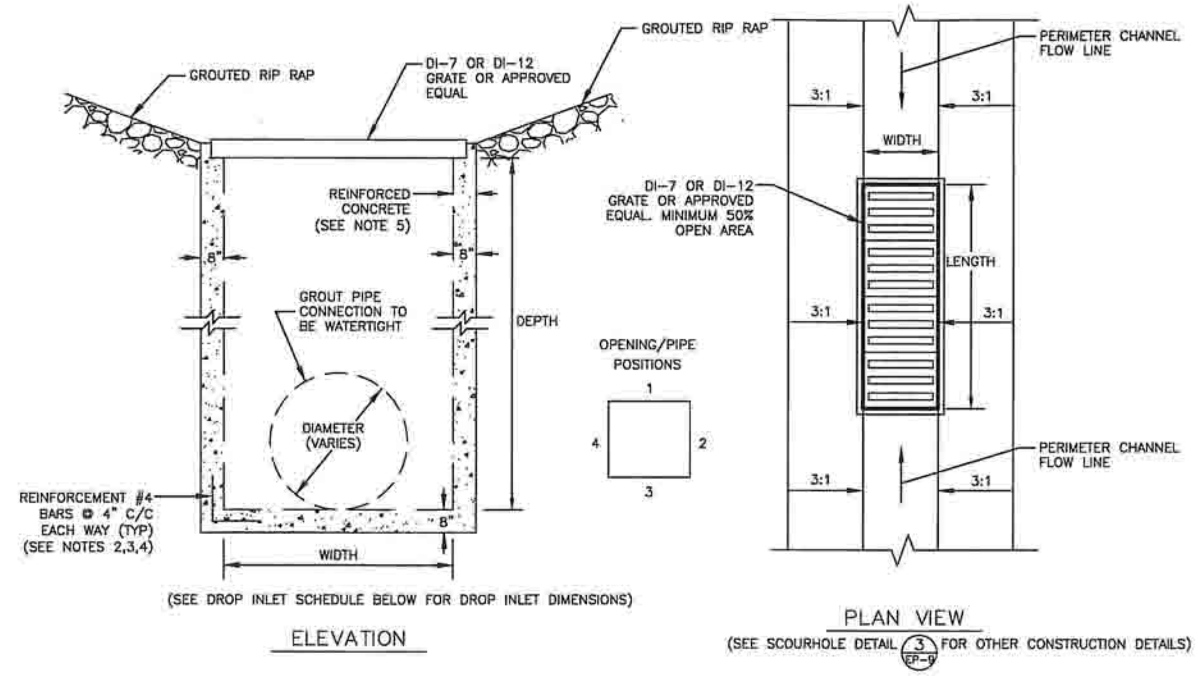
PROJECT No.		063-6526
FILE No.		0636526A07
REV.	SCALE	AS SHOWN
DESIGN	DYR	12/19/06
CADD	JCB	12/19/06
CHECK		
REVIEW		

DWG. EP-7



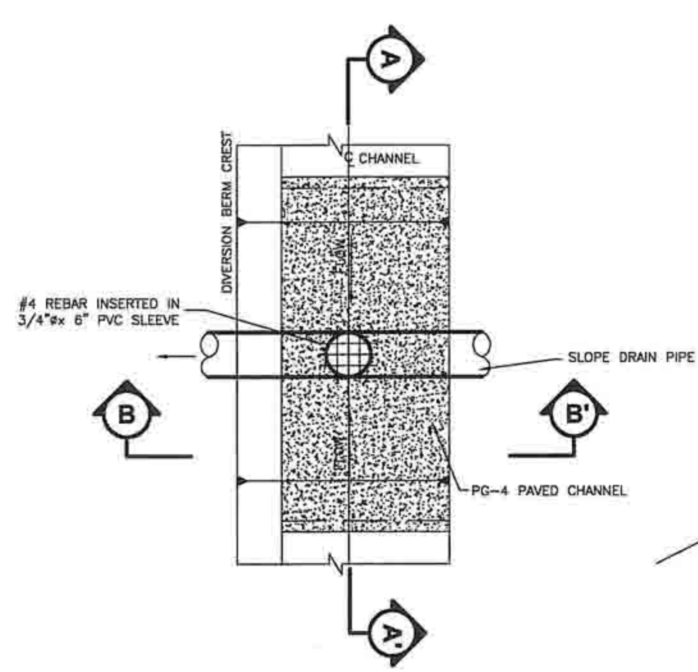
1 EP-8 SEDIMENT TRAP OUTLET PROFILE VIEW DETAIL

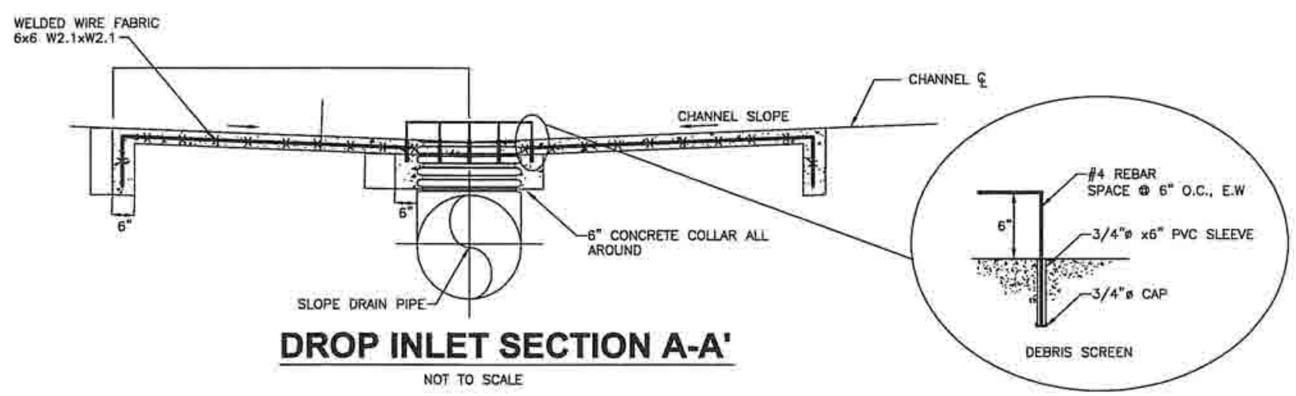
NOT TO SCALE



3 EP-8 DROP INLET DETAIL

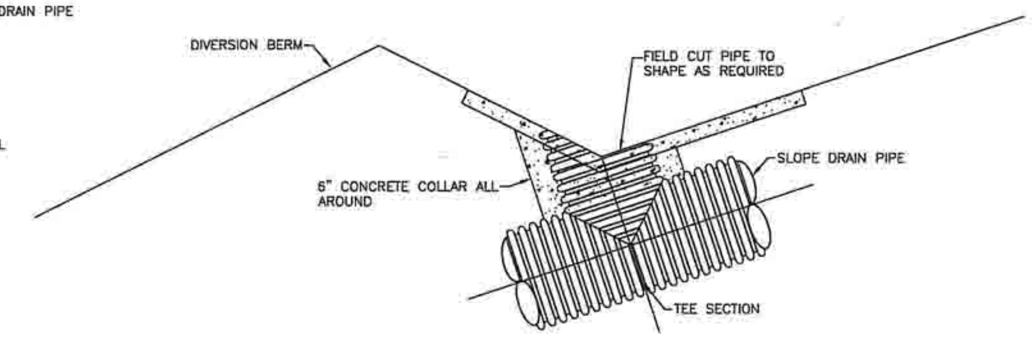
NOT TO SCALE





DROP INLET SECTION A-A'

NOT TO SCALE



DROP INLET SECTION B-B'

NOT TO SCALE

NOTE: DEBRIS SCREEN NOT SHOWN FOR CLARITY

2 EP-8 SLOPE DRAIN DROP INLET

NOT TO SCALE

DROP INLET SCHEDULE

DROP INLET I.D.	WIDTH	LENGTH	DEPTH	TOP OPENING L x W, FT	# OF GRATES (1)	POSITION OF OUTLET PIPE	OUTLET PIPE SIZE(S)
DI-SH-1	3.4'	3'	4.5'	3 x 3.4	1	2	1 - 24"
DI-SH-2	3.4'	3'	8.0'	3 x 3.4	1	2	1 - 24"

NOTES

1. NUMBER OF GRATES IS FOR DI-7. MINIMUM OPEN AREA 59%.
2. REINFORCING BARS SHALL BE DEFORMED STEEL, MIN.. YIELD STRENGTH 60 KSI.
3. PRE-CAST DROP INLET SECTION MAY BE SUBSTITUTED UPON APPROVAL BY ENGINEER.
4. MINIMUM CONCRETE COVER OVER STEEL REINFORCING IS 1.5"
5. CONCRETE SHALL BE MINIMUM 3,000 PSI @28 DAYS.

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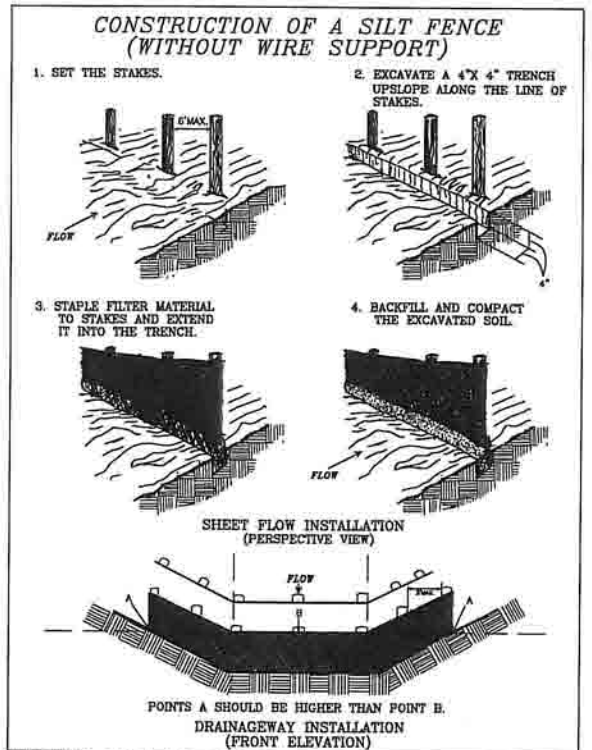
REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
WCA OF HIGH POINT CONSTRUCTION AND DEMOLITION DEBRIS LANDFILL AND RECLAMATION FACILITY
GUILFORD COUNTY, NC

TITLE
EROSION AND SEDIMENT CONTROL DETAILS
SHEET 1 OF 3

PROJECT No.		063-6526
FILE No.		0636526A EP-08
REV. 0	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	OSY	12/19/06
CHECK		
REVIEW		

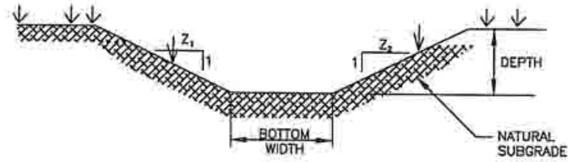
DWG. EP-8



SOURCE: Adapted from Installation of Straw and Fabric Filter Barriers for Sediment Control, Sherwood and Wyant — PLATE 3.05-2

SILT FENCE DETAIL (TYPICAL)

NOT TO SCALE



1 / EP-9 STORMWATER PERIMETER CHANNEL SECTIONS

NOT TO SCALE

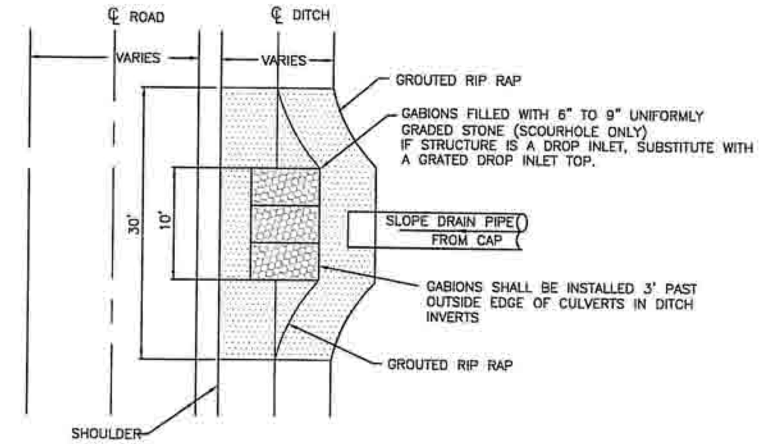
STORMWATER PERIMETER CHANNEL SCHEDULE

CHANNEL No.	CHANNEL LINING	CHANNEL SHAPE	BOTTOM WIDTH (FT.)	DEPTH (FT.)	SIDE SLOPES (Z) Z_1	Z_2
PC-1	GRASS	TRAPEZOID	5	3	3	3
PC-2	GRASS	TRAPEZOID	5	3	3	3
PC-3	GRASS	TRAPEZOID	5	3	3	3
PC-4	GRASS	TRAPEZOID	3	3	3	3
PC-5	GRASS-P	TRAPEZOID	3	3	3	3
PC-6	GRASS-P	TRAPEZOID	3	3	3	3
PC-7	GRASS-P	TRAPEZOID	3	3	3	3
PC-8	GRASS-P	TRAPEZOID	3	3	3	3
PC-9	GRASS	TRAPEZOID	5	3	3	3
PC-10	GRASS	TRAPEZOID	5	3	3	3
PC-11	GRASS-P	TRAPEZOID	5	3	3	3
PC-12	GRASS	TRAPEZOID	5	3	3	3

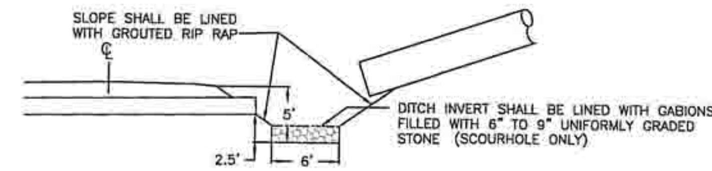
NOTES

1) GRASS-P INDICATES "PERMANENT" EROSION CONTROL MAT REQUIRED (POLYPROPYLENE NETTING/MESH; MIFAFI MIRAMAT 1800 OR EQUIVALENT)

2) GRASS - INDICATES SEEDED GRASS CHANNEL, NO ADDITIONAL EROSION CONTROL REQUIRED.



PLAN



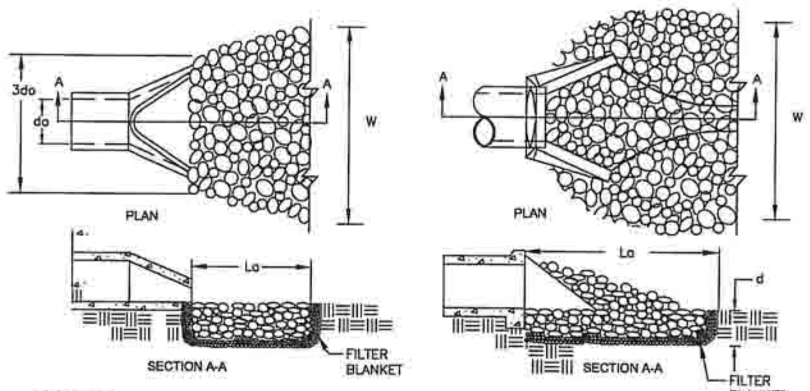
SECTION

3 / EP-9 TYPICAL SLOPE DRAIN SCOURHOLE (SH)

NOT TO SCALE

CULVERT SCHEDULE

CULVERT I.D.	QTY	LENGTH	SIZE	TYPE	INV IN	INV OUT
ST-2	1	72'	24"	CL III RCP	801.5	800.0
ST-3	1	136'	24"	CL III RCP	768.0	752.0

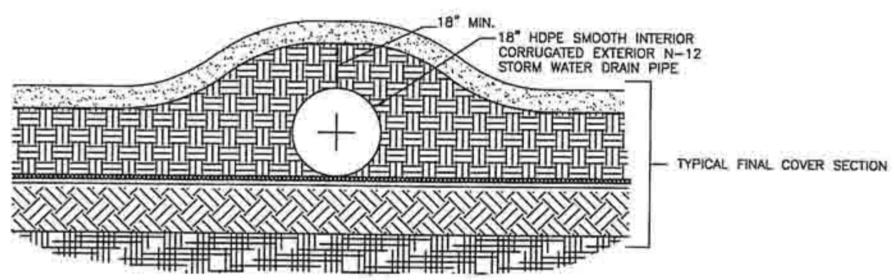


NOTES

1. La IS THE LENGTH OF THE RIP RAP APRON.
2. d=1.5 TIMES THE MAXIMUM STONE DIAMETER BUT NOT LESS THAN 6".
3. IN A WELL-DEFINED CHANNEL, EXTEND THE APRON UP IN THE CHANNEL BANKS TO AN ELEVATION OF 6" ABOVE THE MAXIMUM TAILWATER DEPTH OR TO THE TOP OF THE BANK, WHICHEVER IS LESS.
4. A FILTER BLANKET OR FILTER FABRIC SHALL BE INSTALLED BETWEEN THE RIP RAP AND SOIL FOUNDATION.

OUTLET PROTECTION (TYPICAL)

NOT TO SCALE

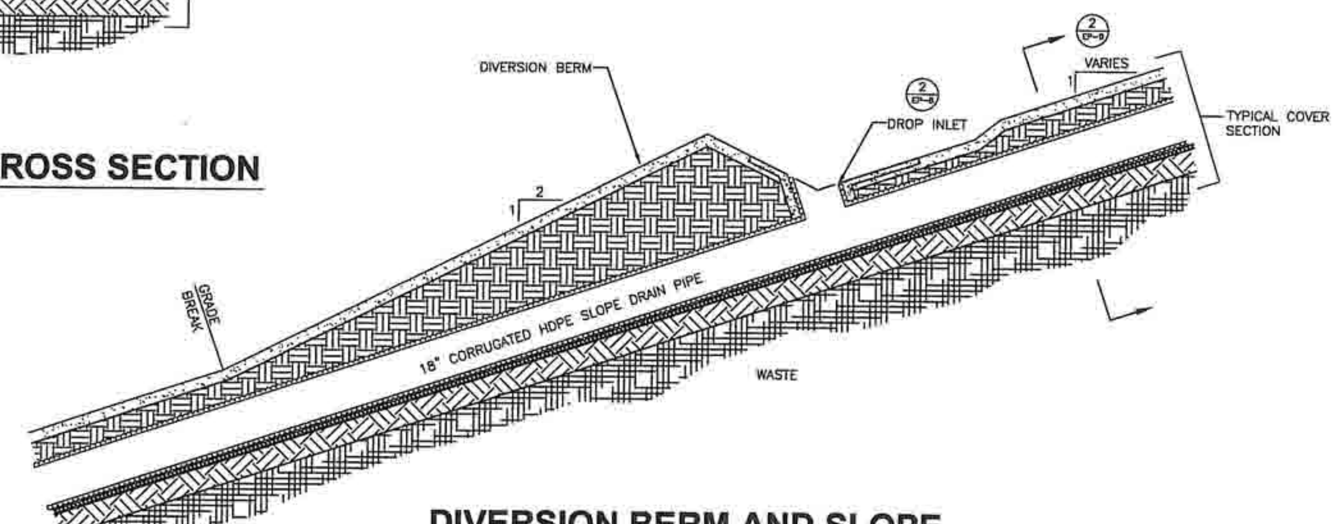


2 / EP-9 TYPICAL SLOPE DRAIN CROSS SECTION

NOT TO SCALE

OUTLET PROTECTION SCHEDULE

CULVERT I.D.	La	d	W	STONE d_{50}
ST-2	15'	12"	17'	6"
ST-3	15'	12"	17'	6"



4 / EP-9 DIVERSION BERM AND SLOPE DRAIN SECTION (TYPICAL)

NOT TO SCALE

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REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

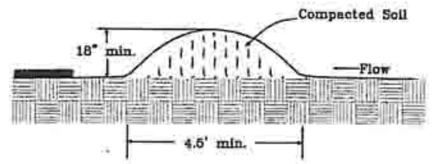
PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND DEMOLITION DEBRIS LANDFILL AND RECLAMATION FACILITY
GUILFORD COUNTY, NC

TITLE
EROSION AND SEDIMENT CONTROL DETAILS
SHEET 2 OF 3

PROJECT No.			063-6526
FILE No.			0636526A EP-09
REV. 0		SCALE	AS SHOWN
DESIGN		CH	12/19/06
CADD		JSH	12/19/06
CHECK			
REVIEW			

DWG. EP-9

TEMPORARY DIVERSION DIKE

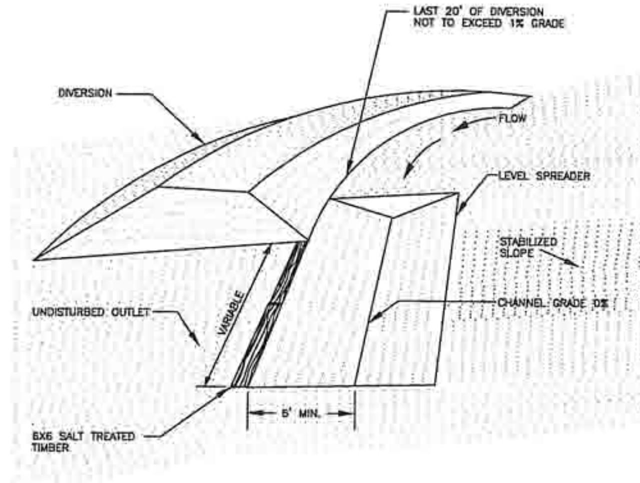


SOURCE: VA. DSWC PLATE 3.09-1

DIVERSION DIKE (TYPICAL)

NOT TO SCALE

LEVEL SPREADER



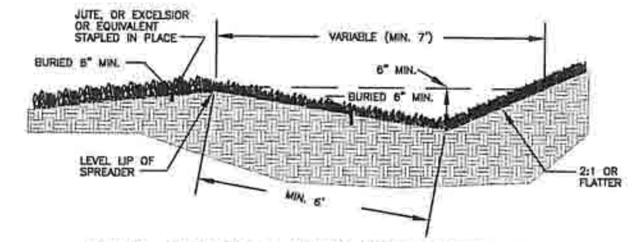
PERSPECTIVE VIEW

NOTE: ALL TEMPORARY BERMS, SWALES AND LEVEL SPREADER DITCH MUST RECEIVE TEMPORARY SEEDING IMMEDIATELY AFTER INSTALLATION

SOURCE: ADAPTED FROM N.C. Erosion and Sediment Control Planning and Design Manual PLATE: 3.21-1

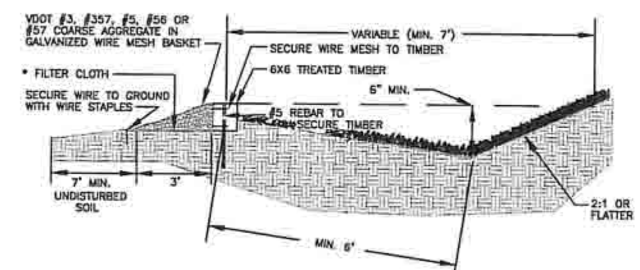
LEVEL SPREADER

CROSS SECTION



LEVEL SPREADER WITH VEGETATED LIP

CROSS SECTION



LEVEL SPREADER WITH RIGID LIP

* MIN. PHYSICAL REQUIREMENTS OF FILTER CLOTH NOTED IN STD. & SPEC. 3.19, RIPRAP

SOURCE: VA. DSWC AND N.C. Erosion and Sediment Control Planning and Design Manual PLATE: 3.21-2

LEVEL SPREADER (TYPICAL)

NOT TO SCALE

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REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND DEMOLITION DEBRIS LANDFILL AND RECLAMATION FACILITY
GUILFORD COUNTY, NC

TITLE
EROSION AND SEDIMENT CONTROL DETAILS
SHEET 3 OF 3

PROJECT No.		063-8526
FILE No.		0638526A EP-10
REV. 0	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	OSY	12/19/06
CHECK		
REVIEW		

DWG. EP-10

EP-1

SECTION 01400

QUALITY CONTROL

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. Quality Control refers to measures taken by the CONTRACTOR to achieve compliance with the requirements for materials and workmanship as stated in the Construction Plans and Specifications.

B. The CONTRACTOR shall provide quality control personnel, and shall provide and pay for all tests needed to achieve Work of specified quality.

C. The CONTRACTOR shall cooperate with the independent firm providing quality assurance services on behalf of the OWNER. The CONTRACTOR shall provide continuous access to the Work to the CQA Consultant. In addition, the CONTRACTOR shall furnish samples of materials, design mix, equipment, tools, storage, and assistance as requested.

1.02 QUALITY CONTROL OF INSTALLATION

A. It is the responsibility of the CONTRACTOR to monitor the work continuously. The CONTRACTOR shall provide quality control personnel, and shall provide and pay for all tests needed to achieve Work of specified quality.

B. The CONTRACTOR shall designate a Quality Control Manager who will be the point of contact between the ENGINEER and the CONTRACTOR on all issues related to Quality Control. The Quality Control Manager will be responsible for verifying that the Work, including all submittals and as-built information, including surveys, complies with the project plans and specifications. The Quality Control Manager shall verify that the materials and Work covered by a submittal are in compliance with the Contract Documents before sending the submittal to the ENGINEER for approval. A submittal form is provided that must accompany each submittal. The form is to be completed and signed by the Quality Control Manager, certifying that the materials and/or Work are in complete accordance with the Contract Documents. Identify the Quality Control Manager at the pre-construction conference.

C. CONTRACTOR shall comply fully with manufacturers' instructions, including each step in sequence.

D. Should manufacturers' instructions conflict with Contract Documents, CONTRACTOR shall request clarification from ENGINEER before proceeding.

E. CONTRACTOR shall comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

F. CONTRACTOR shall perform Work by persons qualified to produce workmanship of specified quality.

G. CONTRACTOR shall complete daily field reports documenting, at a minimum, Work completed, quality control test results, problems encountered, and solutions. These field reports shall be submitted to the CQA field representative at the end of each work day. A summary and copies of all test results of quality control testing shall be submitted to the ENGINEER on a monthly basis in a Quality Control Report. All documents and test results shall bear the seal and signature of a Professional Engineer registered in the State of North Carolina.

H. CONTRACTOR shall cooperate with independent firm providing quality assurance services to OWNER and provide continuous access to the Work to representatives of the CQA Consultant. Samples of materials, design mix, equipment, tools, storage and assistance shall be furnished as requested.

I. The ENGINEER shall determine and decide all questions that may arise as to the quality and acceptability of materials and Work performed; the manner of performance and the rate of progress of said Work; the interpretations of the Contract Documents relating to the Work; the acceptable fulfillment of the Contract Documents on the part of the CONTRACTOR; and the amount and quantity of the several kinds of Work performed and materials which are to be paid for under the contract.

J. To supplement the CONTRACTOR's own quality control program, test results obtained by the CQA firm on behalf of the OWNER may be made available to the CONTRACTOR. It is not, however, the responsibility of the CQA firm to conduct tests of any kind on behalf of the CONTRACTOR, and the use of the CQA firm's test results does not diminish the CONTRACTOR's responsibility to provide comprehensive quality control and conduct all Work required by the Contract Documents.

1.03 INSPECTION AND TESTING SERVICES

A. The CONTRACTOR is responsible for performing and documenting all Quality Control tests as required in the individual Specification Sections. CONTRACTOR shall provide ENGINEER with copies of all Quality Control test results. The CONTRACTOR is to provide and pay for all tests needed to achieve work of specified quality.

B. During placement of structural fill material, the CONTRACTOR is to provide at his own expense a qualified soils technician as needed to insure placement of structural fill material in accordance with the Contract Documents.

C. The CONTRACTOR is required to provide at his own expense a qualified soils technician on-site at all times during construction of the low-permeability soil liner. The CONTRACTOR'S soils technician must have experience in the successful construction of low-permeability soil liners for landfills, and the skills necessary to insure that the specified requirements for the low-permeability soil liner for this project are achieved.

D. The CONTRACTOR shall cooperate with independent firm providing quality assurance services to OWNER. Provide continuous access to the Work to representatives of the CQA Consultant. Furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.

1.04 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. When specified in individual Specification Sections, required material or product suppliers or manufacturers shall provide qualified staff personnel to observe Site conditions, conditions of surfaces and installation, and quality of workmanship as applicable, and to initiate instructions when necessary.

B. Individuals shall report to the ENGINEER within 24 hours observations and Site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

C. Submit report within ten (10) days of observation to ENGINEER for review.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

** END OF SECTION 01400 **

SECTION 01410

QUALITY ASSURANCE SERVICES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. OWNER will employ and pay for the services of the Construction Quality Assurance (CQA) Consultant for observing, testing and documenting activities related to the quality assurance at the site, to assure the OWNER that the Work is completed according to the CQA Plan, Specifications, and Drawings.

B. Quality assurance refers to measures taken by the CQA Consultant on behalf of the OWNER to assess whether the Work is in compliance with the Contract Documents.

C. Employment of the CQA Consultant shall in no way relieve CONTRACTOR's obligations to perform the Work and supply materials in accordance with the Contract Documents.

1.02 INSPECTION AND LABORATORY TESTING SERVICES

A. The OWNER shall appoint, employ, and pay for services of an independent firm to conduct inspection and testing for quality assurance purposes.

B. CONTRACTOR shall cooperate with the CQA Consultant to facilitate the execution of the Work.

C. On behalf of the OWNER, the CQA Consultant shall conduct inspections, tests, and other services specified in individual specification subsections that address quality assurance requirements. No adjustments to the Contract Time will be granted for any quality assurance activities of the CQA Consultant, including testing.

D. Reports shall be submitted by the CQA Consultant to the ENGINEER indicating observations and results of tests and indicating compliance or noncompliance with Contract Documents.

E. Re-testing required because of non-conformance to specified requirements shall be conducted by the same CQA Consultant on instructions by the ENGINEER and will be paid for by the CONTRACTOR.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

* * END OF SECTION 01410 * *

SECTION 01710

PROJECT RECORD DOCUMENTS

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The purpose of the record documents is to provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modifications to proceed without lengthy and expensive site investigation.

B. Throughout progress of Work, maintain an accurate record of all revisions to the Work. Upon completion of Work, transfer the recorded changes to a set of record documents. This includes, but is not limited to, all modifications to piping, roads, utilities, grading, structures, limits of liner, and monitoring devices.

C. Submit five (5) complete sets of Record Documents, including record drawings, and one set of AutoCAD files acceptable to the ENGINEER upon completion of the project.

1.02 SUBMITTALS

A. Submit Record Documents to the ENGINEER prior to the Contract Date when the Work is required to be complete and ready for final payment. Liquidated damages may apply if Record Documents and AutoCAD files are not submitted on time or are incomplete.

B. Accompany submittal with transmittal letter in duplicate, containing:

1. Date;
2. Project title and number;
3. CONTRACTOR's name and address;
4. Title and number of each Record Document; and
5. Signature of CONTRACTOR or his authorized representative.

PART 2 – PRODUCTS

NOT USED

PART 3 – EXECUTION

3.01 SURVEYOR

A. Employ the services of a surveyor licensed in North Carolina to determine actual locations and elevations of installed items and to prepare the record drawings.

3.02 DOCUMENTS REQUIRED

A. Maintain at the site for the OWNER one record copy of:

1. Contract Drawings;
2. Contract Specifications;
3. Contract Addenda;
4. Change Orders and other Modifications to the Contract;
5. ENGINEER'S Field Orders or written instructions;
6. Approved Shop Drawings, Product Data and Samples;
7. Field Test Records;
8. Construction photographs.

3.03 ACCURACY OF RECORDS

A. Thoroughly coordinate all changes within the Record Documents, making adequate and proper entries on each page of the Specifications and each sheet of the Construction Drawings and other documents where such entry is required to properly show the change. Record accuracy shall be such that future searches for the constructed features may reasonably rely on information obtained from Record Documents.

3.04 TIMING OF ENTRIES

A. Make all entries within 24 hours after receipt of information.

3.05 SUBMITTAL

A. The ENGINEER's approval of the current Record Documents shall be a prerequisite to the ENGINEER's approval of requests for progress payment and request for final payment under the Contract.

3.06 PROTECTION OF DOCUMENTS

A. Maintain the job set of record documents completely protected from deterioration and from loss and damage until completion of Work and transfer of recorded data to the final Record Documents.

3.07 MAKING ENTRIES ON DOCUMENTS

A. Use an erasable colored pencil (not ink or indelible pencil) to clearly describe the change by note and by graphic line as required. Date all entries. Highlight the entry by drawing a "cloud" around the affected area or areas.

3.08 FORMAT OF FINAL RECORD DRAWINGS

A. Prepare Record Drawings in an AutoCAD.dwg file or .dxf file, Release 15 or 2007 format acceptable to the ENGINEER.

B. Provide one drawing showing spot elevations on a fifty-foot grid for each of the top of subgrade, top of compacted clay cap, and the top of soil protective/topsoil layer, as applicable. The same grid point locations (northings and eastings) shall be used to obtain spot elevations for each layer. Elevations shall be measured to the nearest 0.01 foot. Include on this same drawing the two-foot contours for the top of the compacted clay cap. Also, provide drawings showing two-foot contours for the top of subgrade, top of compacted clay cap, and the top of soil protective/topsoil layer, as applicable

C. Provide record drawings of all structural fill areas, access roads, and final grades of newly constructed or modified sediment basins.

D. Include as-built locations and invert elevations of all leachate pipes, stormwater pipes, and stormwater channels.

E. If applicable, provide one drawing showing geomembrane panel layout, seam layout, destructive test locations, and repair locations.

** END OF SECTION 01710 **

SECTION 02100

SITE PREPARATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall furnish all materials, labor, equipment, tools and appurtenances required to complete the work as described below.

B. Clearing, grubbing, removal and disposal of vegetation, rocks, roots and debris within the limits of the work except objects designated on the Construction Drawings to remain.

C. Preservation from injury or defacement of all vegetation and objects to remain.

1.02 RELATED SECTIONS

A. Section 02220 – Excavation

B. Section 02125 – Sediment and Erosion Control

C. Section 02936 – Seeding

1.03 LIMITS OF WORK

A. Rights-of-way established by the OWNER.

B. Construction area including the area bounded by lines twenty-five feet outside the construction lines established by the OWNER.

1.04 PROTECTION

A. The CONTRACTOR shall protect living trees not marked for removal within the construction area and those outside the construction area. Cut or scarred surfaces of trees or shrubs shall be treated with a paint prepared especially for tree surgery.

B. Existing structures, roads, sidewalks, paving and curbs shall be protected against damage from vehicular or foot traffic.

C. CONTRACTOR shall protect benchmarks from damage or displacement.

D. CONTRACTOR is responsible for correcting any damage caused by construction activities. CONTRACTOR shall make repairs to the satisfaction of the OWNER or other parties having jurisdiction. All costs for repairs will be borne by the CONTRACTOR.

E. If required by law, CONTRACTOR shall prepare a new erosion and sediment control plan for proposed disturbances due to clearing and grading activities outside the limits of construction shown on the Construction Drawings. Submit the Erosion and Sediment Control Plan regulatory authorities for approval, and pay required review fees. Obtain approval for th submitted plan before initiating clearing activities in the affected area.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 PREPARATION

A. The CONTRACTOR shall maintain bench marks, monuments and other reference points and re-establish, at no cost to the OWNER, if disturbed or destroyed. The CONTRACTOR shall also furnish all labor, materials, supervision and equipment to complete site preparation for the proposed construction, including, but not limited to final grading, hauling, scraping, stockpiling, drainage, and removing of accumulated water during construction.

3.02 CLEARING

A. The CONTRACTOR shall clear stumps from all areas within limits of the contract and stockpile areas.

B. Remove from the site trees, brush, shrubs, downed timber, undergrowth, deadwood, rubbish, and other vegetation and incidental structures to allow for new construction.

C. Remove all trees, stumps, and roots within ten (10) feet of any proposed structure or pipeline.

D. Trees and stumps outside the construction area and marked by the OWNER for removal shall be cut to within six (6) inches of the ground surface.

E. Stumps of trees to be left in place shall be left no more than six (6) inches above original grade.

F. The CONTRACTOR shall perform clearing well in advance of construction or material removal activities.

G. The clearing CONTRACTOR shall not cut or injure any trees or other vegetation outside the limits of the areas on which work is to be done without permission of the OWNER and he shall guard against like action by his employees and subcontractors. Existing vegetation or landscaping beyond clearing limits shall be protected by orange plastic fencing or other clearly visible approved means.

3.04 GRUBBING

A. The CONTRACTOR shall grub from all areas within a 10-foot zone bordering all proposed structures and pipelines.

B. In areas to be cleared, remove all stumps, roots ½ – inch or larger, organic material, and debris to a depth of approximately one foot below existing grade, or one foot below the proposed subgrade elevation, whichever is lower.

C. Remove grassy vegetation in a manner that minimizes the separation of vegetative cover and topsoil or subsoil.

D. Use hands for grubbing inside the drip lines of trees which are to remain.

E. Stockpile topsoil material on site in areas designated by the Engineer or facility personnel.

F. Keep pavement and areas adjacent to site clean and free from mud, dirt, and debris. Clean up debris resulting from site clearing operations continuously with the progress of the Work.

3.05 DEBRIS REMOVAL

A. Unless otherwise noted, trees within the construction limits shall become the property of the CONTRACTOR and shall be removed from the site or disposed on-site as approved by landfill personnel.

B. All material collected in the course of the clearing and grubbing shall be disposed of in a manner consistent with applicable state and county regulations. Such disposal shall be carried on continuously with the removal of the materials in the clearing and grubbing operations and shall not be left until the final clean up period.

C. Burning shall be done only at approved times and at approved locations and in conformity with all local and state regulations and requirements including those requirements of the governing air pollution control authority. The CONTRACTOR shall make all necessary arrangements and pay for all necessary permits. The CONTRACTOR shall take all precautions necessary to prevent the spread of fire outside the immediate areas where burning is being done. No material shall be transported from off-site locations and burned on the landfill property.

D. Prior to depositing surplus material at any off-site location, the clearing and grubbing CONTRACTOR shall obtain a written agreement between himself and the owner of the property on which the disposal is proposed. The agreement shall state that the owner of the property gives permission for the CONTRACTOR to enter and deposit the material at no expense to the OWNER. A copy of the agreement shall be furnished to the OWNER prior to removing any material from the site.

3.06 SITE RESTORATION

A. At the end of the construction period, the CONTRACTOR shall restore to existing grade those areas disturbed by construction activities that lie beyond the limits of construction shown on the Construction Drawings and that are outside the borrow areas. Areas to be filled shall be nominally compacted as may be achieved with construction equipment and permanently seeded in accordance with the requirements of Section 02936.

** END OF SECTION 02100 **

SECTION 02220

EXCAVATION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of excavation, mass excavation stripping, and removal of topsoils; including removal and disposal of excess and unsuitable materials, relocation of excavated soils to designated areas, dewatering and other related and incidental work within the designated area and as required for the construction of other work, as shown, specified or required. CONTRACTOR shall provide a competent person to implement and supervise all work.

B. CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 RELATED SECTIONS

A. Section 01400 – Quality Control

B. Section 01410 – Quality Assurance Services

C. Section 02125 – Sediment and Erosion Control

1.03 DEFINITIONS

A. Excavation shall mean the removal from place of all materials and shall include soil, facilities, structures above and below ground, rock, pavements, topsoil, boggy waste, rubbish, tree stumps, boulders, logs, ashes, cinders, organic material such as peat, humus or organic silt, softened or disturbed soils or other unsuitable bearing materials determined in the field by the ENGINEER.

B. Mucking or mucking-out shall mean excavation, as defined herein before, without prior dewatering.

1.04 PROTECTION OF PEOPLE AND PROPERTY

A. The CONTRACTOR shall plan and conduct his operations so as to prevent damage to existing structures, safeguard people and property, minimize traffic inconvenience, and provide safe working conditions.

B. Excavations, except as specified hereinafter, shall be adequately shored and braced, as necessary. Where the installation of shoring is impractical or might cause damage, as a result of, but not limited to, vibration, settlement or lateral movement, the CONTRACTOR shall utilize other methods.

C. Excavation may be made without sheeting and bracing within the limitations and requirements of the governmental agencies having jurisdiction, provided that:

1. Hazards, such as described herein before, do not exist in the proximity of the excavation.

2. Work is not in streets or other paved, landscaped or improved areas.

3. Work can be restricted to the land provided for the CONTRACTOR's use.

4. Sheeting and bracing are not specifically required by the Contract Documents.

5. The CONTRACTOR shall submit a certification by a Professional Engineer indicating the maximum slope of the sides of the excavation proposed, and that said slopes will be stable under all weather and working conditions for the period that the excavation will be open. Such certification shall be based on the CONTRACTOR's own subsurface exploration and consideration of the options available to the CONTRACTOR such as dewatering, construction equipment, and proximity of spoil area. Any review of comments by the ENGINEER, CQA Consultant, or OWNER shall not relieve the CONTRACTOR of his responsibility arising from the excavation.

D. In cases where excavation without shoring and bracing is not permissible solely because of protection of workers, trench boxes may be used.

E. The CONTRACTOR shall not stockpile any excavated material adjacent to trench excavations without approval of the OWNER or ENGINEER.

F. Prior to exposing subgrades for placement of fills and backfills, surface water runoff shall be contained as practically as possible within the area of the Work.

G. The CONTRACTOR shall employ excavation methods which minimize the need to remove accumulated water from excavations. If unavoidable, however, accumulated water may be disposed by pumping through a sedimentation filter and treating and discharging in accordance with a method approved by the OWNER.

PART 2 - PRODUCTS

2.01 All materials shall be as defined on the Contract Drawings.

2.02 Unsuitable material shall include any soft or non-bearing soils, mulch, waste materials, debris, wood waste, organic material, peat, humus, or any other material deemed unsuitable and required to be removed by the ENGINEER.

PART 3 - EXECUTION

3.01 GENERAL

A. Identify required lines, levels, contours, and datum.

B. The CONTRACTOR shall locate all existing active and abandoned utilities and structures in work areas prior to commencing any excavation activities and shall protect from damage those utilities and structures which are to remain in place. Coordinate Work with owners of utilities. Protect, maintain in service, and prevent damage to utilities not designated to be removed. When utilities are encountered and are not shown on the Contract Drawings, or when locations differ from those shown on the Contract Drawings, notify ENGINEER for instructions before proceeding.

C. Unauthorized excavation consists of the removal of material below or beyond indicated subgrade elevations or sides without approval of the ENGINEER. Unauthorized excavation shall be replaced at CONTRACTOR´s expense.

D. All fill materials used to restore unauthorized excavations shall be subject to the approval of the ENGINEER.

E. Depressions caused by the removal of stumps shall be excavated to firm subgrade.

F. Existing utilities, structures, and fencing shall be protected during the construction period, and if damaged or removed by the CONTRACTOR, shall be repaired or replaced to the satisfaction of the OWNER at the CONTRACTOR's expense.

G. Where excavations have been carried below or beyond points required, restore these areas to the elevations and dimensions shown on the Construction Drawings with material approved by the ENGINEER and compacted as specified.

3.02 MATERIAL STORAGE

A. Stockpile excavated materials satisfactory for use as common fill on-site where directed by OWNER, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.

B. Locate and retain soil materials away from edge of excavations, where the weight of the material could create a surcharge on such edge, whether sheeted or not. Do not store within drip line of trees indicated to remain.

C. Dispose off-site refuse, waste, debris or other materials that cannot be reused during construction or as directed by the OWNER.

3.03 EXCAVATION OF TOPSOIL

A. Excavate topsoil material from areas to be further excavated or regraded.

B. Strip topsoil material to full depth, and stockpile separate from other excavated materials. Stockpile free of roots, stones, and other undesirable materials. Follow guidelines in the North Carolina Erosion and Sediment Control Planning and Design Manual to prevent erosion.

C. Stockpile in area designated on-site.

3.04 EXCAVATION FOR LANDFILL CELLS AND OTHER PROJECT FEATURES

A. Excavate to the lines and grades shown on Drawings.

B. Following excavation for swales, concrete structures, outlets, outfalls, pipes, etc., the CONTRACTOR shall regrade and add compacted fill as needed in order to achieve required surface for placement of materials as shown on the Drawings. All visible sharp protruding objects shall be removed or covered with a minimum of 12 inches of compacted fill.

C. Protect excavation bottoms against freezing. No fill or structures shall be allowed to be placed on frozen materials or subgrades softened as a result of freeze/thaw action.

D. Areas that receive permanent seeding shall be graded below finished grades shown, leaving space for topsoil material.

E. Excavated soil not needed immediately for construction shall be stockpiled on an area designated by the OWNER. Implement erosion and sediment control practices as shown on Drawings and as required by the North Carolina Erosion and Sediment Control Planning and Design Manual.

F. Stockpile or dispose at the active landfill facility continuously with the progress of the work and as directed by facility personnel all excess materials, trash, debris, and materials that are unsatisfactory for backfill or fill.

G. All excavations shall be dewatered as necessary to provide proper protection. The ENGINEER may require excavation to be continuously dewatered 24 hours per day until backfilling has been completed.

H. Where underground streams or springs are found, provide temporary drainage and notify the ENGINEER immediately.

I. Excavate so that banks of excavation will not be undercut and stratum for foundations will not be disturbed.

J. Excavate unsatisfactory soil materials encountered to the additional depth as directed by the ENGINEER.

K. Grade site to prevent introduction of surface water into excavations.

3.05 UNDERCUTTING AND BACKFILLING

A. Excavate muck or other unsuitable soils to a depth below grade as directed by ENGINEER's representative.

B. Limit cut slopes to 2 horizontal to 1 vertical..

C. Backfill excavation with materials meeting the requirements of Section 02225.

D. Prepare subgrade and backfill excavation in strict accordance with Section 02225.

3.06 EXCAVATIONS FOR STRUCTURES

A. Conform to elevations and dimensions shown on Construction Drawings. Extend the excavation a sufficient distance from footings and foundations to permit placement and removal of concrete forms and other construction required. Foundation concrete shall not be placed until the bearing stratum has been examined by ENGINEER and found satisfactory for the design bearing capacity.

3.07 GRADING

A. Uniformly grade all areas within the limits designated on the Construction Drawings, including adjacent transition areas. Finish surfaces within specified tolerances with uniform slopes between points where elevations are shown and existing grades.

B. Finish all surfaces free from irregular changes, and grade to drain as shown on the Construction Drawings.

C. Shape the subgrade under unpaved areas to the proposed line and grade so that the finished surface is within 0.10 feet of the required subgrade elevation.

D. Protect newly graded areas from traffic and erosion. Repair and re-establish grade in settled, eroded, or rutted areas to the specified tolerances.

E. Where compacted areas are disturbed by subsequent construction or adverse weather, scarify the surface, reshape and compact to the required density. Use hand tamper for recompaction over underground utilities.

F. Grade borrow area and conduct borrow activities in accordance with the approved Erosion and Sedimentation Control Plan for the borrow area.

3.08 STOCKPILES

A. Construct stockpile slopes no steeper than 2:1 (Horizontal : Vertical).

B. Soil in stockpiles shall be compacted to a sufficient degree to minimize infiltration of rainfall. Compaction shall be to the satisfaction of the ENGINEER.

C. Slopes of the stockpile shall be "tracked" by movement of a cleated dozer up and down the slope.

D. Grass finished stockpile surfaces that will be exposed for more than 30 days and maintain adequate temporary erosion until grass is well established.

** END OF SECTION 02220 **

SECTION 02225

STRUCTURAL FILL

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The Work of this Section of the Specifications comprises supply of all labor, materials, tools, and equipment, and performance of all work necessary for processing, moisture conditioning, loading, transporting, dumping, spreading, and compacting structural fill for construction of the landfill cells and ancillary support structures.

1.02 REFERENCES

A.	ASTM D422-63	Standard Test Method for Particle – Size Analysis of Soils
B.	ASTM D698-00ae1	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
C.	ASTM D1140-00	Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75-um) Sieve
D.	ASTM D1556-00	Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
E.	ASTM D2216-05	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
F.	ASTM D2487-06	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
G.	ASTM D2922/3017	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
H.	ASTM D2937-04	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
I.	ASTM D4318-05	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
J.	ASTM D4643-00	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

K. ASTM D4959-00 Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating

1.03 RELATED SECTIONS

A. Quality Control – Section 01400

B. Quality Assurance Services – Section 01410

C. Site Preparation – Section 02100

C. Excavation – Section 02220

1.03 DEFINITIONS

A. Structural fill is soil like fill material that shall be placed for construction of the landfill sub-base and perimeter berm to achieve design grades, as shown on the Construction Drawings. The material shall be excavated from cut areas within the landfill or a designated borrow area.

1.04 SUBMITTALS

A. Submit one seventy-five (75) pound bag from each proposed borrow source of each soil type proposed to be used as structural fill to the CQA Consultant at least four weeks prior to beginning fill operations.

B. Proposed fill material shall be approved by the ENGINEER prior to use.

C. Testing of soil samples shall be paid for by CONTRACTOR.

D. Identify proposed borrow sources with the sample submissions.

1.05 TOLERANCES

A. Grading tolerance for all structural fill shall be ± 0.1 feet.

1.06 QUALITY ASURANCE

A. Acceptance by the ENGINEER of structural fill shall be dependent on the CQA Consultant satisfying all requirements of the CQA Plan during the course of the work and the test results showing that all requirements of this Section have been met.

B. Supporting data for CQA purposes shall be obtained by field and laboratory testing to be conducted by the CQA Consultant.

C. Field and laboratory testing conducted by the CQA Consultant will be done at the OWNER's expense.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Fill material shall consist of on-site or off-site borrow area soil free of topsoil, roots, stumps, brush, vegetation, and other organic or deleterious material.

B. Fill material shall have a maximum size aggregate of two inches with no more than 10% retained on the No. 4 sieve.

C. Fill material shall be approved by the ENGINEER prior to its use.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. Prepare areas to receive structural fill in accordance with Section 02100, Site Preparation.

B. Where subgrade requires undercutting, limit cut slopes to 2 horizontal to 1 vertical (2H:1V).

C. Grade areas to receive fill to a uniform surface. Scarify surface if directed by the CQA Consultant or ENGINEER.

D. Eliminate ruts, hummocks, or other uneven features.

E. Proofroll the subgrade with a loaded tandem-axle dump truck having a minimum weight of 20 tons or other similar rubber-tired equipment.

F. Make at least two passes in each direction with the proofrolling equipment.

G. Remove and replace any soft, saturated or yielding areas indicated by pumping or rutting as directed by the CQA Consultant or ENGINEER.

H. Replace soil that has been removed with structural fill material in accordance with the requirements of this Section (Section 02225).

I. Where unsuitable soil was removed, compact the structural fill material to at least 95% of the maximum dry density as determined by ASTM D698 to a depth of at least 12 inches.

J. Dry or wet the subgrade at the discretion of the CQA Consultant or ENGINEER to establish a subgrade with acceptable moisture content.

K. Do not place structural fill until the subgrade has been approved by the CQA Consultant or ENGINEER. When structural fill is to be placed on hillsides with slopes greater than 3H:1V, the existing slopes shall be continuously benched. Benches shall be a minimum of four feet wide. Benching shall consist of a series of horizontal cuts beginning at the intersection with the original ground and continuing at each vertical intersection of the previous cut.

L. The benching requirement may be relaxed in the field by the CQA Consultant or ENGINEER, at their discretion, based on the geometry of the fill area, the type of fill material, and other factors deemed pertinent by the CQA Consultant or ENGINEER.

3.02 CONSTRUCTION

A. Construct project features to the lines and grades shown on the Construction Drawings.

B. Place fill material in lifts no greater than 6 inches compacted depth.

C. Compact fill material to a minimum dry density of 95% of the maximum dry density determined from the Standard Proctor Test (ASTM D698).

D. Moisture must be maintained between four (4) percent below to four (4) percent above the optimum moisture content.

E. Fill material in place, which does not meet the density requirements, shall be recompacted or removed and reworked to meet density objectives.

F. Do not place or compact fill material during sustained period of temperatures below 32° F.

G. Employ a professional land surveyor licensed in North Carolina to conduct a topographic survey of the top of the structural fill layer and prepare a survey drawing showing contours at maximum two-foot intervals.

H. Furnish the ENGINEER with three copies of the topographic survey drawing. This drawing shall become part of the Record Drawings required by this Contract.

3.03 PROTECTION OF WORK

A. CONTRACTOR shall maintain and protect all material in satisfactory condition until final completion and acceptance of the work.

B. Develop a contingency plan for responding to construction deficiencies due to inclement weather, defective materials, and construction inconsistent with the Construction Specifications. The plan shall provide a methodology for selecting and implementing corrective action.

C. Portions of the structural fill damaged due to exposure shall be reworked to meet the Specifications or, at the discretion of the ENGINEER, removed and replaced with conforming material at no additional cost to the OWNER.

D. Payment for structural fill will not be made until it has been covered with the overlying material, seeded, or otherwise protected from damage.

3.04 REMEDIAL MAINTENANCE

A. Maintain structural fill in an undisturbed state until covered or otherwise protected from damage.

B. In the event of slides, sloughing, or erosion in any part of the Work, remove the disturbed material from the damaged area and rebuild such portion as directed by the ENGINEER.

C. Removal of material and repair of damaged areas shall be performed by the CONTRACTOR at no additional cost to the OWNER.

3.05 QUALITY ASSURANCE

A. Field inspection and testing will be performed under provisions of Section 01410.

B. Conduct continuous visual inspection of materials to ensure that proper soils are being used.

C. Laboratory compaction tests will be performed in accordance with ASTM D698 and with Section 01410. Frequency: A minimum of one test for each soil type proposed for use as structural fill.

D. Testing for moisture / density relationship will be conducted on soils used as structural fill in accordance with ASTM D698. Frequency: A minimum of one test per 5,000 cubic yards of loose material delivered.

E. Moisture content of the in-place structural fill will be determined by nuclear methods in accordance with ASTM D3017. Frequency: Four tests per acre per lift. A minimum of every tenth test completed in accordance with ASTM D3017 shall also be tested by direct heating in accordance with ASTM D4959.

F. Density of the in-place structural fill will be determined by nuclear methods in accordance with ASTM D2922. Frequency: Four tests per acre per lift. A minimum of every tenth sample tested in accordance with ASTM D2922 shall also be tested in accordance with either the sand cone method (ASTM D1556) or the drive cylinder method (ASTM D2937).

G. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to OWNER.

H. The horizontal and vertical location of all test locations will be recorded. A drawing will be prepared showing all test locations.

* * END OF SECTION 02225 * *

SECTION 02230

COMPACTED CLAY CAP

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section includes the furnishing of all labor and equipment and material necessary for the placement of the 18-inch thick compacted clay cap. The compacted clay cap shall consist of material placed and compacted in a manner that will provide a maximum permeability of 1.0×10^{-5} cm/sec and meet the requirements of the Construction Quality Assurance (CQA) Plan.

1.02 RELATED SECTIONS

A. Section 02220 – Excavation

B. Section 02223 – Trenching, Backfilling, and Compacting

C. Section 02225 – Strucutral Fill

D. Section 02235 – Test Pad

1.03 REFERENCES

A.	ASTM D422-63(2002)	Standard Test Method for Particle-Size Analysis of Soils
B.	ASTM D698-00ae1	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
C.	ASTM D1556-00	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D.	ASTM D1587-00	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
E.	ASTM D2216-05	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
F.	ASTM D2487-06	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
G.	ASTM D2922/3017	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

H.	ASTM D2937-04	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
I.	ASTM D4318-05	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
J.	ASTM D4959-00	Standard Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating
K.	ASTM D5084-03	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
L.	ASTM D5321-02	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

1.04 SUBMITTALS

A. The CONTRACTOR shall submit the technical data sheet for the proposed compaction equipment to the OWNER or CQA Consultant for review and approval.

B. From each proposed source of compacted clay cap material, the following tests shall be conducted by the CONTRACTOR:

1. Soil Classification (ASTM D2487, which includes Grain Size Analysis – ASTM D422, and Atterberg Limits – ASTM D4318); two per source or material type

2. Moisture Content (ASTM D2216); two per source or material type

3. Hydraulic Conductivity (ASTM D5084); two per source or material type

4. Standard Moisture-Density Relationship (ASTM D698); two per source or material type

If the CQA Consultant determines that the source contains more than one soil type, as determined by the USCS, the tests listed shall be performed for each type.

C. The CONTRACTOR shall provide evidence of availability of sufficient quantities of compacted clay cap material.

D. Proposed cap material shall be approved by the ENGINEER prior to its use.

1.05 CONSTRUCTION QUALITY CONTROL / QUALITY ASSURANCE

A. Acceptance of the compacted clay cap shall be dependent on the satisfaction of all requirements of the CQA Plan during the course of the Work and test results showing that all requirements of this Section (Section 02230) have been met.

B. Supporting data for CQA purposes shall be obtained by field and laboratory testing to be conducted by the CQA Consultant.

C. Field and laboratory testing conducted by the CQA Consultant will be conducted at the OWNER's expense except for retests resulting from failed tests of completed work. The CONTRACTOR shall be responsible for any expenses incurred performing additional tests and reworking the material to achieve test results within specifications.

PART 2 - PRODUCTS

2.01 MATERIAL

A. Compacted clay cap material shall be free of rubble, wood, stumps, brush, metal, cinders, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge, and other deleterious materials. Compacted clay cap material shall be clayey soil, classified according to the USCS as SC, CL, CH, SM, ML, or MH (ASTM D2487).

B. The maximum stone size in the lift directly in contact with the geomembrane shall be one inch in any dimension, and the maximum stone size for the remaining material shall be two inches in any dimension. Maximum amount of fill material allowed to be retained on No. 4 sieve: 10 percent.

C. Compacted clay cap material as delivered to the site shall be a well-blended material free from segregation with the specified permeability. The soil shall be of a consistency at the specified moisture content that it can be readily worked by the specified rollers and by heavy earthmoving equipment without excessive weaving, rutting, or adhesion (sticking) to equipment. On-site compacted clay cap material shall be mixed by disc-harrowing or approved equivalent method to a homogeneous consistency without clods.

D. The compacted clay cap material shall have a permeability no greater than $1.0x10^{-5}$ cm/sec according to ASTM D5084.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. Prepare areas to receive soil layer in accordance with Section 02100 Site Preparation.

B. Where subgrade requires undercutting, limit cut slopes to 2 horizontal to 1 vertical.

C. Grade areas to receive fill to a uniform surface. Scarify surface is directed by the ENGINEER.

D. Eliminate ruts, hummocks, or other uneven features. Remove and replace any soft, saturated, or yielding areas indicated by pumping or rutting. Replace soil that has been removed with structural fill material in accordance with the requirements of Section 02225.

E. Proofroll the subgrade with a loaded tandem-axel dump truck having a minimum weight of 20 tons or other similar rubber-tired equipment. Make at least two passes with the proofrolling equipment.

F. Dry or wet the subgrade at the discretion of the ENGINEER to establish a subgrade with an acceptable moisture content.

G. Do not construct the compacted clay cap until the subgrade has been approved by the ENGINEER.

H. A professional land surveyor licensed in the State of North Carolina shall conduct a topographic survey of the subgrade prior to commencement of construction of the low permeability soil layer.

I. Prior to placing fill material for the compacted clay cap, furnish the ENGINEER with a copy of the survey information for the subgrade spot elevations. This information shall be included in Record Drawings required by this contract, and shall be used by the CONTRACTOR's Quality Control Manager to verify that the constructed soil layers meet the minimum required thickness of this Section and the Construction Drawings. The ENGINEER will review the survey information submitted.

3.02 INSTALLATION

A. The CONTRACTOR shall construct the compacted clay cap on a firm, dry compacted subgrade that meets the requirements of the Construction Specifications.

B. Spread compacted clay cap material immediately after dumping by mechanical equipment or other means.

C. Prior to compaction, mix the soil by disc-harrow or other method to achieve homogeneous consistency.

D. All rocks or cobbles larger than two inches shall be removed.

E. Material for the compacted clay cap shall be placed in uniform lifts not exceeding six inches once compacted. The loose lift thickness shall not exceed the effective depth of compaction for the equipment used.

F. Each lift shall be compacted using appropriately heavy, properly ballasted, deep penetrating foot compactor. The deep penetrating feet shall have a minimum length of seven (7) inches and shall be subject to approval of the ENGINEER. Vibrating rollers and rubber-tired rollers shall not be used for compaction of clayey soil.

G. Provide a minimum of four passes with the compactor regardless of whether the lift meets density specifications. A pass is considered to be one trip of the compacting equipment over the lift and back to the starting point by a single drum roller, or one trip across the lift surface from one end to the other of the compacting equipment has front and back compacting rollers. Each trip shall overlap the adjacent trip by not less than two feet. An equal number of passes shall be made at a 90-degree angle to the previous pass direction.

H. Final compaction criteria (including moisture content and density) shall be determined based on the results of the Test Pad (Section 02235).

I. The CONTRACTOR may modify the compaction and moisture content to fit site conditions and material requirements if he can demonstrate that all design parameters can be satisfied as determined by the ENGINEER or CQA Consultant. The demonstration shall be done at the CONTRACTOR's expense. Compaction procedures e.g., equipment type, number of passes, etc., shall be in accordance with the Test Pad results.

J. After conditioning a lift to be compacted, take soil samples and test for moisture content prior to compaction.

K. If the moisture content is outside the acceptable range, rework the material by scarifying, wetting or drying the soil as required, and recompact the soil.

L. Thoroughly compact each lift and satisfy moisture, density, and permeability requirements before placing a subsequent lift. Successive lifts shall not be placed until the previous lift is accepted by the CQA Consultant or ENGINEER.

M. Avoid desiccation and crusting of the lift surface. If drying of the lift surface occurs before placement of the next lift, scarify this area to a sufficient depth to mix with moist materials, or sprinkle with water and scarify at the direction of the CQA Consultant or ENGINEER.

N. The surface of a compacted lift shall be adequately scarified to allow for tie-in of the subsequent lift.

O. The final lift of the compacted clay cap shall be compacted evenly by a rubber-tired roller, with not less than a 15,000-pound wheel load, for 10 complete passes or as otherwise approved by the CQA Consultant. Provide a smooth finished surface free of rocks, organics, and voids.

P. At the beginning of each work day, the CQA Consultant shall observe the previously installed compacted clay cap. The OWNER or CQA Consultant may specify reworking of the compacted clay cap if, in the judgment of the CQA Consultant, it is required to obtain the required permeability and provide a suitable surface for the subsequent lift. Reworking of the compacted clay cap shall be performed at no additional cost to the OWNER.

Q. The maximum permeability of the compacted clay cap shall be 1.0×10^{-5} cm/sec. If representative permeability tests indicate that the compacted layer does not meet permeability requirements, rework the layer regardless of density/moisture content.

R. No compacted clay cap material shall be placed over a lift that has not been tested and approved by the CQA Consultant.

S. Do not place or compact clay cap material during sustained periods with air temperature below 32° F.

T. Do not place compacted clay cap material on frozen subgrade. If soil freezes, remove placed material, scarify and recompact at the discretion of the CQA Consultant.

U. Seal completed lifts at the end of each day's activities by rolling with rubber tired smooth drum roller and moisten with water as needed.

V. Provide compacted clay cap with a minimum thickness of 18 inches at all required locations. The thickness of the clay cap on the side slopes shall be measured perpendicular to the slope face.

W. The final grades of the compacted clay cap shall be true to grade, with deviations of no more than 0.1 foot from the proposed top-of-cap elevation.

X. Employ a licensed surveyor to conduct a topographic study of the top of the compacted clay cap. Furnish the ENGINEER with three copies of a topographic survey drawing of the top of compacted clay cap showing contours at maximum 2-foot intervals. This drawing shall become part of the Record Drawings required by this Contract.

3.03 PROTECTION OF WORK

A. Protect the finished surface from erosion, desiccation, or other damage.

B. Develop a contingency plan for responding to construction deficiencies due to inclement weather, defective materials, and construction inconsistent with the Contract Specifications. The plan shall provide a methodology for selecting and implementing corrective action.

C. Portions of the compacted clay cap damaged due to exposure shall be reworked to meet the Construction Specifications or, at the discretion of the CQA Consultant, removed and replaced with conforming material at no additional cost to the OWNER.

3.04 REMEDIAL MAINTENANCE

A. Maintain compacted clay cap material in an undisturbed state until covered and protected from damage.

B. In the event of slides, sloughing, or erosion in any part of the Work, remove the disturbed material from the damaged area and rebuild such portion as directed by the OWNER and as observed by the CQA Consultant.

C. Removal of material and repair of damaged areas shall be conducted by the CONTRACTOR at no additional cost to the OWNER.

3.05 QUALITY ASSURANCE

A. The CONTRACTOR shall conduct testing of the proposed cap material to define the moisture content/dry density/permeability performance of the soil, and shall submit compaction curves for the proposed cap material to the ENGINEER for approval prior to placement.

B. If more than one source/type of borrow material is proposed or required, the CONTRACTOR shall perform a borrow evaluation to determine the moisture content/dry density/permeability relationship of each source/type of material. The results of the borrow evaluation shall be submitted to the ENGINEER for approval prior to material placement.

C. Final criteria for construction of the compacted clay cap (including moisture content, compactive effort, and density) shall be determined based on the results of the Test Pad demonstration.

D. Under the supervision of the CQA Consultant, a soils technician from a commercial geotechnical testing company, approved by the CQA Consultant, shall perform soil tests described herein and in the CQA Plan. Samples shall be collected by field testing personnel at the minimum frequencies presented below.

E. Test schedule during compacted clay cap construction:

1. At least one grain size analysis shall be performed per 2,500 yd^3 of soil to be placed. Grain size analysis shall conform to ASTM D422.

2. At least one moisture content test shall be performed per 2,500 yd^3 of soil placed. Moisture content test shall conform to ASTM D2216.

3. At least one moisture-density relationship test per 5,000 yd^3 of soil placed. The moisture density curve test shall conform to ASTM D698.

4. Additional tests may be required when soil gradation tests indicate that there has been a change in the material being supplied.

5. At least one set of Atterberg limit tests shall be performed per 2,500 yd^3 of soil placed. The Atterberg limit tests shall conform to ASTM D4318.

6. Testing of the in-place compacted soil cap will include moisture content tests in accordance with ASTM D3017. Frequency: Five tests per acre per lift. A minimum of every fifth test completed in accordance with ASTM D3017 shall also be tested in accordance with ASTM D4959.

7. Testing of the in-place compacted soil cap will include density tests in accordance with ASTM D2922. Frequency: Five tests per acre per lift. A minimum of every fifth sample tested in accordance with ASTM D2922 shall also be tested in accordance with either the sand cone method (ASTM D1556) or the drive cylinder method (ASTM D2937).

8. At least one in-place permeability test shall be performed per acre per lift of soil placed. The lab permeability test shall conform to ASTM D5084 and shall be conducted using a confining pressure of 5 pounds per square inch and a hydraulic gradient of 10. Samples shall be taken in accordance with ASTM D1587.

9. If a permeability test result fails to meet the permeability requirements, two additional samples shall be taken in the vicinity of the failed sample, and replicate tests conducted. If the replicate tests pass, the section represented by the samples shall be considered as having passed. If either of the replicate tests fails, then the section shall be considered as having failed and shall be removed, replaced, and retested.

F. Test holes shall be plugged using bentonite or a mixture of 50 percent soil and 50 percent bentonite. The backfill shall be tamped in the hole to remove pockets of air or loose soil, and to assure a tight compact seal.

G. The horizontal and vertical location of all test locations will be recorded. A drawing will be prepared showing all test locations.

H. The CONTRACTOR shall cooperate with the CQA Consultant in obtaining samples for testing and conducting in-situ tests during the construction period. The CONTRACTOR shall provide all necessary labor, equipment, and material to refill sample locations with compacted clay cap material as directed.

I. If the tests conducted on a particular lift and section of the placed material do not meet required specifications, the CONTRACTOR shall be responsible for any expenses incurred performing additional tests following recompaction of the material until passing test results are achieved.

** END OF SECTION 02230 **

SECTION 02235

TEST PAD

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section includes the furnishing of all labor, equipment and materials, and completing all operations in connection with compacting, grading, and placing soil materials and all other incidental work necessary for constructing the Test Pad according to Drawings and Technical Specifications.

1.02 TEST PAD PERFORMANCE

A. The maximum allowable coefficient of permeability of the constructed Test Pad shall be 1.0 x 10^{-5} cm/sec.

1.03 REFERENCES

A.	ASTM D422-63(2002)	Standard Test Method for Particle-Size Analysis of Soils
B.	ASTM D698-00ae1	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
C.	ASTM D1556-00	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D.	ASTM D1587-00	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
E.	ASTM D2216-05	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
F.	ASTM D2487-06	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
G.	ASTM D2922/3017	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
H.	ASTM D2937	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
I.	ASTM D4318-05	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
J.	ASTM D4959-00	Standard Test Method for Determination of Water (Moisture) Content of Soil By Direct Heating

J.	ASTM D5084-03	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
K.	ASTM D5321-02	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

1.04 RELATED SECTIONS

A. Carefully examine all of the Contract Documents for requirements affecting the work of this section.

B. Other specification sections containing requirements relating to this section include, but are not limited to, the following:

1. Section 01400 – Quality Control

2. Section 01410 – Quality Assurance Services

3. Section 02100 – Site Preparation

4. Section 02225 – Structural Fill

5. Section 02230 – Compacted Clay Cap

1.05 SUBMITTALS

A. Submit one seventy-five (75) pound bag from each proposed borrow source of each soil type proposed to be used as cap material to the CQA Consultant at least four weeks prior to beginning fill operations.

B. Identify proposed borrow sources with the sample submissions.

C. From each proposed source of compacted clay cap material, the following tests shall be conducted by the CONTRACTOR:

1. Soil Classification (ASTM D2487, which includes Grain Size Analysis – ASTM D422, and Atterberg Limits – ASTM D4318); two per source or material type

2. Moisture Content (ASTM D2216); two per source or material type

3. Hydraulic Conductivity (ASTM D5084); two per source or material type

4. Standard Moisture-Density Relationship (ASTM D698); four per source or material type

D. Proposed Test Pad material shall be approved by the ENGINEER prior to use.

1.06 QUALITY ASSURANCE

A. Acceptance of the Test Pad shall be dependent on the satisfaction of all requirements of the CQA Plan during the course of the Work and test results showing that all requirements of this Section (Section 02235) and Section 02230 have been met.

B. Supporting data for CQA purposes shall be obtained by field and laboratory testing to be conducted by the CQA Consultant.

C. Field and laboratory testing conducted by the CQA Consultant will be conducted at the OWNER's expense except for retests resulting from failed tests of completed work. The CONTRACTOR shall be responsible for any expenses incurred performing additional tests and reworking the material to achieve test results within specifications.

PART 2 - PRODUCTS

2.01 MATERIAL

A. Test Pad material shall be free of rubble, wood, stumps, brush, metal, cinders, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge, and other deleterious materials. Compacted clay cap material shall be clayey soil, classified according to the USCS as SC, CL, CH, SM, ML, or MH (ASTM D2487).

B. The maximum stone size in the lift directly in contact with the geomembrane shall be one inch in any dimension, and the maximum stone size for the remaining material shall be two inches in any dimension. Maximum amount of fill material allowed to be retained on No. 4 sieve: 10 percent.

C. Test Pad material as delivered to the site shall be a well-blended material free from segregation. The soil shall be of a consistency at the specified moisture content that it can be readily worked by the specified rollers and by heavy earthmoving equipment without excessive weaving, rutting, or adhesion (sticking) to equipment. On-site Test Pad material shall be shall be mixed by disc-harrowing or approved equivalent method to a homogeneous consistency without clods.

PART 3 - EXECUTION

3.01 GENERAL

A. Allow sufficient time for testing of the Test Pad prior to construction of the compacted clay cap.

B. Construct Test Pad a minimum of 50 foot wide x 150 foot long using the same construction methods, equipment, and material to be used for the 18-inch compacted clay cap.

C. The location of the Test Pad shall be selected by the CONTRACTOR and approved by the ENGINEER.

D. The Test Pad may be constructed as part of the compacted clay cap. If constructed as part of the compacted clay cap, all materials and associated testing shall be in accordance with Specification Section 02230.

E. Construct lifts not exceeding six inches compacted thickness unless otherwise approved in writing by the ENGINEER.

F. Inspect each lift. Do not place subsequent lift until the previous lift is approved by the CQA Consultant or the ENGINEER.

D. If the source for the soil cap material changes, or the properties of the material from the borrow source change significantly as determined by the CQA Consultant, construct new Test Pad per the Specifications contained herein.

E. Construct access ramps as necessary to provide for the even distribution of traffic on the Test Pad. Following the completion of the Test Pad, remove the access ramps.

F. If tests indicate that the compacted material fails to meet the design criteria, remove and reconstruct the failed sections at no additional cost to the OWNER.

G. Do not begin construction of the compacted soil cap until the Test Pad has been completed and approved in writing by the ENGINEER.

3.02 PROTECTION OF WORK

A. CONTRACTOR shall maintain and protect all material in satisfactory condition until final completion and acceptance of the work.

B. Develop a contingency plan for responding to construction deficiencies due to inclement weather, defective materials, and construction inconsistent with the Construction Specifications. The plan shall provide a methodology for selecting and implementing corrective action.

C. Portions of the Test Pad damaged due to exposure shall be reworked to meet the Construction Specifications or, at the discretion of the ENGINEER, removed and replaced with conforming material at no additional cost to the OWNER.

D. Payment for Test Pad fill will not be made until it has been covered with the overlying material or otherwise protected from damage.

3.03 QUALITY ASSURANCE

A. The CONTRACTOR shall conduct testing of the proposed compacted clay cap material to define the moisture content/dry density/permeability performance of the soil, and shall submit compaction curves for the proposed cap material to the ENGINEER for approval prior to placement.

B. If more than one source/type of borrow material is proposed or required, the CONTRACTOR shall perform a borrow evaluation to determine the moisture content/dry density/permeability relationship of each source/type of material. The results of the borrow evaluation shall be submitted to the ENGINEER for approval prior to material placement.

C. Final criteria for construction of the compacted clay cap (including moisture content, compactive effort, and density) shall be determined based on the results of the Test Pad demonstration.

D. Sieve analyses will be conducted on soils used to construct the Test Pad in accordance with ASTM D422. Frequency: A minimum of one test per lift per Test Pad.

E. Testing for Atterberg limits will be conducted on soils used to construct the Test Pad in accordance with ASTM D4318. Frequency: A minimum of one test per lift per Test Pad.

F. Testing of the in-place compacted soil will include moisture content tests in accordance with ASTM D3017 (nuclear method). Frequency: Five tests per lift per Test Pad. A minimum of every fifth test completed in accordance with ASTM D3017 shall also be tested in accordance with ASTM D4959.

G. Testing of the in-place density of the compacted soil will include density tests in accordance with ASTM D2922 (nuclear method). Frequency: Five tests per lift per Test Pad. A minimum of every fifth sample tested in accordance with ASTM D2922 shall also be tested in accordance with either the sand cone method (ASTM D1556) or the drive cylinder method (ASTM D2937).

H. Permeability testing of undisturbed samples of the in-place Test Pad will be conducted in accordance with ASTM D5084. Frequency: One test per lift per Test Pad. Conduct tests using a confining pressure of 5 pounds per square inch (psi) and a hydraulic gradient of 10. Samples shall be taken in accordance with ASTM D1587.

I. If a permeability test result fails to meet the permeability requirements, two additional samples shall be taken in the vicinity of the failed sample, and replicate tests conducted. If the replicate tests pass, the section represented by the samples shall be considered as having passed. If either of the replicate tests fails, then the section shall be considered as having failed and shall be removed, replaced, and retested.

J. Test holes shall be plugged using a mixture of 50 percent soil and 50 percent bentonite.

K. The horizontal and vertical location of all test locations will be recorded. A drawing will be prepared showing all test locations.

** END OF SECTION 02235 **

SECTION 02770

POLYETHYLENE GEOMEMBRANES

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The Work of this section includes specifications and guidelines for supply of all labor, materials, and equipment, and performance of all Work necessary for the manufacture, fabrication (if needed), supply, and installation of geomembrane as specified herein and as shown on the Construction Drawings.

1.02 RELATED SECTIONS

A. Carefully examine all of the Contract Documents for requirements that affect the work of this section.

B. Other specification sections that contain requirements relating to this work include, but are not limited to, the following:

1. Section 01400 – Quality Control

2. Section 01410 – Quality Assurance Services

3. Section 02220 – Excavation

1.03 REFERENCES

A. ASTM International (ASTM)

1.	ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
2.	ASTM D1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
3.	ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
4.	ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
5.	ASTM D1603	Standard Test Method for Carbon Black in Olefin Plastics
6.	ASTM D3895	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry

7.	ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
8.	ASTM D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
9.	ASTM D5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
10.	ASTM D5323	Standard Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes
11.	ASTM D5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
12.	ASTM D5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
13.	ASTM D5721	Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
14.	ASTM D5820	Standard Practice For Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
15.	ASTM D5885	Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
16.	ASTM D5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
17.	ASTM D6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
18.	ASTM D6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

B. Geosynthetic Institute (GSI)

1.	GRI GM-9	Standard Practice for Cold Weather Seaming of Geomembranes
2.	GRI GM-11	Accelerated Weathering of Geomembranes Using a Fluorescent UVA Device

3.	GRI GM-12	Asperity Measurement of Textured Geomembranes Using a Depth Gauge
4.	GRI GM-13	Standard Specification for Test Methods, Test Properties and Testing Frequency for High Density Polyethlyene (HDPE) Smooth and Textured Geomembranes
5.	GRI GM-17	Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes"
6.	GRI GM-19	Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

1.04 SUBMITTALS

A. Submit manufacturer's material samples, specifications, and warranty to the ENGINEER at the pre-construction conference. Manufacturer's specifications shall give full details of minimum physical properties and test methods used.

B. Submit shop drawings and product data at least 7 days prior to shipment.

C. Submit shop drawings detailing special joint or termination conditions.

D. The Manufacturer shall supply the following product data to the OWNER or CQA Consultant at least seven (7) days prior to shipment of geomembrane to site:

1. Resin data including the following:

    a. Certification stating that the resin meets the requirements of this Specification,

    b. Certification stating all resin is from the same Manufacturer, and

    c. A copy of the QC certificates issued by the geomembrane Manufacturer and resin supplier.

2. Geomembrane sheet data including the following:

    a. Certification that material reworked from manufacturing process will not exceed 10 percent by weight of material in accordance with GRI GM-17 and

    b. A copy of the QC certificates issued by the geomembrane Manufacturer.

3. Certification that extrudate resins and/or rod are from one Manufacturer, are the same resin type, and was obtained from the same resin supplier as the resin used to manufacture the geomembrane material.

E. Submit Manufacturer's written instructions for storage, handling, installation, and seaming of polyethylene geomembranes.

F. Submit material supplier's written instructions for the repair of HDPE material.

G. Submit panel layout with details (i.e., pipe boots and seaming process) as required for the HDPE geomembrane installation at least 14 days prior to mobilization of crews. Panel layout and details shall be approved by ENGINEER prior to installation.

1.05 CONTRACTOR'S QUALIFICATIONS

A. The Installer shall have at least five years experience working with HDPE geomembrane and other flexible membrane liner (FML) materials.

B. The Installer shall have installed a minimum 50 acres of FML or comparable geosynthetic systems on a minimum of five different projects.

C. The installation shall be supervised by an individual having installed a minimum of 1,000,000 square feet of FML.

D. The Installer is required to demonstrate compliance to the above requirements to the satisfaction of the ENGINEER or CQA Consultant at the pre-construction conference.

1.06 WARRANTY

A. The material shall be warranted on a pro-rata basis against Manufacturer's defects for a period of five years from the date of geomembrane completion.

B. The installation shall be warranted against defects in workmanship for a period of one year from the date of geomembrane completion.

1.05 QUALITY ASSURANCE/CONTROL

A. Acceptance by the ENGINEER of the HDPE geomembrane cap shall be dependent on the Geosynthetic CQA Consultant satisfying requirements of the CQA Plan during the course of the work and the test results showing that all requirements of this Section have been met.

B. Supporting data for CQA purposes shall be obtained by field and laboratory testing to be conducted by the CQA Consultant.

C. Field and laboratory testing conducted by the CQA Consultant will be done at the OWNER's expense.

D. ENGINEER will administer the CQA Program.

PART 2 – PRODUCTS

2.01 GENERAL

A. Geomembrane shall be comprised of LLDPE material manufactured of new, first quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures.

B. Geomembranes shall be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. Repair defects by cutting out the defect and welding a new piece of LLDPE material in its place. Weld in accordance with the requirements for field weld seams. Seams for repairs shall be tested in accordance with the required field seam test procedures.

C. Geomembranes shall be manufactured in minimum seamless widths of 22 feet.

D. Labels on the roll shall identify the thickness, length, width, and manufacturer's mark number. The roll shall also indicate the date, lot and batch number of the roll, the square feet in the roll, and the total roll weight as measured after manufacture.

E. There shall be no factory seams. All seams shall be welded in the field by trained technicians.

F. Edges of the rolled material shall be trimmed at the factory to remove non-conforming material.

G. The minimum required peak interface friction angle between the overlying protective cover and the textured geomembrane is 19 degrees, or as otherwise approved by the ENGINEER.

H. The minimum required peak interface friction angle between the geonet composite/nonwoven geotextile gas collection layer and the textured geomembrane is 19 degrees, or as otherwise approved by the ENGINEER.

I. Use an independent laboratory to conduct tests to verify interface friction angles (ASTM D5321 or ASTM D6243 for GCL). The independent laboratory selected to conduct the tests shall be approved by the ENGINEER prior to testing. A minimum of two tests will be performed for each interface. The CONTRACTOR shall be responsible for payment of these tests.

J. Direct shear tests shall be conducted with nominal loads approximating in-situ conditions, including construction equipment loads. The specimen shall be a minimum of 12 inches square and shall be from the same run or lot number as the material to be placed.

K. Prepare a test report that addresses complete test details, procedures, and results. Submit report to the ENGINEER at least 4 weeks prior to placement.

2.02 GEOMEMBRANE CAP

A. The geomembrane liner shall consist of a linear low density polyethylene (LLDPE) flexible geomembrane. The geomembrane shall be unreinforced, 1.02 mm (40 mil) thick, and textured on both sides.

B. The resin shall be new first quality, compounded polyethylene resin that is manufactured specifically for producing geomembrane. At no time shall the Manufacturer intermix resin types. The natural resin (without carbon black) shall meet the following additional requirements as shown in Table 3.

Table 3: Natural Resin Requirements

Property	Test Method[1]	LLDPE Resin
Density (g/cm^3)	ASTM D792 (B) or D1505	≥ 0.92
Melt Flow Index (g/10 min.)	ASTM D1238 (190° C/2.16 kg)	≤ 1.0
OIT (minutes)	ASTM D3895 (1 atm, 200° C)	≥ 100

1. All procedures and values are subject to change without prior notification.

C. Geomembrane shall be 40-mil textured LLDPE geomembrane or approved equal, and meet the minimum requirements shown in Table 4 of this specification. The Manufacturer shall conduct quality control (QC) testing at the frequencies provided in Table 4 to assure conformance with the requirements.

Table 4: Minimum Values for Coextruded Textured LLDPE Geomembranes

Property	Test Method	Values	QC Frequency	QA Frequency
Minimum Thickness (mil)	ASTM D5994	38 (min) 40 (MARV)	per roll	per roll
Minimum Density (g/cm^3)	ASTM D792 (B) or D1505	0.92	per 200,000 lbs.	per 200,000 lbs.
Asperity Height (mil)	GRI GM-12	10	every 2nd roll[4]	every 2nd roll[4]
Carbon Black Content (%)	ASTM D1603, modified	2.0 to 3.0	45,000 lbs.	45,000 lbs.
Carbon Black Dispersion	ASTM D5596	See Note 2	45,000 lbs.	45,000 lbs.
Tensile Properties (each direction)[1] • Strength @ Break (lb/in) • Elongation @ Break (%)	ASTM D6693; Type IV, 2 ipm 2.0" gauge length	 60 250	per 20,000 lbs.	per 20,000 lbs.
Tear Resistance (lb)	ASTM D1004	22	45,000 lbs.	45,000 lbs.
Puncture Resistance (lb)	ASTM D4833	44	45,000 lbs.	45,000 lbs.
Oxidative Induction Time (min)[3] • Std. OIT • High Pressure OIT	 ASTM D3895 ASTM D5885	 100 400	200,000 lbs.	--

Property	Test Method	Values	QC Frequency	QA Frequency
Oven Aging at 85° C[3] • High Pressure OIT (%)	ASTM D5721	60	per resin formulation	--
UV Resistance[3] • High Pressure OIT (%)	GRI – GM11	35	per resin formulation	--
2% Secant Modulus (lb/in max)[3]	ASTM D5323	2400	per resin formulation	--

1. The combination of stress concentrations due to coextrusion texture geometry and the small specimen size results in large variation of test results. Therefore, these tensile properties are minimum average roll values.
2. Only near spherical agglomerates are considered. Nine of ten views shall be Category 1 or 2. No more than one view Category 3.
3. Not required for QA testing.

D. Geomembrane pre-construction quality conformance samples shall be taken by the CQA Consultant from preshipped material at the factory or from shipped material on site at the frequency provided in Table 4. Samples shall be shipped to the Testing Laboratory for conformance testing of the properties listed in Table 4 for QA testing.

E. The extrudate rod and/or bead shall be made from same type resin as the geomembrane. Additives shall be thoroughly dispersed, and the material shall be free of contamination by moisture or foreign matter.

2.03 FACTORY QUALITY CONTROL

A. Quality control testing shall be carried out by the Manufacturer to demonstrate that the geomembrane meets the Specifications in this section. Additional testing may be carried out for purposes of determining conformance by the CQA Consultant. If the results of the Manufacturer's and the CQA Consultant's testing differ significantly, the testing shall be repeated by the CQA Consultant, and the Manufacturer shall be allowed to monitor this testing. The results of this latter series of tests shall prevail, provided that the applicable test methods have been followed.

B. Prior to the delivery of any geomembrane material, the manufacturer shall submit the following information:

1. The origin (resin supplier's name, resin production plant), identification (brand name, number), and production date of the resin.

2. A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane.

3. Copies of the quality control certificates issued by the resin supplier.

4. Reports on the tests conducted by the Manufacturer to confirm that the quality of the resin used to manufacture the geomembrane satisfy these Specifications.

5. A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in these Specifications, or equivalent.

6. Reports on the tests, including sampling procedures, conducted by the manufacturer to confirm that the geomembrane meets the Specifications. Manufacturing quality control testing frequencies shall be in accordance with Tables 1 to 4 of this Specification.

7. A certification that property values given in the properties sheet are guaranteed by the geomembrane manufacturer

C. Prior to shipment, the geomembrane Manufacturer shall provide a quality control certificate for each roll of geomembrane. The quality control certificate shall be signed by a responsible party employed by the geomembrane manufacturer, such as the production manager. The quality control certificate shall include:

1. Roll numbers and identification, resin lot, and batch numbers.

2. Sampling procedures and results of quality control tests.

PART 3 – EXECUTION

3.01 PREPARATION

A. Ensure that surfaces to be lined are smooth and free of rocks, stones, roots, sharp objects, or debris of any kind.

B. Provide a firm, unyielding foundation for the geomembrane with no abrupt changes or break in grade.

C. Surface moisture shall not be excessively wet or dry or in any condition that will impede proper installation. Under no condition shall the geomembrane be placed over standing water on the subgrade

D. The Installer and the ENGINEER or CQA Consultant shall approve the subgrade before the installation. No geomembrane shall be placed on unsuitable subgrade. No stones or sharp objects shall be present on the surface to be lined.

E. The Installer shall certify in writing that the surface on which the geomembrane shall be installed is acceptable. The certificate of acceptance shall be given by the Installer to the CQA Consultant prior to commencement of geomembrane installation in the area under consideration.

3.03 CQA SAMPLES

A. Conformance samples shall be collected by the CQA Consultant upon delivery to the site at a frequency detailed in Section 2.02.

B. The outer layer of the geomembrane roll shall be discarded prior to sampling a roll.

C. Samples shall be collected by cutting the full-width of the geomembrane sheet a minimum of three (3) feet wide in the machine direction. After cutting, the geomembrane sample shall be manually rolled around a core at least three (3) inches in diameter. The geomembrane shall be wound on the core without slack. Strapping tape a minimum of two (2) inches in width shall then be wound around the sample in at least two places to secure the loose end. The CQA Consultant shall mark the machine direction on the samples with an arrow.

D. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot and roll number. The date, a unique sample number, the machine direction, and the top surface of the geomembrane shall also be noted on the sample.

3.04 ANCHOR TRENCHES

A. Excavate to the lines and widths shown on the Construction Drawings.

B. Remove all loose soil from the anchor trenches.

C. Prevent desiccation of trench soils prior to backfilling.

3.05 DEPLOYMENT

A. It shall be the responsibility of the Installer to assign each field panel an "identification code" (number or letter-number) consistent with the layout plan. This field panel identification code shall be as simple and logical as possible.

B. The CQA Consultant shall visually inspect the geomembrane during deployment. Any defects or suspect areas shall be marked and repaired, if necessary. Damaged panels or portions of damaged panels which have been rejected shall be removed from the work area. Any repairs shall be made according to procedures described in the CQA Plan and this Section.

C. Geomembrane shall be placed in a manner to prevent damage to underlying compacted geosynthetic materials.

D. Secure the panels as they are placed to prevent excessive movement.

D. No vehicles shall be permitted on the geomembrane prior to the placement of adequate soil cover.

F. All traffic over final covered areas shall be restricted to stabilized roadways.

G. All pipe penetrations through the geomembrane shall be sealed with a boot of the same HDPE material as the panels, meeting the same resin specifications, and installed according to the Construction Drawings and Specifications.

H. Sufficient material (slack) shall be provided to allow for geomembrane expansion and contraction.

3.06 FIELD SEAMING

A. Individual geomembrane panels shall overlap a minimum of 3 inches for extrusion welding or 4 inches for hot wedge welding.

B. Clean area to be welded and prepare area according to Manufacturer's instructions.

C. Remove wrinkles in panels prior to beginning field seaming.

D. Weld all sheeting together using the hot wedge fusion or extrusion method.

E. In the extrusion method, use extrudate having a composition identical to the geomembrane to be welded.

F. Wedge seams shall be double-track wedge seams.

G. If extension seams are used, grinding shall be done only by trained technicians.

H. Any area showing gouges or excessive wear due to grinding shall be removed and replaced using the procedure for replacement of damaged material.

I. Use welding equipment capable of continuously monitoring and controlling the temperatures and pressures in the zone of contact where the machine is fusing lining material. Ensure that changes in environmental conditions do not affect the integrity of the weld.

J. No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, cut and overlap the material and repair using the extrusion welding method in accordance with procedures outlined in the CQA Plan.

K. Replace or repair with an additional piece of LLDPE geomembrane any geomembrane area showing damage due to excessive scuffing, puncture, or distress from any cause.

3.07 FIELD DAMAGE

A. Protect the geomembrane from damage.

B. Panels that have been moved or have developed excessive wrinkles shall be inspected and repaired or replaced as required by the CQA Consultant or ENGINEER.

C. If a large wrinkle develops at the toe of the slope, and cutting and seaming is determined to be an acceptable repair, this operation shall be the final operation in the cap installation prior to covering.

3.08 FIELD SEAM TESTING

A. Use on-site non-destructive testing on all welds to ensure watertight, homogeneous and continuous seams. Acceptable methods are the air pressure test and the vacuum box test.

B. All tests must include visual inspection of all seams.

C. Submit a detailed test protocol for approval prior to installation of the material.

D. The installer's quality control technician shall inspect each seam. Any area showing a defect shall be marked and repaired in accordance with HDPE repair procedures.

E. Prepare a trial seam three feet long with each welding machine/operator combination each day prior to production seaming and every four hours thereafter, under the same conditions as exist for the liner welding. A new trial seam will be required if changing weather conditions warrant or if operators are changed on a machine.

F. Mark each test weld with the date, ambient temperature, and welding machine number.

G. Samples of weld one inch wide shall be cut from the trial seam and tested for shear and peel. Five specimens shall be tested for peel (both inside and outside tracks for fusion seams) and five specimens shall be tested for shear.

H. Seams shall be stronger than the geomembrane material as determined by film tear bond failure. Seams will be evaluated based on Section 4.4.4.3 of the CQA Plan.

I. Portions of the weld sample shall be kept for subsequent testing on laboratory tensiometer equipment.

J. Random weld samples may be removed from the installed welded sheeting for testing if deemed necessary by the OWNER, ENGINEER, or CQA Consultant.

K. Destructive testing of the seams is required on a maximum 500-foot frequency. The CQA Consultant will identify the location of the tests.

L. Samples of the weld shall be removed and tested in accordance with the CQA Plan.

M. For each test, three samples will be retained. One will be tested on site by the Installer, one will be retained by CQA Consultant for laboratory testing, and one will be retained by the OWNER for archival record of the weld.

N. If a destructive sample fails any test, the testing shall be repeated at locations ten feet away prior to and after the original sample location.

O. If the second tests pass, the failed portion of the seam must be repaired, as detailed in Section 3.09 of this Specification.

P. If any second test fails, repeat the procedure above until a passing section of the seam is found.

Q. The failed seam must be capped. All seams must be bound on both ends by sections that pass destructive tests.

R. Upon completion of the test, patch the area of the test in accordance with the CQA Plan.

3.09 REPAIR PROCEDURES

A. Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test shall be repaired. All repairs shall be conducted in accordance with this Specification. All repairs shall be subjected to the nondestructive seam testing procedures described in this Specification.

B. Remove damaged geomembrane, and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.

C. Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test. Installer shall be responsible for repair of damaged or defective areas. Agreement upon the appropriate repair method shall be decided between the CQA Consultant and the Installer. Available procedures are provided in the CQA Plan

D. For all repair methods, the following procedures shall be observed.

1. Surfaces of the geomembrane that are to be repaired by extrusion welds shall be lightly abraded with a disc grinder or equivalent to assure cleanliness.

2. All geomembrane surfaces shall be clean and dry at the time of repair.

3. Extend patches or caps at least six inches for extrusion weld and four inches for wedge weld beyond the edge of the defect. Round all corners of patch material.

4. The geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

E. Repair Verification

1. Number and log each patch repair (completed by CQA Consultant).

2. Non-destructively test each repair using methods specified in this Technical Specification and the CQA Plan.

3.10 VISUAL INSPECTION AND EVALUATION

A. Immediately before covering, the geomembrane shall be visually inspected by the CQA Consultant for defects, holes, or damage due to weather conditions or construction activities.

B. Any suspect locations shall be non-destructively tested in accordance with this Specification. Any location that fails non-destructive testing shall be repaired in accordance with this Specification and non-destructively retested.

3.11 MATERIALS IN CONTACT WITH GEOMEMBRANE

A. Do not place protective cover or granular materials on the geomembrane at ambient temperatures below 0 degrees C (32 degrees F) or above 40 degrees C (104 degrees F), unless otherwise specified.

B. No vehicular equipment shall be operated directly on top of the geomembrane.

C. Equipment used shall not damage the geomembrane by handling, trafficking, or leakage of hydrocarbons (i.e., fuels).

D. Equipment used for spreading protective cover or granular drainage layer material shall not be driven directly on the geomembrane. A minimum thickness of 1 foot of protective cover or granular material shall be maintained between spreading equipment and the geomembrane. A minimum thickness of 3 feet of granular material shall be maintained between rubber-tired hauling vehicles and the geomembrane.

E. Equipment used for spreading protective cover or granular material shall be a light low ground pressure dozer (such as a wide-pad Caterpillar D6H LGP or lighter), or approved equal.

F. Spreading equipment operating on soil materials shall not spin their tracks, make sharp turns, or make sharp, rapid starts or stops. Soil materials shall be pushed carefully from previously placed material and not dumped directly onto geosynthetics. Protective cover and drainage layer spreading operations shall be continuously monitored by the CQA Consultant. Placement of soil materials on the geomembrane shall not be allowed within 50 feet of any unseamed edge of geomembrane

3.12 RECORDS AND QUALITY ASSURANCE

A. The following records shall be kept as part of the installation process:

1. Panel Placement Log
2. Trial Seam Testing Log
3. Panel Seaming/Testing Log
4. Repair/Testing Log
5. Geomembrane Panel Layout Record Drawing (including locations of destructive test samples and repairs)

B. All repaired field defects, patches, reworked seams, repaired fish mouths, and any other non-standard field seams shall have the following information marked on the geomembrane with a suitable marker:

1. Initials of Repair Technician with Machine Number
2. Date Repaired
3. Date of Test
4. Indication of Pass/Fail

C. Do not cover the geomembrane until all repairs have been properly tested and documented.

D. Results of the test and monitoring reports shall be turned over to the CQA Consultant for review on a daily basis.

3.13 GEOMEMBRANE SYSTEM ACCEPTANCE

A. The Installer shall retain all ownership of and responsibility for the geosynthetics in the lining system until acceptance by the CQA Consultant.

B. The geosynthetic caping system shall be accepted by the CQA Consultant when all four of the following requirements have been satisfied:

1. The installation is finished.

2. Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

3. A written construction report, including "as built" drawings and all other installation documents, has been prepared by the CQA Consultant.

4. CQA Consultant testing and inspection has been completed and accepted, as applicable.

* * END OF SECTION 02770 * *

SECTION 02936

SEEDING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this Section includes the furnishing of all labor, materials, equipment and incidentals required for preparations and placement of seeding as directed by the OWNER and as shown on the Drawings. This work shall include maintenance of established vegetation until final acceptance. The CONTRACTOR shall be expected to provide and place all erosion materials and topsoil necessary to complete the work.

B. CONTRACTOR shall revegetate all areas disturbed by his operations. All areas disturbed or not having sufficient vegetation to prevent erosion shall be revegetated.

1.02 RELATED SECTIONS

A. Section 02220 – Excavation

B. Section 02225 – Structural Fill

C. Section 02905 – Erosion Layer

1.03 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

B. The ENGINEER reserves the right to test, reject, or accept all materials before application.

1.04 MAINTENANCE DATA

A. Submit maintenance data for continuing OWNER maintenance.

B. Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Transport and handle products in accordance with the Manufacturer's instructions.

B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging will not be acceptable.

C. Deliver fertilizer in waterproof bags showing weight, chemical, analysis, and name of manufacturer.

D. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

E. Store and protect products in accordance with the Manufacturer's instructions with seals and labels intact and legible.

1.06 TEMPORARY VEGETATION

A. Refer to the North Carolina Erosion and Sediment Control Planning and Design Manual, Section 6.10 – Practice Standards and Specifications, Temporary Seeding.

B. When earth moving activities are completed more than 21 days prior to installation of permanent control measures, or final grading is completed during a season not favorable for immediate establishment of permanent vegetation, stabilize with rapid growing annual grasses of a seasonally appropriate species.

C. Temporary seeding applies on any cleared, unvegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than one (1) year.

1.07 PERMANENT SEEDING

A. Refer to the North Carolina Erosion and Sediment Control Planning and Design Manual, Section 6.11 – Practice Standards and Specifications, Permanent Seeding.

PART 2 – PRODUCTS

2.01 SOIL MATERIALS

A. Erosion control material shall be free of weeds as specified in Technical Specification Section 02905.

2.02 FERTILIZER

A. Fertilizer shall comply with applicable state laws of North Carolina and shall be delivered in unopened bags or other unopened convenient standard container, each fully labeled with the manufacturer's guaranteed analysis.

B. Fertilizer shall contain not less than 10 percent nitrogen, 10 percent available phosphoric acid and 10 percent water soluble potash (N-P-K, 10-10-10), unless otherwise needed based on fertility test of soil materials.

C. Any fertilizer which becomes caked or otherwise damaged, making it unsuitable for use, will not be acceptable and shall be immediately removed from the job site.

2.03 SEED

A. Seed shall be brought on site unmixed unless the mixture is certified and stated on the package as to the quality and mixture. Mixing shall be done at the project site from the original unopened packages.

2.04 AGRICULTURAL GROUND DOLOMITIC LIMESTONE

A. Lime shall comply with applicable state laws of North Carolina and shall be delivered in unopened bags or other unopened convenient standard containers, each fully labeled with the manufacturer's guaranteed analysis.

B. Lime shall be ground limestone containing not less than 85 percent total carbonates and shall be ground to such fineness that 90 percent by weight will pass through a No. 20 mesh sieve and 50 percent by weight will pass through a No. 100 mesh sieve, unless otherwise needed based on fertility test of soil material.

2.05 SEED MULCH

A. Refer to the North Carolina Erosion and Sediment Control Planning and Design Manual, Section 6.14 – Practice Standards and Specifications, Mulching.

B. Seeding mulch shall be wood fiber, straw, or non-woven fibers free from weeds and foreign matter detrimental to plant life.

PART 3 – EXECUTION

3.01 GENERAL

A. Areas to be seeded include all areas disturbed during construction that are not to be paved.

B. Verify that prepared soil base is ready to receive the work of this section.

3.02 FERTILIZER AND LIME

A. Apply lime at the rate of 2000 - 3000 lbs/acre (45 - 70 lbs/1000 ft^2), and fertilizer at the rate of 700 - 1000 lbs/acre (16 - 23 lbs/1000 ft^2), or apply lime and fertilizer per soil specific test data.

B. Mix thoroughly into upper four to six inches of topsoil.

C. Lightly water to aid the dissipation of fertilizer and lime.

3.03 SEEDBED PREPARATION

A. Remove loose rocks, roots, and other obstructions so that they will not interfere with the establishment and maintenance of vegetation.

B. Prepare seedbed to a depth of four to six inches.

C. The areas shall be made friable and receptive to seeding by approved methods, which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.

D. Fine grade areas to a firm even surface, free from lumps or stones 1 inch or more in any dimension. Installation of grass areas may be done immediately after finish grading provided the seeding bed is in a good condition and not muddy or hard. If it is hard, till to a friable condition again.

3.04 TEMPORARY SEEDING

A. Provide temporary seeding on any cleared, non-vegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than one year or when seeding dates will prevent the establishment of vegetative cover if permanent seeding is attempted.

Seed in accordance with the following schedule and application rates:

Seeding Dates	Seeding Mixture	Rate (lbs/acre)
January 1 – May 1	Rye (grain) Kobe lespedeza	120 50
May 1 – August 15	German millet OR Small-stemmed Sudangrass	40 OR 50
August 15 – December 30	Rye (grain)	120

B. To amend soil, follow recommendations of soil tests or apply 2000 lbs/acre ground agricultural limestone and 750 - 1000 lbs/acre 10-10-10 fertilizer, as recommended in the North Carolina Erosion and Sediment Control Planning and Design Manual, Section 6.10 – Practice Standards and Specifications, Temporary Seeding.

C. Mulch with three inch straw applied at the rate of 4000 lbs/acre. Anchor by tacking with asphalt, netting, or a mulch anchoring tool.

D. Refertilize if growth is not fully adequate.

E. Reseed, refertilize, and mulch immediately following erosion or other damage.

3.05 PERMANENT SEEDING – STEEP SLOPES (3:1)

A. Seed steep slopes (3:1) in accordance with the following schedule and application rates:

Seeding Dates	Seeding Mixture	Rate (lbs/acre)
August 20 – October 25 February 1 – April 15	Tall fescue Sericea lespedeza Kobe lespedeza Pensacola Bahiagrass	100 30 10 25

B. After August 15, use unscarified sericea seed.

C. Where a neat appearance is desired, omit sericea and substitute 40 lb/acre Bahiagras or 15 lb/acre Bermudagrass. Use common Bermudagrass only where it is unlikely to become a pest.

D. Between May 1 and August 15, add 10 lb/acre German millet or 15 lb/acre Sudangrass as a nurse plant. Prior to May 1 or after August 15, add 40 lb/acre rye (grain).

E. Fall is best for tall fescue, and lespedezas in late winter. Overseeding of Kobe lespedeza over fall-seeded tall fescue is effective. Use unhulled Bermudagrass seed in fall.

F. Apply lime and fertilizer according to soil tests, or apply 4,000 lbs/acre ground agricultural limestone and 1,000 lbs/acre 10-10-10 fertilizer.

G. Apply 4,000-5,000 lb/acre grain straw or equivalent cover of another suitable mulching material. Anchor straw by tacking with asphalt, roving, netting, or by crimping with a mulch anchoring tool. Netting is the preferred anchoring method on steep slopes.

H. Refertilize in the second year unless growth is fully adequate.

I. May be mowed once or twice a year, but mowing is not necessary.

J. Reseed, fertilize, and mulch damaged areas immediately.

3.06 PERMANENT SEEDING – GRASS LINED CHANNELS

A. Seed grass lined channels in accordance with the following schedule and application rates:

Seeding Dates	Seeding Mixture	Rate (lbs/acre)
August 25 – October	Tall fescue	200 (4-5 lb/1,000 ft^2)

B. Between May 1 and August 15, add 15 lb/acre German millet or 15 lb/acre Sudangrass as a nurse plant. Prior to May 1 or after August 15, add 40 lb/acre rye (grain).

C. Avoid seeding from November to January. If seeding must be done at this time, add 40 lb/acre rye grain and use a channel lining that offers protection.

D. Apply lime and fertilizer according to soil tests, or apply 4,000 lbs/acre ground agricultural limestone and 1,000 lbs/acre 10-10-10 fertilizer. Operate tillage equipment across the waterway.

E. Use a rolled erosion control product to cover the bottom of channels and ditches, and staple securely. The lining should extend above the highest calculated depth of flow. On channel side slopes above this height, and in drainages not requiring temporary linings, apply 4,000 lb/acre grain straw, and anchor straw by stapling netting over the top. Mulch and anchoring materials must not be allowed to wash down slopes where they can clog drainage devices.

F. Refertilize in late winter of the following year; use soil tests or apply 150 lb/acre 10-10-10.

G. Inspect and repair mulch frequently.

H. Mow regularly to a height of 2-4 inches.

3.07 PERMANENT SEEDING – LOW MAINTENANCE AREAS

A. Seed low maintenance areas in accordance with the following schedule and application rates:

Seeding Dates	**Seeding Mixture**	**Rate (lbs/acre)**
August 20 – October 25 February 1 – April 15	Tall fescue Sericea lespedeza Kobe lespedeza	80 20 10

B. After August 15, use unscarified sericea seed.

C. Where periodic mowing is planned or a neat appearance is desired, omit sericea and increase Kobe lespedeza to 40 lb/acre.

D. Between May 1 and August 15, add 10 lb/acre German millet or 15 lb/acre Sudangrass as a nurse plant. Prior to May 1 or after August 15, add 40 lb/acre rye (grain).

E. Fall is best for tall fescue, and lespedezas in late winter. Overseeding of Kobe lespedeza over fall-seeded tall fescue is effective.

F. Apply lime and fertilizer according to soil tests, or apply 4,000 lbs/acre ground agricultural limestone and 1,000 lbs/acre 10-10-10 fertilizer.

G. Apply 4,000 lb/acre grain straw or equivalent cover of another suitable mulching material. Anchor straw by tacking with asphalt, roving, netting, or by crimping with a mulch anchoring tool.

H. Refertilize in the second year unless growth is fully adequate.

I. May be mowed once or twice a year, but mowing is not necessary.

J. Reseed, fertilize, and mulch damaged areas immediately.

3.08 REPLANTING

A. The CONTRACTOR shall be required to replant areas damaged by water, wind, fire, equipment or pedestrian traffic as necessary or when ordered by the OWNER at no cost to the OWNER.

B. All areas and spots that do not show a prompt catch of vegetation shall be reseeded at fifteen day intervals until a growth of grass is established. CONTRACTOR shall reseed as required to establish a minimum of 95% vegetation coverage within 1 year of initial planting. Remedial seeding, fertilizer and lime will be applied at no additional cost to the OWNER.

3.09 COMPACTION

A. The CONTRACTOR shall keep all equipment and vehicular and pedestrian traffic off areas that have been seeded to prevent excessive compaction and damage to young plants. Where such compaction has occurred, the CONTRACTOR shall rework the soil to make a suitable seedbed; then reseed and reblanket such areas with the full amounts of the specified materials, at no extra expense to the OWNER.

3.10 MULCHING

A. If seeding is done with hydromulching, then seeding mixture shall be increased 10 percent.

B. Petroleum-based binders are not allowed.

C. Hydromulching of seeding areas shall have approved mulch applied at a rate as recommended by the manufacturer for tacking agent.

D. Other methods of mulching shall not be applied prior to approval by the ENGINEER.

3.11 MAINTENANCE OF GRASS AREAS

A. Water, weed, and reseed throughout the construction contract and/or acceptance by the OWNER after seeding areas are substantially established turf areas.

B. Install and maintain temporary protection fences, barriers, and signs where deemed necessary.

* * * * * END OF SECTION * * * * *

EP-2

OBJECTIVE:

The purpose of the current analysis is to evaluate the post-closure stability of the landfill at the Phase 2 Expansion of the WCA of High Point C&D Landfill. The facility is located along the eastern border of the City of High Point, along the west side of Riverdale Drive, SR 1145, in southern Guilford County, North Carolina. The C&D (construction and demolition) landfill facility property consists of approximately 154 acres with 49.2 acres used for C&D waste disposal. The proposed Phase 2 expansion is located immediately adjacent to the northern and eastern limits of the first five-year phase developed at the site and includes a 9.4-acre disposal cell. This analysis investigates the stability of two critical cross sections for the proposed Phase 2 final grades.

METHODS:

Rocscience's two-dimensional limit-equilibrium slope stability model, SLIDE 5.0, was used for factor of safety calculation. SLIDE analyzes the stability of slip surfaces using vertical slice limit equilibrium methods (Rocscience, 2006). Random circular failure surface and block search routines were used to locate the critical failure surface (the surface with the lowest factor of safety). The search was restricted to failure surfaces with a minimum thickness of three feet; superficial slides were ignored.

- The critical circular failure surfaces were determined using the simplified Bishop method. This is a method of slices defined assuming a circular failure surface and equilibrium based on slice weights and shear force. No horizontal (interslice) forces are addressed.
- Noncircular, wedge, or block failures were determined using Spencer's Method. Spencer's is a method of slices that assumes parallel interslice forces and normal forces acting at the center of the base of the slice. It is considered a complete static equilibrium equation.

ASSUMPTIONS:

- The general geometry was taken from the Phase 2 Engineering Plan Drawings (Golder, 2007). The cross sections reach the maximum elevation of 898 feet with 3H:1V (horizontal:vertical) sideslopes. Copies of these drawings are included in Attachment A as Figures 1 through 3.
- The bedrock profile was estimated based on the Bedrock Elevation Contour Map with Proposed Base Grades (Golder, 2007). This is included as Figure 4 in Attachment A.
- Base grades proposed for the Phase 2 expansion include in-situ soils and structural fill. No liner or leachate collection system is proposed for the expansion. The facility will be capped with a soil vegetative and protective layer, a gas collection layer, and either a minimum 18 inch soil cap or an alternate 40 mil FML geomembrane cap with overlying drainage collection layer.
  - The subgrade of the proposed landfill consists of the underlying native soils and controlled fill components (berms and embankments). The underlying in-situ materials that will serve as the foundation for the landfill include saprolitic silty sands and clayey sands.
  - Phase 2 is designed to maintain a minimum four foot separation between the post-settlement bottom elevation of waste and either the seasonal high ground-water table or the bedrock datum plane contours established in the Design Hydrogeological Report (Golder, 2007). The design vertical separation is illustrated on cross sections detailing proposed base grades, the seasonal high groundwater table, and the top of bedrock. This report is also the basis of the groundwater table assumed for the stability runs.
- Subsurface stratigraphy assumptions were based on Golder's geotechnical borehole logs from July 2006. The borehole logs are included as Attachment B.
- The peak ground acceleration (pga) for the site was determined using the United States Geological Survey (USGS) 2002 interactive system, looking the site up by its latitude and longitude, 35.948° latitude by -79.915° longitude (http://eqint.cr.usgs.gov/eq-men/). The pga corresponding to a 2% probability of

exceedance within 50 years was 0.1069 g. This criterion is considered by the USGS as equivalent to 10% in 250 years. This data is included as Attachment C.

- The material properties were decided based on laboratory data, information from the client, and typical soil values. Copies of the supporting data are included as Attachment D. The material properties modeled are:

  - Existing Soil: Saprolitic silty sands and clayey sands excavated to a thickness of approximately four feet. Modeled assuming values for low-plasticity clay (CL) as a conservative measure.
  - Bedrock: Anticipated as competent bedrock and was therefore modeled as an infinite strength barrier.
  - CDD: From Kavazanjian et al (1995), the anticipated unit weight range for municipal solid waste is 40 to 80 lb/ft^3. For this analysis, a unit weight of 70 lb/ft^3 was assumed.
  - Structural Fill: Fill used to bring the site up to design grades. On-site materials are anticipated as reusable structural fill. Typical shear strength values assumed for a clayey sand or silty sand with some plasticity.

TABLE 1
MATERIAL PROPERTIES

Material	Strength Type	Unit Weight, γ (lb/ft^3)	Cohesion, c' (lb/ft^2)	Friction Angle, ϕ' (degrees)
CDD	Mohr-Coulomb	125	0	35
Structural Fill	Mohr-Coulomb	114	0	34
Bedrock	Infinite Strength	160	NA	NA
Existing Soil	Mohr-Coulomb	110	0	28

ANALYSES:

Post-closure global stability was evaluated for static loading conditions for the final landfill geometry. The locations of the critical cross-sections selected for analysis are shown on cap grade drawing included in Attachment A. The geometry of the cross sections analyzed, including assumed water table conditions, are included in Attachment E with the SLIDE output results. Results from stability analyses are summarized in Table 2.

TABLE 2
RESULTS OF STABILITY ANALYSES

File Name	Failure	Setting	FS	Search	Method
Section A st circ gl.sli	circular	static	2.370	Auto Refine	Simplified Bishop
Section A st bl gl.sli	block	static	2.348	Block	Spencer
Section A ps circ gl.sli	circular	pseudostatic	1.687	Auto Refine	Simplified Bishop
Section A ps bl gl.sli	block	pseudostatic	1.665	Block	Spencer
Section B st circ gl.sli	circular	static	2.491	Auto Refine	Simplified Bishop
Section B st bl gl.sli	block	static	2.668	Block	Spencer
Section B ps circ gl.sli	circular	pseudostatic	1.744	Auto Refine	Simplified Bishop
Section B ps bl gl.sli	block	pseudostatic	1.851	Block	Spencer

CONCLUSIONS/RESULTS:

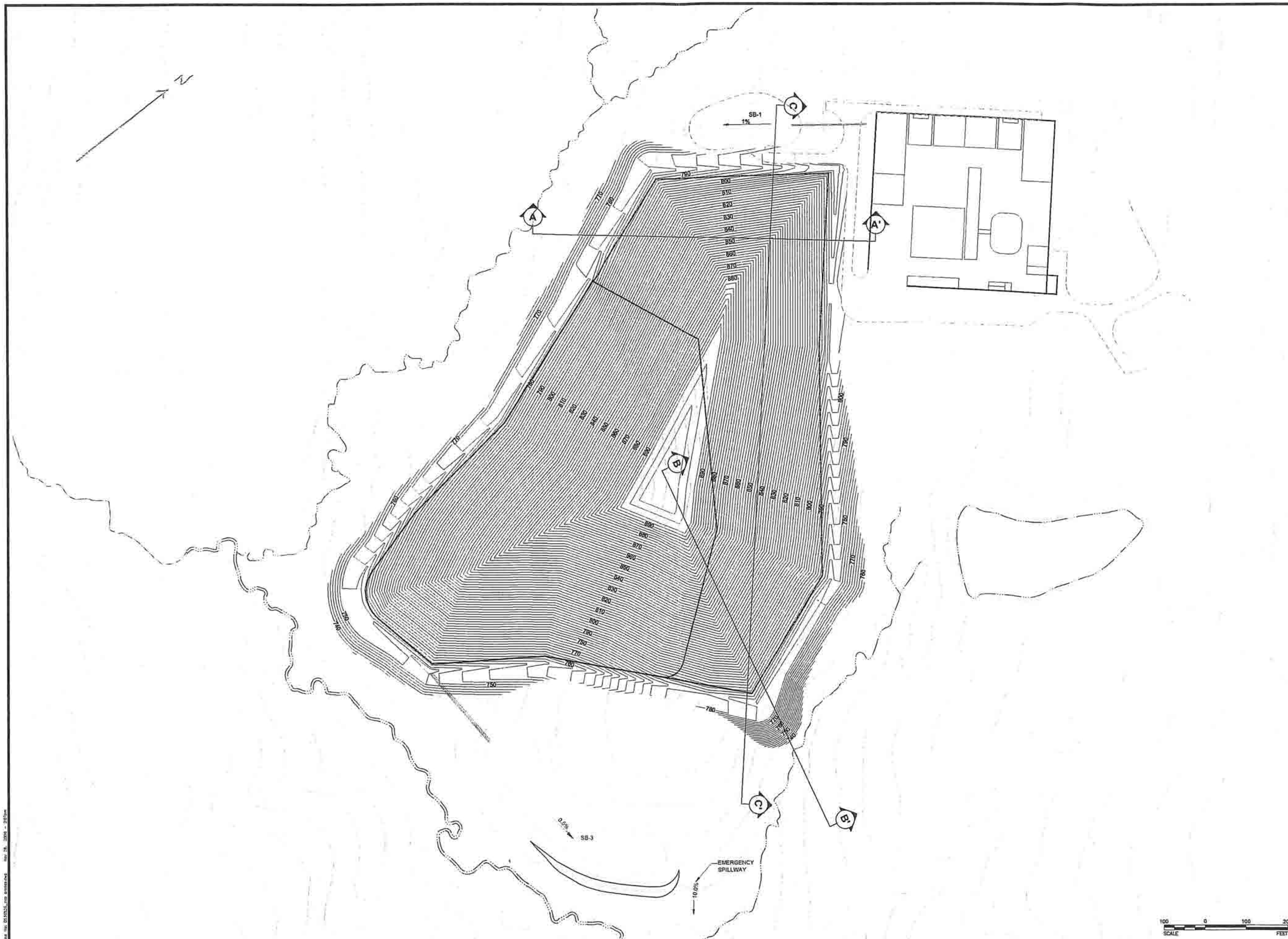
The Phase 2 construction of the WCA of High Point C&D Landfill permit design has a final elevation of 898 ft. with a 3H:1V sideslope. The stability analysis indicates factors of safety greater than 1.5 for static circular and block failures and greater than 1.1 for pseudostatic circular and block failures. The minimum factors of safety calculated were 2.3 for static and 1.6 for pseudostatic. Under the current standard of care, the conditions for this proposed phase are within acceptable limits for slope stability and bearing capacity.

REFERENCES:

- Golder Associates Inc. (2007). WCA of High Point Construction and Demolition Debris Landfill and Reclamation Facility. Guilford County, North Carolina. Phase 2 Engineering Plan.
- Golder Associates Inc. (2007). WCA of High Point Construction and Demolition Debris Landfill and Reclamation Facility. Guilford County, North Carolina. Phase 2 Design Hydrogeological Plan.
- Rocscience Inc. (2006) Slide v5.0: 2D Limit Equilibrium Slope Stability and Groundwater Analysis for Rock and Soil, Toronto, Canada.
- United States Geological Survey, (USGS 1990). "Preliminary Map of Horizontal Acceleration (Expressed as Percentage of Gravity) in Rock with 90 Percent Probability of Not Being Exceeded in 250 Years," Open File Report No. 82-1033, 1990. Algermissen, et. al.

ATTACHMENT A

ENGINEERING PLAN DRAWINGS



SCALE 100 0 100 200 FEET

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	10/16/06	GES	BEDROCK CONTOURS	CLF		

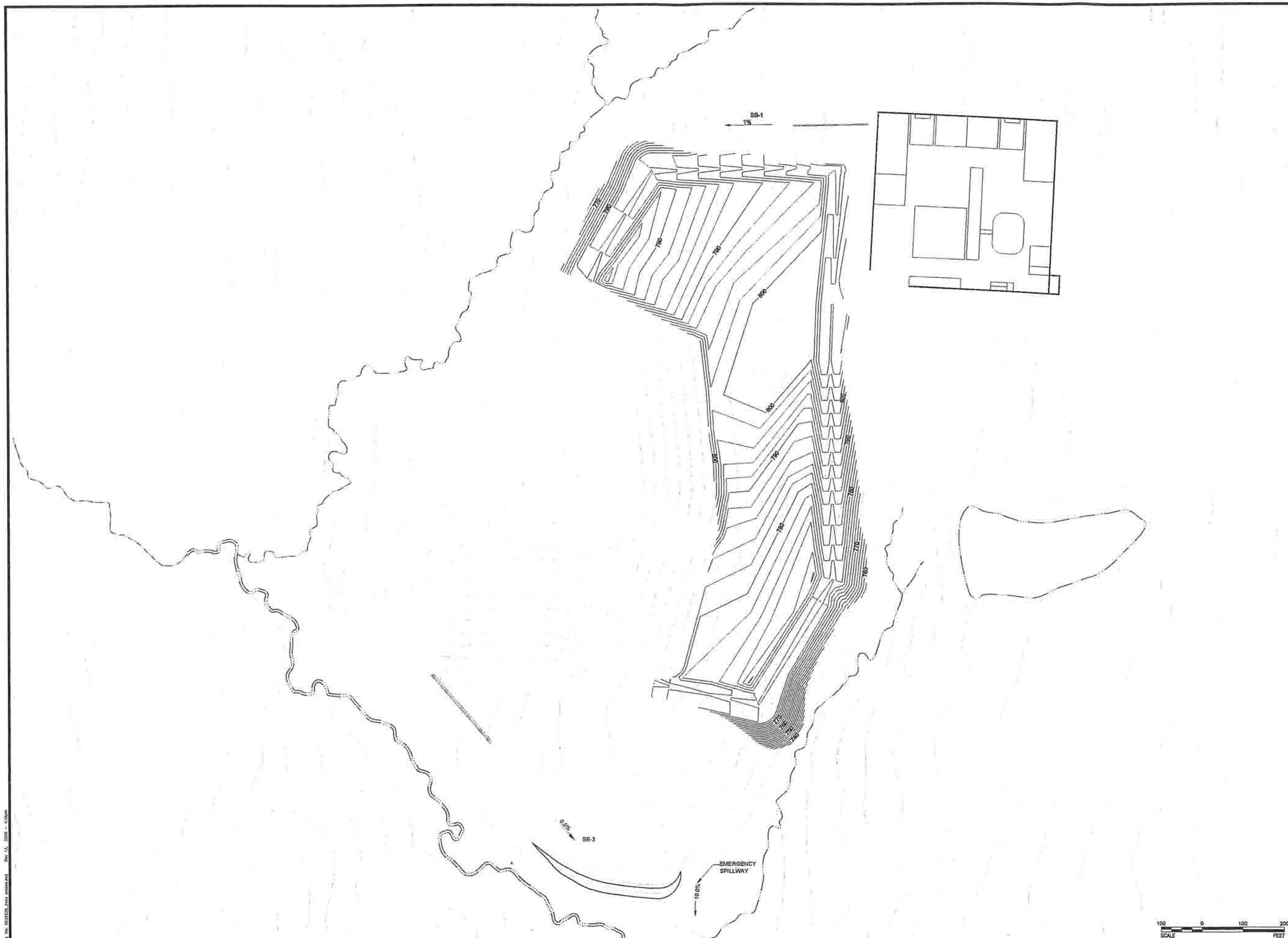
Golder Associates
GREENSBORO, NORTH CAROLINA

PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE
**EXISTING TOPOGRAPHY
WITH PROPOSED PHASE 2
CAP GRADES**

PROJECT No.		063-6526
FILE No.		
REV.	SCALE	AS SHOWN
DESIGN	CH	11/07/06
CADD	JDS	11/07/06
CHECK		
REVIEW		

DWG. ?



Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	10/16/06		BEDROCK CONTOURS	CLF		

PROJECT

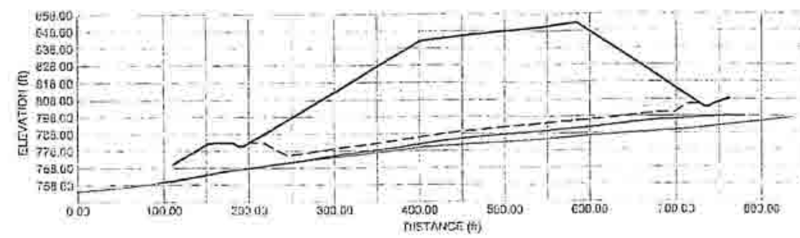
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE

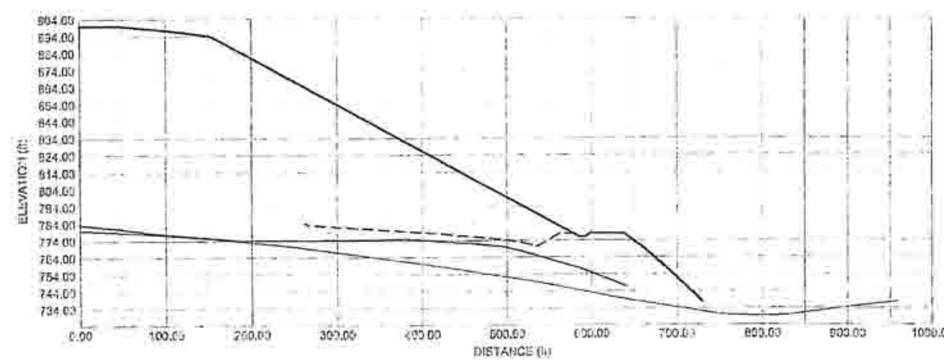
EXISTING TOPOGRAPHY WITH PROPOSED PHASE 2 BASE GRADES

PROJECT No.		063-6526
FILE No.		
REV.	SCALE	AS SHOWN
DESIGN	CH	11/07/06
CADD	JDS	11/07/06
CHECK		
REVIEW		

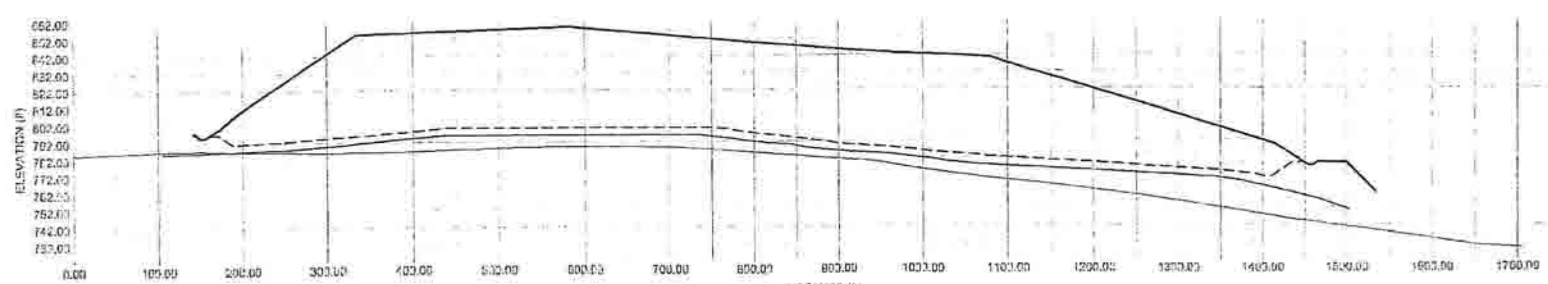
DWG. ?



(A) CROSS SECTION A-A'



(B) CROSS SECTION B-B'



(C) CROSS SECTION C-C'

2x VERTICAL EXAGGERATION

100 0 100 200

SCALE FEET

Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
1	10/16/06		BEDROCK CONTOURS	CLF		

PROJECT

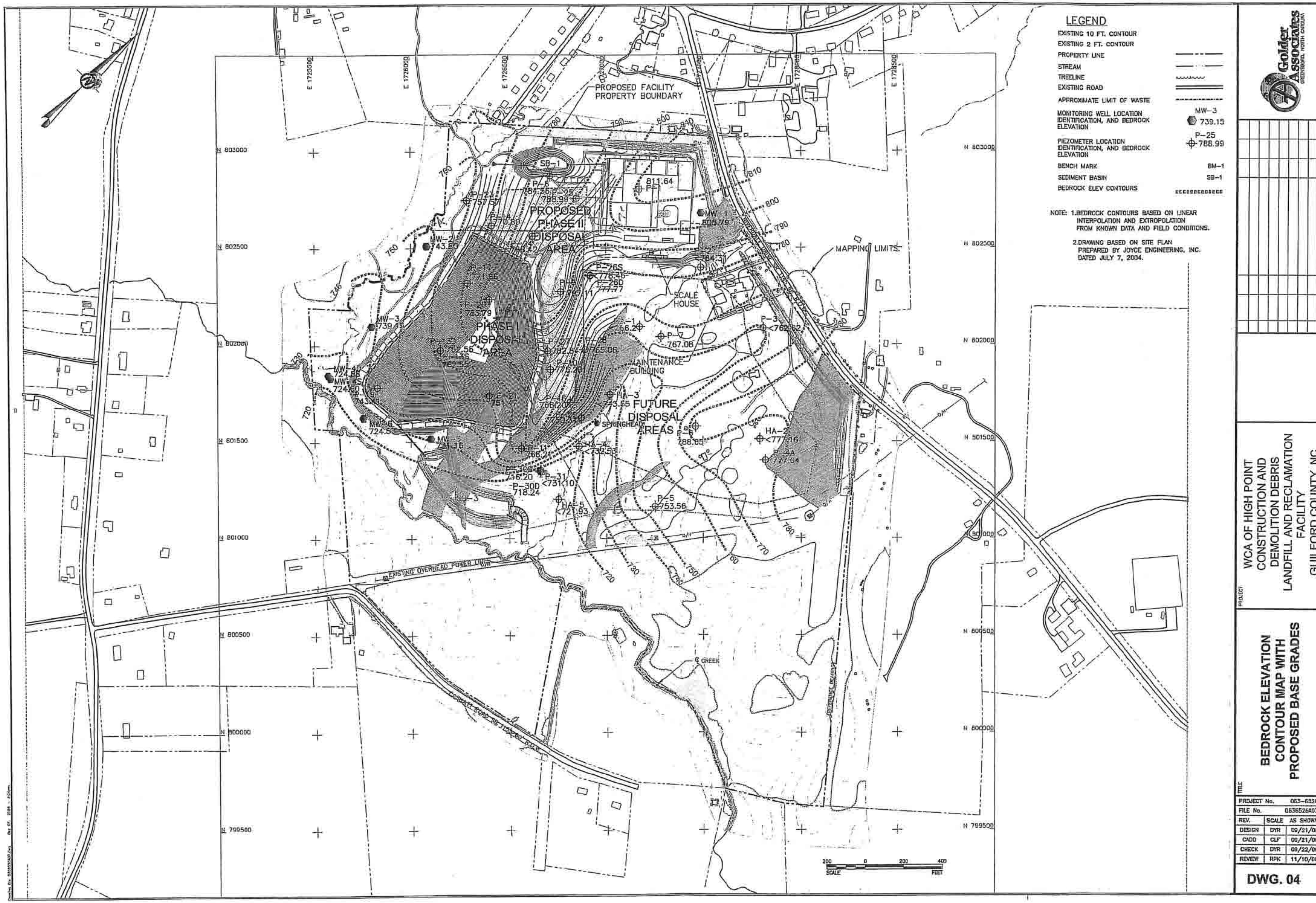
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE

CROSS SECTIONS

PROJECT No.		063-6526	
FILE No.			
REV.		SCALE	AS SHOWN
DESIGN			
CADD	JDS	28/11/06	
CHECK			
REVIEW			

DWG. ?


LEGEND
EXISTING 10 FT. CONTOUR
EXISTING 2 FT. CONTOUR
PROPERTY LINE
STREAM
TREELINE
EXISTING ROAD
APPROXIMATE LIMIT OF WASTE
MONITORING WELL LOCATION IDENTIFICATION, AND BEDROCK ELEVATION
MW-3
739.15
PIEZOMETER LOCATION IDENTIFICATION, AND BEDROCK ELEVATION
P-25
788.99
BENCH MARK
BM-1
SEDIMENT BASIN
SB-1
BEDROCK ELEV CONTOURS
NOTE: 1.BEDROCK CONTOURS BASED ON LINEAR INTERPOLATION AND EXTROPOLATION FROM KNOWN DATA AND FIELD CONDITIONS.
2.DRAWING BASED ON SITE PLAN PREPARED BY JOYCE ENGINEERING, INC. DATED JULY 7, 2004.
PROPOSED FACILITY PROPERTY BOUNDARY
PROPOSED PHASE II DISPOSAL AREA
PHASE I DISPOSAL AREA
FUTURE DISPOSAL AREAS
SCALE HOUSE
MAINTENANCE BUILDING
MAPPING LIMITS
SPRINGHEAD
EXISTING OVERHEAD POWER LINE
CREEK
REV. DATE DES REVISION DESCRIPTION CADD CHK RVW
Golder Associates
GREENSBORO, NORTH CAROLINA
PROJECT
WCA OF HIGH POINT CONSTRUCTION AND DEMOLITION DEBRIS LANDFILL AND RECLAMATION FACILITY
GUILFORD COUNTY, NC
TITLE
BEDROCK ELEVATION CONTOUR MAP WITH PROPOSED BASE GRADES
PROJECT No. 053-6526
FILE No. 0636526A07
REV. SCALE AS SHOWN
DESIGN DYR 09/21/06
CADD CLF 09/21/06
CHECK DYR 09/22/06
REVIEW RPK 11/10/06
DWG. 04

ATTACHMENT B

GEOTECHNICAL BOREHOLE LOGS

RECORD OF BOREHOLE P-23

SHEET 1 of 1

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 25.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/5/06
DATE COMPLETED: 7/5/06

NORTHING: 802,748.0
EASTING: 1,726,285.2
GS ELEVATION: 760.6 ft
TOC ELEVATION: 762.6 ft

DEPTH W.L.: 2.0 ft
ELEVATION W.L.: 760.6 ft
DATE W.L.: 7/6/06
TIME W.L.: 12:11 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0	760	0.0 - 3.0 SILTY SAND - brown fine grained silty sand, moist. Medium grained silty sand at 0.75 ft. Gray medium grained silty sand at 1.25 ft. Auger refusal at 3 ft	SM		757.6 / 3.0		SPT	3-3-4-8	7	100.0 / 2.0	
5	755	3.0 - 12.5 BEDROCK - granitic cuttings consisting of mainly quartz and biotite, coarse sand size cuttings, very competent									Grout
10	750	Less competent from 11 to 11.25 ft (possible fracture) based on drilling response			748.1 / 12.5						Bentonite
15	745	12.5 - 24.0 BEDROCK - mafic rock, small pebble size black cuttings with green dust. Apparent fracture at 20.5 ft based on drilling response, ~0.5 ft thick									
20	740	Less competent at 21.5 ft									#2 Sand; Screen
		Some granitic cuttings mixed with mafic rock cuttings at 23 ft			736.6 / 24.0						
25	735	24.0 - 25.0 BEDROCK - granitic cuttings with some mafic rock cuttings			735.6						
		Boring completed at 25.0 ft									
30	730										
35	725										
40											

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.04-15 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 15-25 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 13-25 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 11-13 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-11 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: 3x3x0.5 ft concrete
Protective Casing: 4-inch square aluminum

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

BOREHOLE RECORD 063526.100.GPJ PIEDMONT.GDT 12/5/06

RECORD OF BOREHOLE P-24

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 33.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 6/30/06
DATE COMPLETED: 6/30/06

NORTHING: 802,562.7
EASTING: 1,726,620.0
GS ELEVATION: 797.4 ft
TOC ELEVATION: 799.3 ft

DEPTH W.L.: 17.2 ft
ELEVATION W.L.: 782.1 ft
DATE W.L.: 7/3/06
TIME W.L.: 9:26 am

DEPTH (ft)	SOIL PROFILE: DESCRIPTION	USCS	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0	0.0 - 5.3 SILTY SAND - Tan medium grained silty sand, moist Changes to orange medium grained silty sand at 0.75 ft, moist at 1 ft	SM	792.2 / 5.3		SPT	2-2-3-8	5	100.0 / 2.0	
5	5.3 - 9.0 PARTIALLY WEATHERED ROCK - orange and white mottled coarse grained silty sand Auger refusal at 9 ft	SM	788.4 / 9.0		SPT	25-50/4	50/4	40.0 / 2.0	Grout
10	9.0 - 33.0 BEDROCK - very weathered, tan medium grained to pebble size cuttings, granitic More competent at 14 ft, tan medium grained sand size cuttings consisting mainly of quartz Apparent large fracture from 20.75 to 23 ft based on drilling response White and tan coarse sand size cuttings consisting of mainly quartz with some biotite at 25 ft Apparent small fracture from 26.5 to 26.75 ft based on drilling response Apparent fracture from 29 to 29.5 ft based on drilling response. Coarse sand to small pebble size cuttings with some iron staining Less competent material from 31.5 to 32 ft		764.4						Bentonite #2 Sand Screen
33	Boring completed at 33.0 ft								

Elevation scale: 795, 790, 785, 780, 775, 770, 765, 760. Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40.

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.05-18 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 18-33 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 16-33 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 14-16 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-14 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-25

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 37.5 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 6/29/06
DATE COMPLETED: 6/29/06

NORTHING: 802,762.7
EASTING: 1,726,810.0
GS ELEVATION: 802.5 ft
TOC ELEVATION: 805.2 ft

DEPTH W.L.: 21.1 ft
ELEVATION W.L.: 784.2 ft
DATE W.L.: 6/30/06
TIME W.L.: 9:27 am

DEPTH (ft)	DESCRIPTION	USCS	ELEV. / DEPTH (ft)	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC
0	0.0 - 6.0 SILTY SAND - orange fine to medium grained silty sand, moist	SM		SPT	6-5-5-7	10	100.0 / 2.0
5	Gray and orange medium to coarse grained silty sand at 5 ft, dry		796.5 / 6.0	SPT	4-6-50	>50	70.0 / 2.0
6	6.0 - 13.5 PARTIALLY WEATHERED ROCK - white weathered quartz sand with large quartz gravel	SWG					
11				SPT	50/5	50/5	10.0 / 2.0
13.5	Auger refusal at 13.5 ft		789.0 / 13.5				
13.5	13.5 - 37.5 BEDROCK - coarse sand to pebble size granitic cuttings consisting of mainly quartz and biotite						
18	Fine to medium grained sand size cuttings by 18 ft						
30	Small fracture at 30 ft based on drilling response						
31.5	Fracture from 31.5 to 32 ft based on drilling response. Granitic cuttings with some gravel size mafic rock cuttings that show some iron staining Pebble size granitic cuttings with some mafic rock cuttings at 33 ft Medium sand size granitic cuttings at 34 ft						
36	Weathered cuttings at 36 ft		765.0				
37.5	Boring completed at 37.5 ft						

Elevation scale (ft): 800, 795, 790, 785, 780, 775, 770, 765

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES: Grout, Bentonite, #2 Sand, Screen

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.75-27.5 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 27.5-37.5 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 26-37.5 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 24-26 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-24 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-26D

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 74.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/3/06
DATE COMPLETED: 7/7/06

NORTHING: 802,352.0
EASTING: 1,726,918.8
GS ELEVATION: 805.8 ft
TOC ELEVATION: 807.0 ft

DEPTH W.L.: 17.0 ft
ELEVATION W.L.: 790.1 ft
DATE W.L.: 7/11/06
TIME W.L.: 11:08 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC
0	805	0.0 - 10.0 SILTY SAND - orange and tan mottled medium grained silty sand with minor organics, moist Some clay at 1.75 ft	SM				SPT	1-5-5-6	10	100.0 / 2.0
5	800	White medium grained silty sand with granitic texture at 5 ft, dry					SPT	4-16-20-31	36	100.0 / 2.0
		More dense at 8 ft			795.8 / 10.0					
10	795	10.0 - 15.0 PARTIALLY WEATHERED ROCK - white medium grained clayey sand with granitic texture, dry	SC		790.8 / 15.0		SPT	31-50/3	50/3	35.0 / 2.0
15	790	15.0 - 25.0 PARTIALLY WEATHERED ROCK - white medium grained silty sand, dense	SM				SPT	50/4	50/4	10.0 / 2.0
20	785	White and tan coarse grained silty sand with granitic texture at 20 ft, dry, weathered quartz and biotite grains			780.8 / 25.0		SPT	35-50/4	50/4	25.0 / 2.0
25	780	25.0 - 28.0 PARTIALLY WEATHERED ROCK - grayish green mafic rock fragments and silt. Nearly vertical foliation present Gravel size rock fragments in cuttings at 27 ft Auger refusal at 28 ft	GM		777.8 / 28.0		SPT	8-50/5	50/5	15.0 / 2.0
		28.0 - 29.0 BEDROCK - grayish green mafic rock cuttings			776.8 / 29.0					
30	775	29.0 - 40.0 BEDROCK - coarse grained sand size quartz cuttings, very weathered, moist at 30 ft								
35	770	More competent at 32.5 ft, wet Core Run (33 to 38 ft) Rec = 100%, RQD = 100%, very competent granitic rock consisting primarily of quartz and biotite, one natural fracture at 36.4 ft with ~30 degree dip								
40		Core Run (38 to 41.25 ft) Rec = 89%, RQD = 89%, granitic rock consisting of quartz and biotite, one natural fracture with iron staining at 40.9 ft with ~40 degree dip.			765.8					

Log continued on next page

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES

Grout

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -1.25-53.5 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 53.5-73.5 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 51-73.5 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 49-51 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-49 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: HQ Core, 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-26D

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 74.0 ft
LOCATION: Jamestown, NC

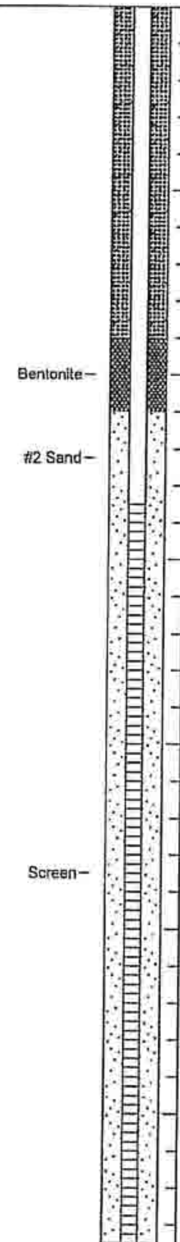
DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/3/06
DATE COMPLETED: 7/7/06

NORTHING: 802,352.0
EASTING: 1,726,918.8
GS ELEVATION: 805.8 ft
TOC ELEVATION: 807.0 ft

DEPTH W.L.: 17.0 ft
ELEVATION W.L.: 790.1 ft
DATE W.L.: 7/11/06
TIME W.L.: 11:08 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC
40	765	40.0 - 56.0 Stop coring at 41.25 ft because boring washing out			40.0					
45	760									
50	755									
55	750				749.8 56.0					
		56.0 - 60.5 BEDROCK - black mafic rock cuttings Mafic rock cuttings with some granitic cuttings by 59 ft			745.3 60.5					
60	745	60.5 - 73.5 BEDROCK - granitic rock consisting of quartz and biotite cuttings								
65	740									
70	735				732.3 73.5					
75	730	Boring completed at 74.0 ft								
80										

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -1.25-53.5 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 53.5-73.5 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 51-73.5 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 49-51 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-49 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: HQ Core, 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-26S

SHEET 1 of 1

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 28.0 ft
LOCATION: Jamestown, NC

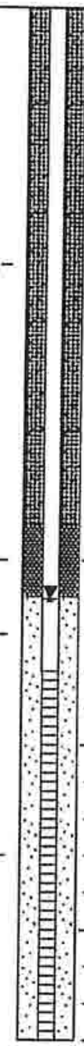
DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/10/06
DATE COMPLETED: 7/10/06

NORTHING: 802,360.8
EASTING: 1,726,918.7
GS ELEVATION: 806.5 ft
TOC ELEVATION: 808.7 ft

DEPTH W.L.: 16.1 ft
ELEVATION W.L.: 792.7 ft
DATE W.L.: 7/11/06
TIME W.L.: 11:09 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC
0		0.0 - 10.5 SILTY SAND - brown silty sand, moist Orange silty sand by 1 ft					
	805						
5		White and tan silty sand by 5 ft	SM				
	800						
10				796.0 10.5			
	795	10.5 - 28.0 PARTIALLY WEATHERED ROCK - white medium grained silty sand					
15							
	790						
20			SM				
	785						
25		More competent at 25 ft					
	780			778.5			
		Boring completed at 28.0 ft					
30	775						
35	770						
40							

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.25-16 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 18-28 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 16-28 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 14-16 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-14 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 6-inch Tricone
Rock Drill: None

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

BOREHOLE RECORD 063526.100.GPJ PIEDMONT.GDT 12/5/06

RECORD OF BOREHOLE P-27

SHEET 1 of 1

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 40.0 ft
LOCATION: Jamestown, NC

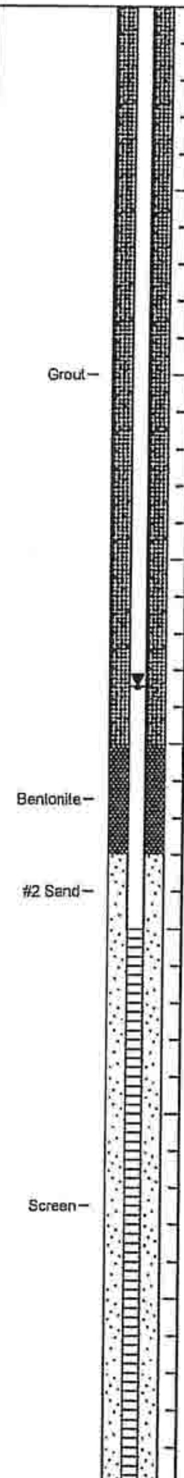
DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 6/29/06
DATE COMPLETED: 6/30/06

NORTHING: 801,970.9
EASTING: 1,726,699.4
GS ELEVATION: 796.3 ft
TOC ELEVATION: 800.0 ft

DEPTH W.L.: 18.5 ft
ELEVATION W.L.: 781.5 ft
DATE W.L.: 7/3/06
TIME W.L.: 9:30 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC
0	795	0.0 - 5.0 SILTY SAND - dark brown silty sand, moist Tan and orange mottled medium grained silty sand, dry	SM		791.3 5.0		SPT	4-4-10-24	14	100.0 2.0
5	790	5.0 - 13.5 PARTIALLY WEATHERED ROCK - medium to coarse grained silty sand, dry Attempted to push Shelby tube from 5-7 ft, bent tube	SM				SPT	50/4	50/4	10.0 2.0
10	785	Some pebble size rock fragments present at 10 ft					SPT	50/2	50/2	10.0 2.0
		Auger refusal at 13.5 ft			782.8 13.5					
15	780	13.5 - 40.0 BEDROCK - weathered tan coarse grained sand to pebble size granitic cuttings								
20	775	White and tan medium grained sand size granitic cuttings at 20 ft Some mafic rock pieces mixed in with granitic cuttings at 22 ft								
25	770	Apparent fracture from 25.5 to 26 ft based on drilling response								
30	765	Apparent small fracture at 32.5 to 32.75 ft based on drilling response, coarse grained sand to small pebble size cuttings consisting of weathered quartz, biotite, and feldspar at 33.5 ft								
35	760	Apparent fracture from 37.5 to 37.75 ft based on drilling response, dust died slightly, gravel size quartz and biotite cuttings								
40		Boring completed at 40.0 ft			756.3					

MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES



WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -3.65-25 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 25-40 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 23-40 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 20-23 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-20 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-28

SHEET 1 of 1

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 32.5 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/6/06
DATE COMPLETED: 7/6/06

NORTHING: 801,976.8
EASTING: 1,726,891.0
GS ELEVATION: 784.6 ft
TOC ELEVATION: 787.4 ft

DEPTH W.L.: 19.4 ft
ELEVATION W.L.: 767.9 ft
DATE W.L.: 7/7/06
TIME W.L.: 3:53 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0		0.0 - 6.0 SILTY SAND - brown medium grained silty sand Orange medium grained silty sand with some clay at 1.75 ft, moist	SM				SPT	2-2-3-5	5	75.0 / 2.0	
5	780				778.6 / 6.0		SPT	9-46-50/5	>50	50.0 / 2.0	
		6.0 - 19.5 PARTIALLY WEATHERED ROCK - tan and white fine to medium grained silty sand, very dense, dry	SM								
10	775	Granitic texture with highly weathered quartz and mica grains at 10 ft					SPT	17-32-50/4	44.5	60.0 / 2.0	Grout
15	770						SPT	15-37-50/4	49.5	40.0 / 2.0	
		Auger refusal at 19.5 ft			765.1 / 19.5						
20	765	19.5 - 32.5 BEDROCK - very weathered gray granitic silt to pebble size cuttings									Bentonite
		More competent by 22 ft									#2 Sand
25	760	Apparent fracture at 25 ft based on drilling response									
		Apparent fracture at 28 ft based on drilling response									Screen
30	755	Apparent fracture at 30 ft based on drilling response, tan dust			752.1						
		Boring completed at 32.5 ft									
35	750										
40	745										

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.79-22.5
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 22.5-32.5 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 21-32.5 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 19-21 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-19 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-29

SHEET 1 of 1

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 27.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/6/06
DATE COMPLETED: 7/6/06

NORTHING: 801,623.8
EASTING: 1,726,871.6
GS ELEVATION: 759.3 ft
TOC ELEVATION: 762.8 ft

DEPTH W.L.: 17.6 ft
ELEVATION W.L.: 745.2 ft
DATE W.L.: 7/7/06
TIME W.L.: 3:58 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0		0.0 - 9.0 SILTY SAND - orange medium grained fill, dry Dark brown silty sand with organics at 2.5 ft Orange medium grained silty sand at 4 ft White and orange silty sand with granitic texture at 5 ft, very dense Auger refusal at 9 ft	SM		750.3 9.0		SPT	13-29-32-42	>50	50.0 2.0	Grout
5	755										
10	750	9.0 - 13.0 BEDROCK - very weathered tan silt to pebble size cuttings, dry Tannish gray cuttings at 10 ft			746.3 13.0						Bentonite #2 Sand
15	745	13.0 - 18.0 BEDROCK - very weathered green mafic rock cuttings, dry			741.3 18.0						
20	740	18.0 - 27.0 BEDROCK - weathered tan granitic cuttings									Screen
25	735	Competent rock at 25 ft, quartz and biotite cuttings			732.3						
		Boring completed at 27.0 ft									
30	730										
35	725										
40	720										

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -3.47-12 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 12-27 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 10-27 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 8-10 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-8 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-30D

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 70.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/10/06
DATE COMPLETED: 7/11/06

NORTHING: 801,341.6
EASTING: 1,726,657.8
GS ELEVATION: 761.2 ft
TOC ELEVATION: 763.3 ft

DEPTH W.L.: 30.7 ft
ELEVATION W.L.: 732.6 ft
DATE W.L.: 7/12/06
TIME W.L.: 10:59 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0	760	0.0 - 9.5 SILTY SAND - orange silty sand fill material In-place orange silty sand at 2ft, dry Shleby Tube pushed from 3-5 ft	SM							
						SH			100.0 / 2.0	
5	755					SPT	4-2-22-50/4	24	75.0 / 2.0	
10	750	9.5 - 40.0 PARTIALLY WEATHERED ROCK - white and tan medium grained silty sand, very dense, dry Cuttings slightly moist at 11 ft	SM	751.7 / 9.5		SPT	50/4	50/4	25.0 / 2.0	
15	745	White coarse-grained silty sand at 15 ft, dry				SPT	45-50/1	50/1	35.0 / 2.0	
20	740	Very competent at 20 ft				SPT	50/1	50/1	10.0 / 2.0	
25	735									Grout
30	730									
35	725									
40		Log continued on next page		721.2						

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.03-60 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 60-70 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 58-70 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 56-58 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-56 ft
Type: Portland/Bentonite

WELL COMPLETION
Pad: 3x3x0.5 ft concrete
Protective Casing: 4-inch square aluminum

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: 6-inch Tricone, HQ Core, 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-30D

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 70.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/10/06
DATE COMPLETED: 7/11/06

NORTHING: 801,341.6
EASTING: 1,726,657.8
GS ELEVATION: 761.2 ft
TOC ELEVATION: 763.3 ft

DEPTH W.L.: 30.7 ft
ELEVATION W.L.: 732.6 ft
DATE W.L.: 7/12/06
TIME W.L.: 10:59 am

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	BLOWS per 6 in (140 lb hammer 30 inch drop)	N	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
40	720	40.0 - 43.0 White coarse grained silty sand with pebble to gravel size granitic rock fragments at 40 ft Auger refusal at 43 ft	SM		40.0 718.2						
45	715	43.0 - 57.0 BEDROCK - weathered granitic cuttings Core Run (45 to 50 ft) Rec = 99%, RQD = 82%, very weathered granitic rock mainly consisting of quartz and biotite, natural fractures throughout ranging from 20 to 60 degree dips			43.0						
50	710	Core Run (50 to 55 ft) Rec = 100%, RQD = 68%, very weathered granitic rock with highly fractured zones from 51 to 52 ft and 54 to 55 ft with one fracture at 53 ft. Fractures range from nearly horizontal to ~45 degrees, visible foliation at ~ 35 degrees									
55	705	Core Run (55 to 60 ft) Rec = 48%, RQD = 40%, very weathered granitic rock to 57 ft, highly fractured			704.2						Bentonite
		57.0 - 61.0 BEDROCK - very weathered green mafic rock, highly fractured with poor recovery Core Run (60 to 65 ft) Rec = 86%, RQD = 31%, very weathered green mafic rock to 61 ft, highly broken up			57.0 700.2						#2 Sand
60	700	61.0 - 67.0 BEDROCK - very weathered granitic rock, highly broken up			61.0						
65	695				694.2						Screen
		67.0 - 69.5 BEDROCK - black pebble size mafic rock fragments Fracture at 68 ft based on drilling response			67.0 691.7						
70	690	69.5 - 70.0 BEDROCK - very weathered granitic rock cuttings, large fracture at 69.5 ft based on drilling response Boring completed at 70.0 ft			691.2						
75	685										
80											

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.03-60 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 60-70 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 58-70 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 56-58 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-56 ft
Type: Portland/Bentonite

WELL COMPLETION
Pad: 3x3x0.5 ft concrete
Protective Casing: 4-inch square aluminum

DRILLING METHODS
Soil Drill: 6.25-inch ID Hollow Stem Augers
Rock Drill: 6-inch Tricone,HQ Core, 6-inch Downhole Hammer

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-30S

SHEET 1 of 2

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 45.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/13/06
DATE COMPLETED: 7/13/06

NORTHING: 801,358.3
EASTING: 1,726,660.6
GS ELEVATION: 761.2 ft
TOC ELEVATION: 763.5 ft

DEPTH W.L.: 29.7 ft
ELEVATION W.L.: 733.8 ft
DATE W.L.: 7/25/06
TIME W.L.: 12:19 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0	760	0.0 - 9.5 SILTY SAND - orange silty sand fill material, dry In-place orange silty sand at 2 ft Cuttings lighter at 5 ft More competent at 7 ft	SM		751.7 9.5				
5	755								
10	750	9.5 - 42.0 PARTIALLY WEATHERED ROCK - tan medium grained silty sand, dry Light tan cuttings at 14 ft Light gray cuttings at 30 ft	MLG						Grout
15	745								
20	740								
25	735								Bentonite
30	730								#2 Sand
35	725								Screen
40		Log continued on next page							

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.32-30 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 30-45 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 28-45 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 24-28 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-24 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: 3x3x0.5 ft concrete
Protective Casing: 4-inch square aluminum

DRILLING METHODS
Soil Drill: 6-inch Tricone
Rock Drill: None

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

BOREHOLE RECORD 063526.100.GPJ PIEDMONT.GDT 12/5/06

RECORD OF BOREHOLE P-30S

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 45.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/13/06
DATE COMPLETED: 7/13/06

NORTHING: 801,358.3
EASTING: 1,726,660.5
GS ELEVATION: 761.2 ft
TOC ELEVATION: 763.5 ft

DEPTH W.L.: 29.7 ft
ELEVATION W.L.: 733.8 ft
DATE W.L.: 7/25/06
TIME W.L.: 12:19 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
40	720		MLG		719.2				
		42.0 - 44.0 PARTIALLY WEATHERED ROCK - dark green gravelly silt with weathered mafic rock fragments	SM		42.0 717.2				
45		44.0 - 45.0 PARTIALLY WEATHERED ROCK - light tan silty sand Tricone refusal at 45 ft			44.0 716.2				
	715	Boring completed at 45.0 ft							
50	710								
55	705								
60	700								
65	695								
70	690								
75	685								
80									

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.32-30 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 30-45 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 28-45 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 24-28 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-24 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: 3x3x0.5 ft concrete
Protective Casing: 4-inch square aluminum

DRILLING METHODS
Soil Drill: 6-inch Tricone
Rock Drill: None

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE P-31

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 30.0 ft
LOCATION: Jamestown, NC

DRILL RIG: Gus Pech GP-1100B
DATE STARTED: 7/11/06
DATE COMPLETED: 7/11/06

NORTHING: 801,352.8
EASTING: 1,726,661.7
GS ELEVATION: 761.1 ft
TOC ELEVATION: 763.1 ft

DEPTH W.L.: 27.7 ft
ELEVATION W.L.: 735.3 ft
DATE W.L.: 7/25/06
TIME W.L.: 12:23 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0	760	0.0 - 9.5 SILTY SAND - orange silty sand fill material In-place orange silty sand, dry							
5	755	Cuttings become lighter at 5 ft	SM						Grout
		Harder to drill at 7 ft			751.6 9.5				
10	750	9.5 - 30.0 PARTIALLY WEATHERED ROCK - tan medium grained silty sand Gray pebble size rock fragments in cuttings at 10 ft, dry							Bentonite
		Light tan cuttings at 14 ft							#2 Sand
15	745								
20	740		SM						
		Moist cuttings by 22 ft							Screen
25	735								
		More competent at 28 ft			731.1				
30	730	Boring completed at 30.0 ft							
35	725								
40									

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -1.97-15 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 15-30 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010
End Cap: Threaded

FILTER PACK
Interval: 13-30
Type: #2 Sand

FILTER PACK SEAL
Interval: 11-13 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-11 ft
Type: Portland/Bentonite Mix

WELL COMPLETION
Pad: 3x3x0.5 ft concrete
Protective Casing: 4-inch square aluminum

DRILLING METHODS
Soil Drill: 4.25-inch ID HSA
Rock Drill: None

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: SAEDACCO
DRILLER: Robert Miller

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE HA-3

SHEET 1 of 1

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 5.0 ft
LOCATION: Jamestown, NC

DRILL RIG: N/A
DATE STARTED: 7/11/06
DATE COMPLETED: 7/11/06

NORTHING: 801,744.7
EASTING: 1,727,020.7
GS ELEVATION: 748.6 ft
TOC ELEVATION: 752.2 ft

DEPTH W.L.: 0.5 ft
ELEVATION W.L.: 751.8 ft
DATE W.L.: 7/12/06
TIME W.L.: 12:05 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0		0.0 - 5.0 SILTY SAND - brown silty sand, moist Saturated by 3 ft	SM		743.6				Bentonite #2 Sand Screen
5	745	Boring completed at 5.0 ft							
10	740								
15	735								
20	730								
25	725								
30	720								
35	715								
40	710								

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -3.68-1
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 1-5 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010-inch
End Cap: Threaded

FILTER PACK
Interval: 1-5 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 0-1 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-1 ft
Type: 3/8 Bentonite chip

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 3-inch Hand Auger
Rock Drill: None

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: Golder Associates Inc.
DRILLER: N/A

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE HA-4

SHEET 1 of 1

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 2.5 ft
LOCATION: Jamestown, NC

DRILL RIG: N/A
DATE STARTED: 7/11/06
DATE COMPLETED: 7/11/06

NORTHING: 801,478.1
EASTING: 1,726,859.1
GS ELEVATION: 735.0 ft
TOC ELEVATION: 737.8 ft

DEPTH W.L.: 1.3 ft
ELEVATION W.L.: 736.6 ft
DATE W.L.: 7/12/06
TIME W.L.: 12:15 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES
0	735	0.0 - 2.5 SILTY SAND - brown silty sand Saturated by 2 ft	SM		732.5				Bentonite #2 Sand Screen
		Boring completed at 2.5 ft							
5	730								
10	725								
15	720								
20	715								
25	710								
30	705								
35	700								
40									

WELL CONSTRUCTION DETAILS

WELL CASING
Interval: -2.79-1.5 ft
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 1.5-2.5 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010-inch
End Cap:

FILTER PACK
Interval: 0.5-2.5 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 0-0.5 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval:
Type:

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 3-inch Hand Auger
Rock Drill: None

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: Golder Associates Inc.
DRILLER: N/A

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

RECORD OF BOREHOLE HA-5

PROJECT: WCA of High Point, LLC
PROJECT NUMBER: 0636526.100
DRILLED DEPTH: 4.0 ft
LOCATION: Jamestown, NC

DRILL RIG: N/A
DATE STARTED: 7/11/06
DATE COMPLETED: 7/11/06

NORTHING: 801,203.2
EASTING: 1,726,752.8
GS ELEVATION: 725.9 ft
TOC ELEVATION: 728.2 ft

DEPTH W.L.: 0.3 ft
ELEVATION W.L.: 727.8 ft
DATE W.L.: 7/12/06
TIME W.L.: 12:10 pm

DEPTH (ft)	ELEVATION (ft)	SOIL PROFILE: DESCRIPTION	USCS	GRAPHIC LOG	ELEV. / DEPTH (ft)	SAMPLES: NUMBER	TYPE	REC	MONITORING WELL/ PIEZOMETER DIAGRAM and NOTES	WELL CONSTRUCTION DETAILS
0	725	0.0 - 4.0 SILTY SAND - brown silty sand with organics Saturated by 2 ft	SM		721.9				Bentonite #2 Sand Screen	
5	720	Boring completed at 4.0 ft								
10	715									
15	710									
20	705									
25	700									
30	695									
35	690									
40										

WELL CASING
Interval: -2.24-0.5 FT
Material: PVC
Diameter: 2-inch
Joint Type: Threaded

WELL SCREEN
Interval: 2-4 ft
Material: PVC
Diameter: 2-inch
Slot Size: 0.010-inch
End Cap:

FILTER PACK
Interval: 0.5-4 ft
Type: #2 Sand

FILTER PACK SEAL
Interval: 0-0.5 ft
Type: 3/8 Bentonite Chip

ANNULUS SEAL
Interval: 0-0.5 ft
Type: 3/8 Bentonite Chip

WELL COMPLETION
Pad: None
Protective Casing: None

DRILLING METHODS
Soil Drill: 3-inch Hand Auger
Rock Drill: None

LOG SCALE: 1 in = 5 ft
DRILLING COMPANY: Golder Associates Inc.
DRILLER: N/A

GA INSPECTOR: David Reedy, P.G.
CHECKED BY: Rachel P. Kirkman, P.G.
DATE: 12/1/06

Golder Associates

ATTACHMENT C

USGS SEISMIC DATA

```
LOCATION                        35.568514 Lat.  -79.549194 Long.
The interpolated Probabilistic ground motion values, in %g,
at the requested point are:
            10%PE in 50 yr   2%PE in 50 yr
   PGA          3.75            10.69
0.2 sec SA      9.06            25.21
1.0 sec SA      3.27             9.29
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

SEISMIC HAZARD: Hazard by Lat/Lon, 2002

YAHOO! LOCAL Maps

Wca of High Point LLC (336) 886-3560
5830 Riverdale Drive, Jamestown, NC 27282

When using any driving directions or map, it's a good idea to do a reality check and make sure the road still exists, watch out for construction, and follow all traffic safety precautions. This is only to be used as an aid in planning.

Free Reverse Geocoding
Use this free service to integrate reverse geocoding into your site
www.telenetrics.com

Address GeoCoding
Get address latitude & longitude. U.S. & Canadia. Free trail.
www.MelissaData.com

Earth Photos & Topo Maps
Find hi-res photos and topos of any location in the country
www.GlobeXplorer.com

Latit
Speci
delive
www.

Ads by Google

geocoder.us

find the latitude & longitude of any US address - for *free*

Read the NEW Geocoder.US Blog

The new Blog is the place to look for what is happening with Geocoder.us.

Recent Blog Entries:

- How to calculate the distance between two points
- Degrees, Minutes, Seconds? Decimal Degrees? Huh?
- Added display of coordinates in Degree-Minute-Seconds form in demo.cgi
- How many digits are enough? 38.2? 38.23? 38.234? How many digits of precision do we need?

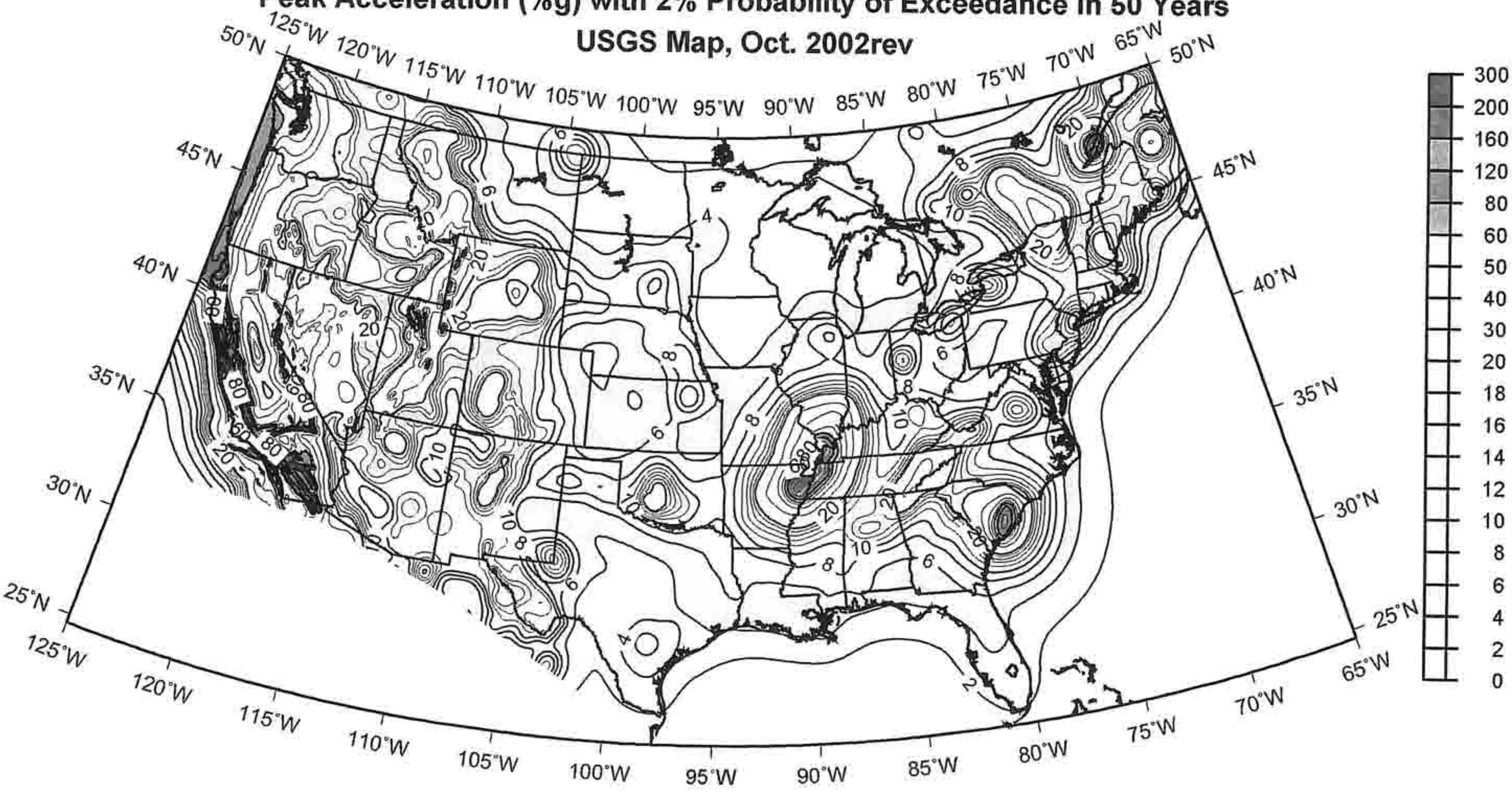
Address	5829 Riverdale Rd NC 27282 (35.947524, -79.915323)
Latitude	35.947524 ° N 35 ° 56' 51.1" 35 ° 56.8514' (degree m.mmmm)
Longitude	-79.915323 ° W 79 ° 54' 55.2" -79 ° 54.9194' (degree m.mmmm)

Search for another address:

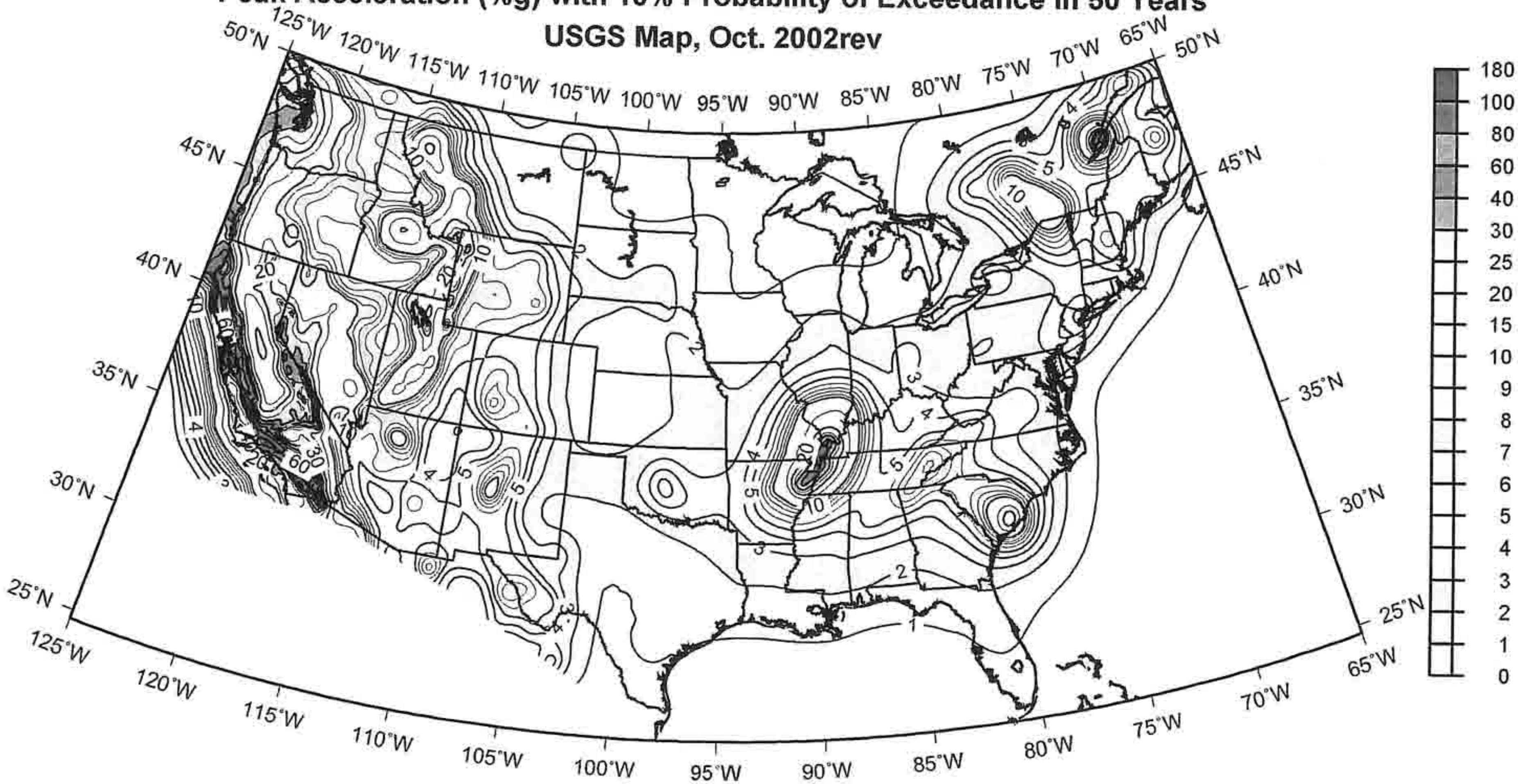
5830 Riverdale Dr, Jamestown, NC 27282

Submit

Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
USGS Map, Oct. 2002rev



Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years
USGS Map, Oct. 2002rev



ATTACHMENT D

MATERIAL PROPERTY SUPPORTING INFORMATION

Existing + Structural Fill Assumptions

Table 11. Average Effective Stress Shear Strengths for Compacted Soils

Unified Classification	Soil Type	Proctor Compaction[1]			Void Ratio e_o	Cohesion[2] c' kgf/cm^2	Friction Angle ϕ' deg
		Maximum Dry Unit Weight		Optimum Water Content %			
		pcf	kN/m^3				
GW	well graded clean gravels, gravel-sand mixtures	> 119	> 19.4	< 13.3	*	*	> 30
GP	poorly graded clean gravels, gravel-sand mixtures	> 110	> 18.0	< 12.4	*	*	> 37
GM	silty gravels, poorly graded gravel-sand-silt	> 114	> 18.6	< 14.5	*	*	> 34
GC	clayey gravels, gravel-sand-clay mixtures	> 115	> 18.8	< 14.7	*	*	> 31
SW	well graded clean sand, gravelly sand	119 ± 2	19.4 ± 0.3	13.3 ± 2.5	0.37 ± *	*	30 ± 1
SP	poorly graded clean sand, sand-gravel mixtures	110 ± 1	18.0 ± 0.2	12.4 ± 1.0	0.50 ± 0.03	*	37 ± 1
SM	silty sands, sand-silt mixtures	114 ± 1	18.6 ± 0.2	14.5 ± 0.4	0.48 ± 0.02	0.21 ± 0.07	34 ± 1
SC-SM	sand-silt-clay with slightly plastic fines	119 ± 1	19.4 ± 0.2	12.8 ± 0.5	0.41 ± 0.02	0.15 ± 0.06	33 ± 3
SC	clayey sands, poorly graded sand-clay mixtures	115 ± 1	18.8 ± 0.2	14.7 ± 0.4	0.48 ± 0.01	0.12 ± 0.06	31 ± 3
ML	inorganic silts and clayey silts	103 ± 2	16.8 ± 0.3	19.2 ± 0.7	0.63 ± 0.02	0.09 ± *	32 ± 2
CL-ML	mixtures of inorganic silts and clays	109 ± 1	17.8 ± 0.2	16.8 ± 0.7	0.54 ± 0.03	0.23 ± *	32 ± 2
CL	inorganic clays of low to medium plasticity	108 ± 1	17.6 ± 0.2	17.3 ± 3.0	0.56 ± 0.01	0.14 ± 0.02	28 ± 2
OL	organic silts and silty clays of low plasticity	*	*	*	*	*	*
MH	inorganic clayey silts, elastic silts	82 ± 4	13.4 ± 0.7	36.3 ± 3.2	1.15 ± 0.12	0.21 ± 0.09	25 ± 3
CH	inorganic clays of high plasticity	94 ± 2	15.3 ± 0.3	25.5 ± 1.2	0.80 ± 0.04	0.12 ± 0.06	19 ± 5
OH	organic clays and silty clays	*	*	*	*	*	*

* denotes insufficient data, > is greater than, < is less than
Maximum liquid limit for the MH soil : 81%
Maximum liquid limit for the CH soil : 88%

[1] USBR standard compaction. Energy per unit volume equivalent to AASHTO standard compaction.

[2] From specimens compacted to maximum dry unit weight and optimum water content. Specimens saturated before shear.

SWITCH ORDER OF PAGES

VIRGINIA TECH

DEPARTMENT OF CIVIL ENGINEERING

GEOTECHNICAL ENGINEERING

SHEAR STRENGTH CORRELATIONS FOR GEOTECHNICAL ENGINEERING

by

J. M. Duncan[1]

R. C. Horz[2]

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August, 1989

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[2]Civil Engineer, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

[3]Geotechnical Engineer, Keith and Schnars, PA, Ft. Lauderdale, Florida

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Bioreactor LANDFILL STABILITY: Key Considerations

Of all the engineering issues associated with bioreactor landfills, slope stability is among the most important.

By R.C. Bachus, M.F. Houlihan, E. Kavazanjian, R. Isenberg, and J.F. Beech

Sidebar

References

Designers and regulators often express concern that the introduction of water or other liquids to enhance the degradation of the waste will reduce the stability of the waste mass. Although the introduction of liquids has several potentially destabilizing effects, they can be mitigated through sound design, construction, and operating practices. This article summarizes the state of the practice for bioreactor landfill design, construction, and operation and their influence on bioreactor landfill slope stability. Based on the information presented in this article, bioreactor landfills can be designed, constructed, and operated in compliance with regulatory requirements and standards of practice for slope stability.

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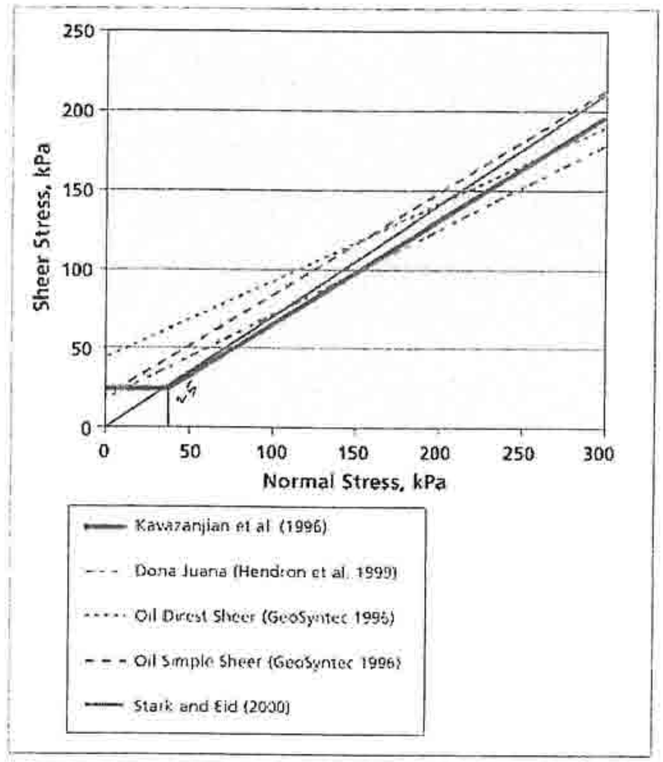
Bioreactor Stability Overview

In a typical bioreactor landfill, leachate and/or other liquids are introduced into the waste mass to enhance waste decomposition, resulting in increased moisture content compared to a conventional, dry landfill. There are two stability-related technical issues that must be considered to address the introduction of liquids: (1) the impact of the presence of liquids; and (2) the impact of the accelerated degradation of the waste. To understand the impact of the presence of liquids, one must understand the migration of

Shear Strength

The selected values of shear strength of waste and soils are critical to the calculated factor of safety because stabilizing forces are primarily a function of material shear strength and both the driving and stabilizing forces are a function of the weight. Extensive testing has been conducted on the shear strength of soil/geosynthetic and geosynthetic/geosynthetic interfaces that commonly exist in modern landfills. These data indicate that the shear strengths of these interfaces are typically lower than the shear strengths of waste or soil and that the presence of liquids may reduce interface shear strength. Fortunately, laboratory interface tests have long been conducted considering "wetted" or "hydrated" interface conditions in order to represent worst-case conditions. More recently, studies have been undertaken to assess the shear strength of solid waste. Figure 2 provides a summary of the recommended Mohr-Coulomb strength envelopes for MSW from several recent investigations. The bi-linear envelope from Kavazanjian et al. [1995] was developed to represent an approximate lower bound of measured laboratory strengths and back-calculated shear strengths as performed by the authors and as reported in the literature. Recent data from large-scale direct-shear tests conducted on waste recovered from bioreactor landfills [Kavazanjian et al. 2001], as well as laboratory testing and back-calculated shear strengths from landfills having highly degraded waste and zones of high liquid content [Isenberg 2003] indicate that there is little to no difference between the strength envelopes for "dry" waste from conventional landfills and "wet" degraded waste from bioreactor landfills. Still, because all landfills are different, waste shear strength properties should be selected to reflect the specific waste composition, density, placement and compaction methods, daily cover, and other operational practices.

Figure 2
Bi-Linear Failure Envelope for MSW



Unit Weight
Recent field data indicate that the unit weight of MSW is higher than the values commonly used in practice. The authors have observed that "typical" values of MSW unit weight used in practice today are in the range of 55 to 65 lb/ft^3. This range of values appears to be based primarily on old literature and reports from landfill owners based on the total weight of waste placed in the landfill, and does not account for the impact of cover soils and absorbed liquids on total unit weight. Figure 3 shows field data from recent in situ testing for unit weight performed at Operating Industries Inc. (OII) Landfill in southern California [Matasovic and Kavazanjian 1998] and at Tri-Cities Landfill in northern California [UC Berkeley 2003], two relatively dry MSW landfills. These data indicate "typical" unit weight values in the range of 80 to 110 lb/ft^3, with the higher values occurring in areas having a high construction-and-demolition debris content. The addition of liquid to waste is likely to increase the unit weight to even higher values. In fact, field testing in saturated-waste zones at OII (which are not reported in Figure 3) yielded unit weight values as high as 135 lb/ft^3 [Matasovic and Kavazanjian 1998]. These values of both wet and dry unit weight are significantly higher than the values typically used in engineering practice today. While an increased unit weight has little to no impact on the internal stability of a frictional material (because the increased weight proportionally increases the driving forces and the shear strength), it would reduce the stability of a cohesive material and could

as sulfide (S^{2-}) and bisulfide (HS^-) at pH levels above 8. Townsend (1998), Jang (2000), and Weber (1999) reported that at pH levels between 6 and 8, hydrogen sulfide and bisulfide ion are the predominant species. Equal concentrations of hydrogen sulfide and bisulfide ion are present at pH 7.1 and 25°C. The relative abundance of H_2S, HS^-, and S^{-2} is as a function of solution pH and equilibrium reactions are shown in Equations 2.1 and 2.2 The negative logarithms of acidity constants (pK_a) for the above two reactions are 6.99 and 12.92, respectively (Benjamin, 2002).

Table 2.1 Components of C&D Waste

Components	Description (Content example)
Wood	Dimensional lumber, plywood, oriented strand board, particle board, laminates, scraps.
Concrete	Rubble, block (whole or broken).
Drywall	Sheetrock, gypsum, plaster.
Metal	Pipes, re-bar, sheet metal, wire/cable, fasteners, metal buckets Aluminum, copper, brass, steel.
Paper/Cardboard	Cardboard box, packages, packing materials.
Roofing Material	Asphalt shingles, tarpaper, roofing compound and clay tile shingles.
Plastic	Vinyl siding, doors, windows, floor tile, pipes.
MSW	Not generated during construction, demolition or renovation of building such as food waste, Food wrappers, bottles, paper bags.
Carpet/Padding	Woven wool, synthetic fiber.
Insulation	Fiber glass, venting or air conditioning ducts
Buckets	Plastic containers, barrels.
Vegetative debris	Stumps, branches, brush.
Dirt/Soil/Rocks	Material generated from earthwork other than vegetative debris.
Other	Byproduct of construction, demolition or renovation of building such as rubber hose, television set.

(Source: US EPA, 1998; Chakrabarti, 2002) because the light waste (e.g. paper, aluminum cans, etc.) will be taken out of the waste stream. A baling operation substantially reduces the refuse volume and increases the unit weight up to $11\,kN/m^3$, (Tchobanoglous *et al.*, 1977). For submerged refuse, a saturated unit weight of 10.3–$11.1\,kN/m^3$ could be used. In the absence of site specific data, the unit weights in Table 11.1 could be assumed for average municipal waste in communities with minimal recycling.

Old landfills that have undergone substantial settlement are expected to have larger unit weight. The long-term unit weight could be estimated knowing the age of the fill and deformation characteristics. For example, if an old landfill eventually settles 30% of its original volume by the time it is completed (Oweis and Khera, 1986), and undergoes additional long term settlement of 10%, the unit weight of refuse would increase by 67%, which is consistent with reported values (see Table 11.1). In communities with an active recycling program, an approximate estimate could be made for the unit weight based on the composition of the waste stream (Oweis and Khera, 1990). If, for example, paper products, plastics, and glass are excluded from the waste stream and replaced by food waste, the unit weight may increase by about 30% or more, which is significant in the stability assessment.

Incineration is used in many locations to reduce the volume of combustible components of municipal refuse which, is often about 70% of the waste stream. Well-burned residue from a modern incinerator may weigh about $16\,kN/m^3$ (100 pcf) or more after compaction. For existing landfills, the unit weight could be established by field density measurements.

11.5.2 Shear strength of waste

The modified Coloumb failure criterion could be used to characterize the shear strength of waste. Considering an apparent friction angle ϕ_a and apparent cohesion c_a, the shear strength τ along a given plane is a function of the effective stress σ'_n normal to that plane. The laboratory determination of strength is usually given at a strain level of 15–20% because the samples do not actually collapse. Fang *et al.* (1977) used the double punch test for determining the tensile resistance of compacted refuse, and together with the unconfined compression test, values of c_a and ϕ_a of 63 kPa and 19°, respectively, were derived. Drained direct shear tests on specimens that measured 287 mm by 434 mm reported by Landva and Clark (1990) indicated the following results.

Shredded refuse:	$c_a = 23\,kPa$ (480 psf)	$\phi_a = 24°$
Old refuse:	$c_a = 16\,kPa$ (334 psf)	$\phi_a = 33°$
Artificial refuse:	$c_a = 0$	$\phi_a = 27°$ to $41°$
Fresh artificial refuse:	$c_a = 0$	$\phi_a = 36°$

These results are consistent with the c_a and ϕ_a combinations inferred from the failure of the Global landfill and field testing of refuse described by Oweis *et al.* (1985). Triaxial tests on anistopically consolidated samples of 2-year-old milled refuse yielded ϕ_a of 40° (Stoll, 1971), and 15° was recommended to forestall lateral spreading.

Essentially all tests on refuse are affected by the soil content, and results can vary over a wide range, especially when small samples are tested. Direct shear tests on 106-mm-diameter samples of mixed refuse yielded inferred friction angles from 39° to 81° (Siegel *et al.*, 1990). Refuse with more granular soil typically exhibits higher friction.

The age of the refuse is expected to affect the field strength. As the refuse ages it becomes denser and hence, stronger. Decomposition, however, may produce the opposite effect. It is wise, therefore, to use conservative strength parameters for stability calculations. Another factor is the expected variation in the character of refuse as the proportion of recyclables becomes less. With more garbage waste, the refuse would be expected to be heavier and the strength is expected to be less than current data indicate.

Higher strengths were reported in the literature for incinerator residue. A friction angle of 45° was reported by Schoenberger and Fungaroli (1971) on a residue with a density of $15.4\,kN/m^3$ using the direct shear test. The high angularity of the particles was cited as a probable reason for the high strength. Poran and Ali (1989) used unconsolidated-undrained triaxial tests to determine the strength of partially saturated residue with about 20% by weight passing No. 200 sieve (0.074 mm openings) and reported apparent friction angles of 43° to 45° at a maximum dry density of $13.5\,kN/m^3$ and an optimum moisture content of 23.5% (60–70% saturation). It is probable that such apparently high friction angles are partially due to the development of negative porewater pressures. If waste will eventually become saturated in the landfill, tests for stability assessment should be based on saturated samples. Unless supported by laboratory tests, the angle of shearing resistance for stability assessment should not exceed an equivalent granular soil.

LDD assumptions

11.6 SHEAR ALONG INTERFACES

In modern landfill designs for liners and covers, geomembranes, geotextiles, drainage nets and reinforcement may be used in conjunction with earthen materials. The stability is expressed in terms of the safety

Geotechnical Practice for Waste Disposal

Edited by

David E. Daniel

Professor of Civil Engineering
The University of Texas at Austin
USA

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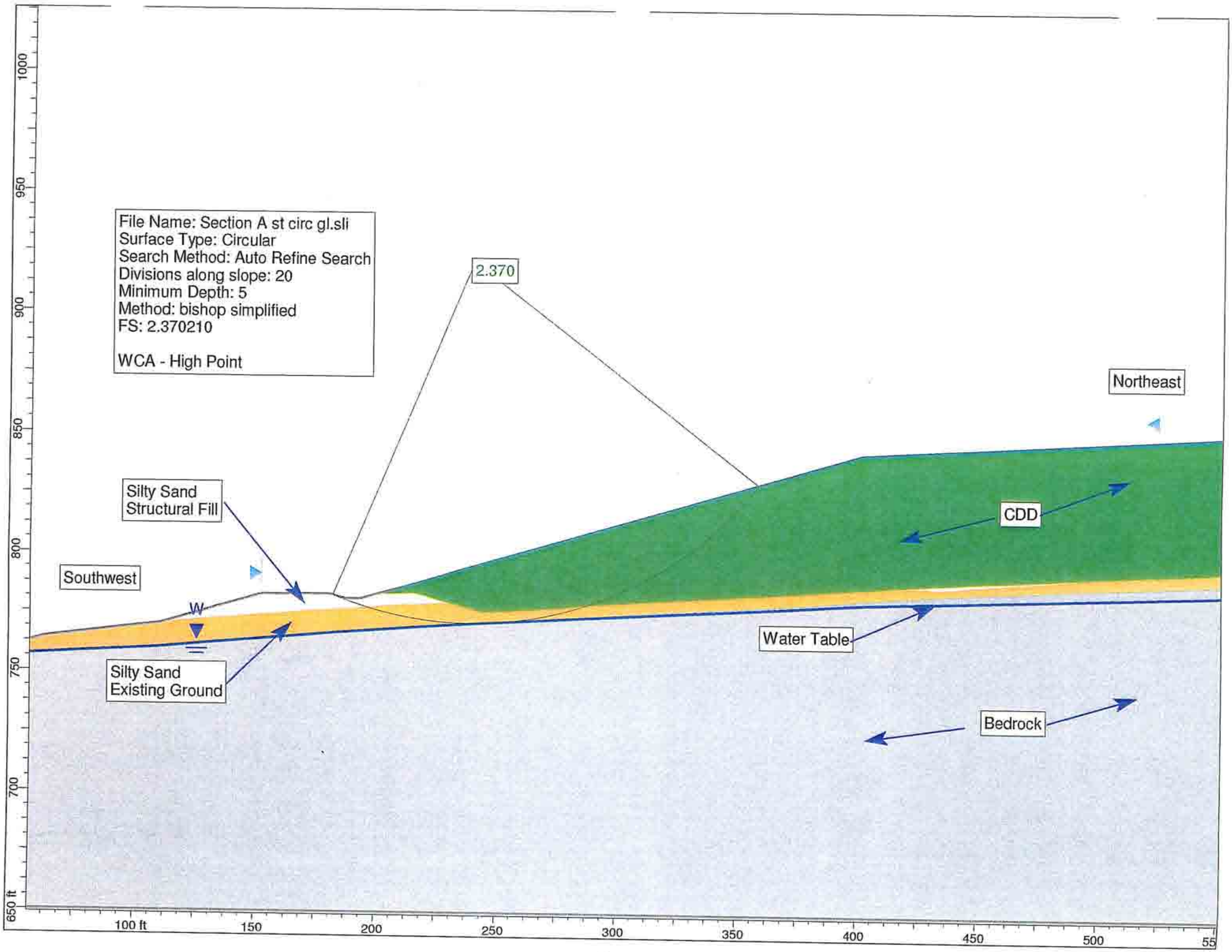
ATTACHMENT E

SLIDE OUTPUT FILES


File Name: Section A st circ gl.sli
Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 20
Minimum Depth: 5
Method: bishop simplified
FS: 2.370210
WCA - High Point
2.370
Northeast
Southwest
Silty Sand Structural Fill
Silty Sand Existing Ground
CDD
Water Table
Bedrock
W
650 ft
700
750
800
850
900
950
1000
100 ft
150
200
250
300
350
400
450
500
55

Slide Analysis Information

Document Name

File Name: Section A st circ gl.sli

Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
Failure Direction: Right to Left
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
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 20
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: 5

Material Properties

Material: CDD
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Structural Fill

Strength Type: Mohr-Coulomb
Unit Weight: 114 lb/ft3
Cohesion: 0 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Bedrock
Strength Type: Infinite strength
Unit Weight: 160 lb/ft3

Material: Existing Soil
Strength Type: Mohr-Coulomb
Unit Weight: 110 lb/ft3
Cohesion: 0 psf
Friction Angle: 28 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 2.370210
Center: 239.510, 921.137
Radius: 150.226
Left Slip Surface Endpoint: 182.142, 782.296
Right Slip Surface Endpoint: 358.719, 829.720
Resisting Moment=3.87004e+007 lb-ft
Driving Moment=1.63278e+007 lb-ft

Method: spencer
FS: 2.351750
Center: 239.602, 920.956
Radius: 150.043
Left Slip Surface Endpoint: 182.549, 782.183
Right Slip Surface Endpoint: 358.719, 829.720
Resisting Moment=3.83561e+007 lb-ft
Driving Moment=1.63096e+007 lb-ft
Resisting Horizontal Force=236230 lb
Driving Horizontal Force=100449 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 4149
Number of Invalid Surfaces: 0

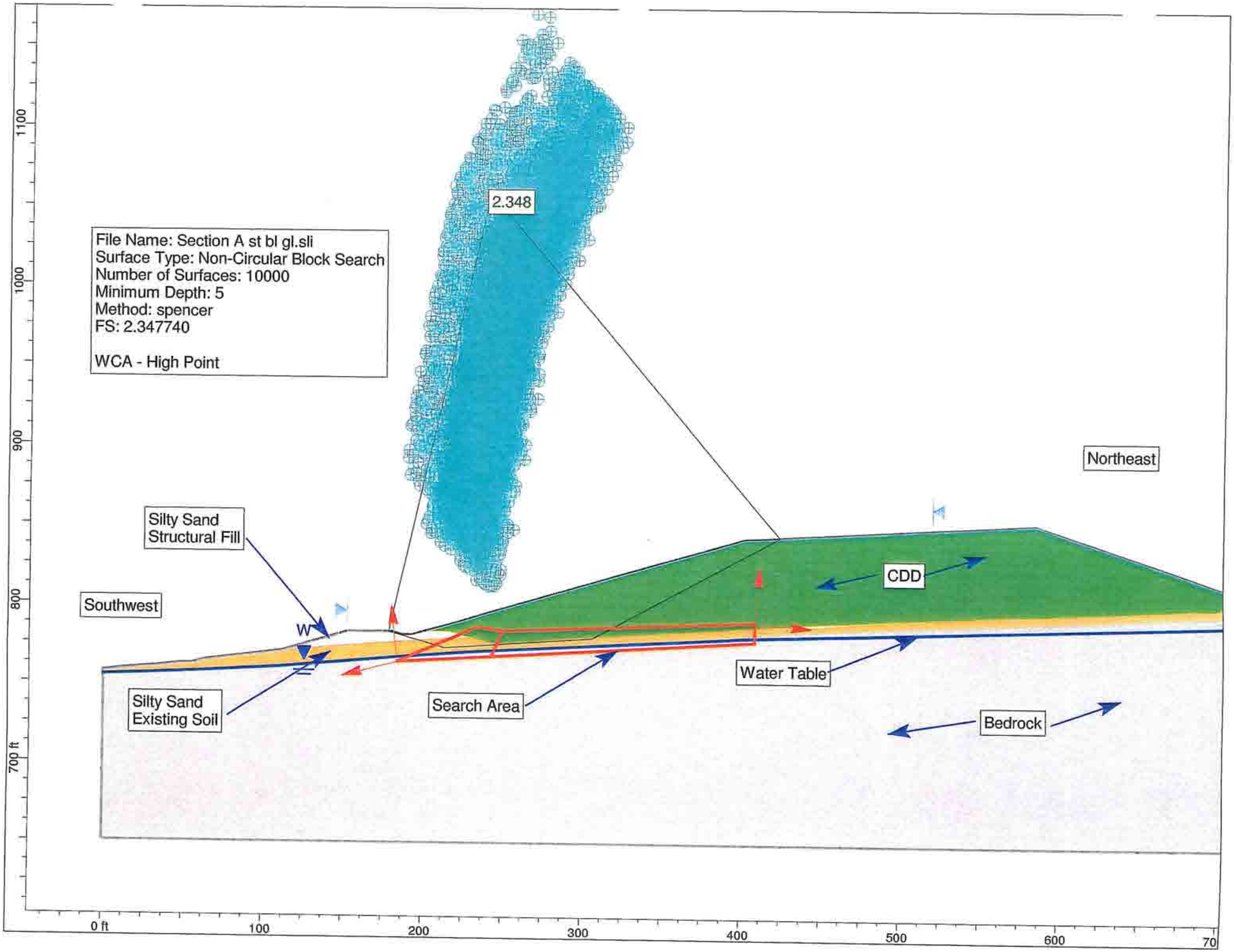
Method: spencer
Number of Valid Surfaces: 4117
Number of Invalid Surfaces: 32
Error Codes:
Error Code -108 reported for 13 surfaces
Error Code -111 reported for 19 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment
or total driving force < 0.1. This is to
limit the calculation of extremely high safety
factors if the driving force is very small
(0.1 is an arbitrary number).

-111 = safety factor equation did not converge



File Name: Section A st bl gl.sli
Surface Type: Non-Circular Block Search
Number of Surfaces: 10000
Minimum Depth: 5
Method: spencer
FS: 2.347740
WCA - High Point
2.348
Northeast
Southwest
Silty Sand Structural Fill
Silty Sand Existing Soil
CDD
Search Area
Water Table
Bedrock
W
1100
1000
900
800
700 ft
0 ft
100
200
300
400
500
600
70

Slide Analysis Information

Document Name

File Name: Section A st bl gl.sli

Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
Failure Direction: Right to Left
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
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 10000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 95
Left Projection Angle (End Angle): 195
Right Projection Angle (Start Angle): -5
Right Projection Angle (End Angle): 85
Minimum Elevation: Not Defined
Minimum Depth: 5

Material Properties

Material: CDD
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unit Weight: 114 lb/ft3
Cohesion: 0 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Bedrock
Strength Type: Infinite strength
Unit Weight: 160 lb/ft3

Material: Existing Soil
Strength Type: Mohr-Coulomb
Unit Weight: 110 lb/ft3
Cohesion: 0 psf
Friction Angle: 28 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 2.297450
Axis Location: 229.597, 1022.307
Left Slip Surface Endpoint: 180.989, 782.617
Right Slip Surface Endpoint: 392.183, 839.606
Resisting Moment=6.76955e+007 lb-ft
Driving Moment=2.94655e+007 lb-ft

Method: spencer
FS: 2.347740
Axis Location: 240.557, 1058.452
Left Slip Surface Endpoint: 178.814, 782.733
Right Slip Surface Endpoint: 424.087, 843.625
Resisting Moment=9.94674e+007 lb-ft
Driving Moment=4.23673e+007 lb-ft
Resisting Horizontal Force=331603 lb
Driving Horizontal Force=141244 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 6296
Number of Invalid Surfaces: 3704
Error Codes:
Error Code -99 reported for 1663 surfaces
Error Code -108 reported for 63 surfaces
Error Code -111 reported for 73 surfaces
Error Code -112 reported for 1905 surfaces

Method: spencer
Number of Valid Surfaces: 4777
Number of Invalid Surfaces: 5223
Error Codes:

Error Code -99 reported for 1663 surfaces
Error Code -108 reported for 1039 surfaces
Error Code -111 reported for 492 surfaces
Error Code -112 reported for 2029 surfaces

Error Codes

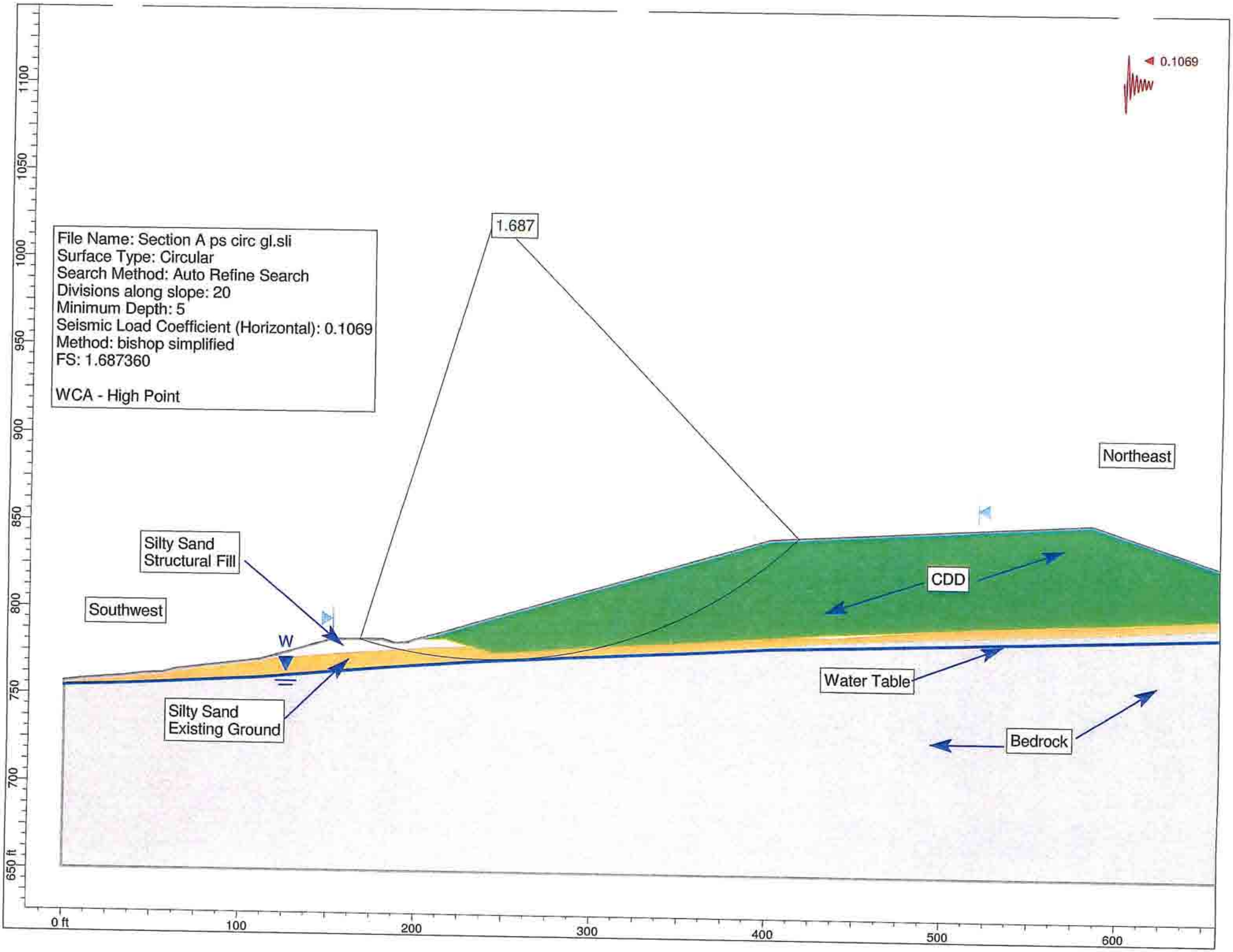
The following errors were encountered during the computation:

-99 = Slip surface intersects an infinite strength material. If infinite strength regions are defined for a model, a large number of potential slip surfaces may show this error code. This is Normal.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.



0.1069
File Name: Section A ps circ gl.sli
Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 20
Minimum Depth: 5
Seismic Load Coefficient (Horizontal): 0.1069
Method: bishop simplified
FS: 1.687360
WCA - High Point
1.687
Northeast
Southwest
Silty Sand
Structural Fill
W
CDD
Water Table
Silty Sand
Existing Ground
Bedrock
1100
1050
1000
950
900
850
800
750
700
650 ft
0 ft
100
200
300
400
500
600

Slide Analysis Information

Document Name

File Name: Section A ps circ gl.sli

Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
Failure Direction: Right to Left
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
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 20
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: 5

Loading

Seismic Load Coefficient (Horizontal): 0.1069

Material Properties

Material: CDD
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 35 degrees

Water Surface: Water Table
Custom Hu value: 1

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unit Weight: 114 lb/ft3
Cohesion: 0 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Bedrock
Strength Type: Infinite strength
Unit Weight: 160 lb/ft3

Material: Existing Soil
Strength Type: Mohr-Coulomb
Unit Weight: 110 lb/ft3
Cohesion: 0 psf
Friction Angle: 28 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 1.687360
Center: 241.434, 1024.629
Radius: 252.915
Left Slip Surface Endpoint: 167.900, 782.641
Right Slip Surface Endpoint: 417.709, 843.265
Resisting Moment=1.02175e+008 lb-ft
Driving Moment=6.05534e+007 lb-ft

Method: spencer
FS: 1.675450
Center: 247.592, 1010.858
Radius: 237.769
Left Slip Surface Endpoint: 187.505, 780.806
Right Slip Surface Endpoint: 416.166, 843.178
Resisting Moment=9.17314e+007 lb-ft
Driving Moment=5.47503e+007 lb-ft
Resisting Horizontal Force=362579 lb
Driving Horizontal Force=216407 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 5147
Number of Invalid Surfaces: 0

Method: spencer
Number of Valid Surfaces: 5092
Number of Invalid Surfaces: 55
Error Codes:

Error Code -108 reported for 15 surfaces
Error Code -111 reported for 10 surfaces
Error Code -112 reported for 30 surfaces

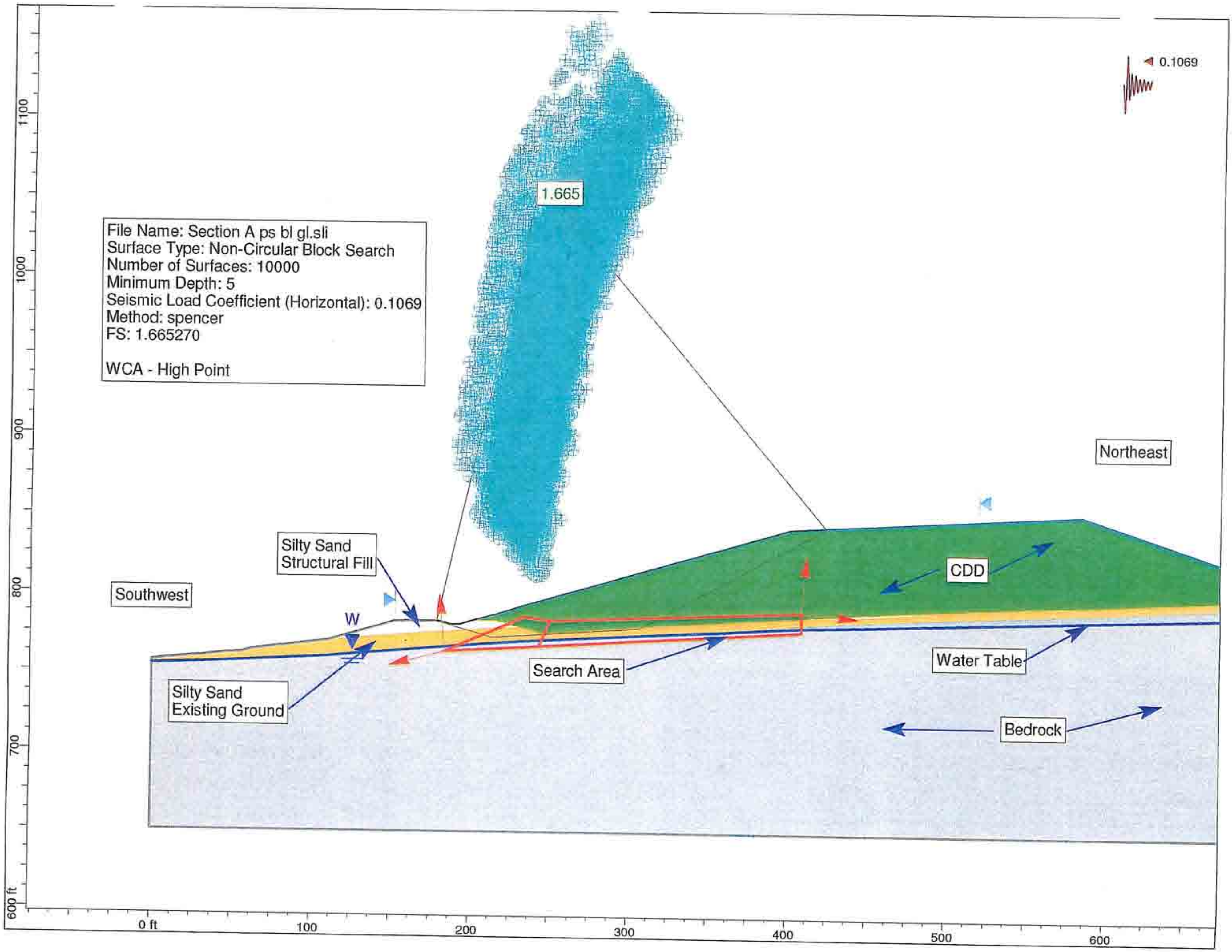
Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment
or total driving force < 0.1. This is to
limit the calculation of extremely high safety
factors if the driving force is very small
(0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F)
< 0.2 for the final iteration of the safety factor calculation. This screens out
some slip surfaces which may not be valid in the context of the analysis, in
particular, deep seated slip surfaces with many high negative base angle
slices in the passive zone.



File Name: Section A ps bl gl.sli
Surface Type: Non-Circular Block Search
Number of Surfaces: 10000
Minimum Depth: 5
Seismic Load Coefficient (Horizontal): 0.1069
Method: spencer
FS: 1.665270
WCA - High Point
0.1069
1.665
Southwest
Northeast
Silty Sand Structural Fill
Silty Sand Existing Ground
W
CDD
Search Area
Water Table
Bedrock
600 ft
700
800
900
1000
1100
0 ft
100
200
300
400
500
600

Slide Analysis Information

Document Name

File Name: Section A ps bl gl.sli

Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
Failure Direction: Right to Left
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
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 10000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 95
Left Projection Angle (End Angle): 195
Right Projection Angle (Start Angle): -5
Right Projection Angle (End Angle): 85
Minimum Elevation: Not Defined
Minimum Depth: 5

Loading

Seismic Load Coefficient (Horizontal): 0.1069

Material Properties

Material: CDD
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf

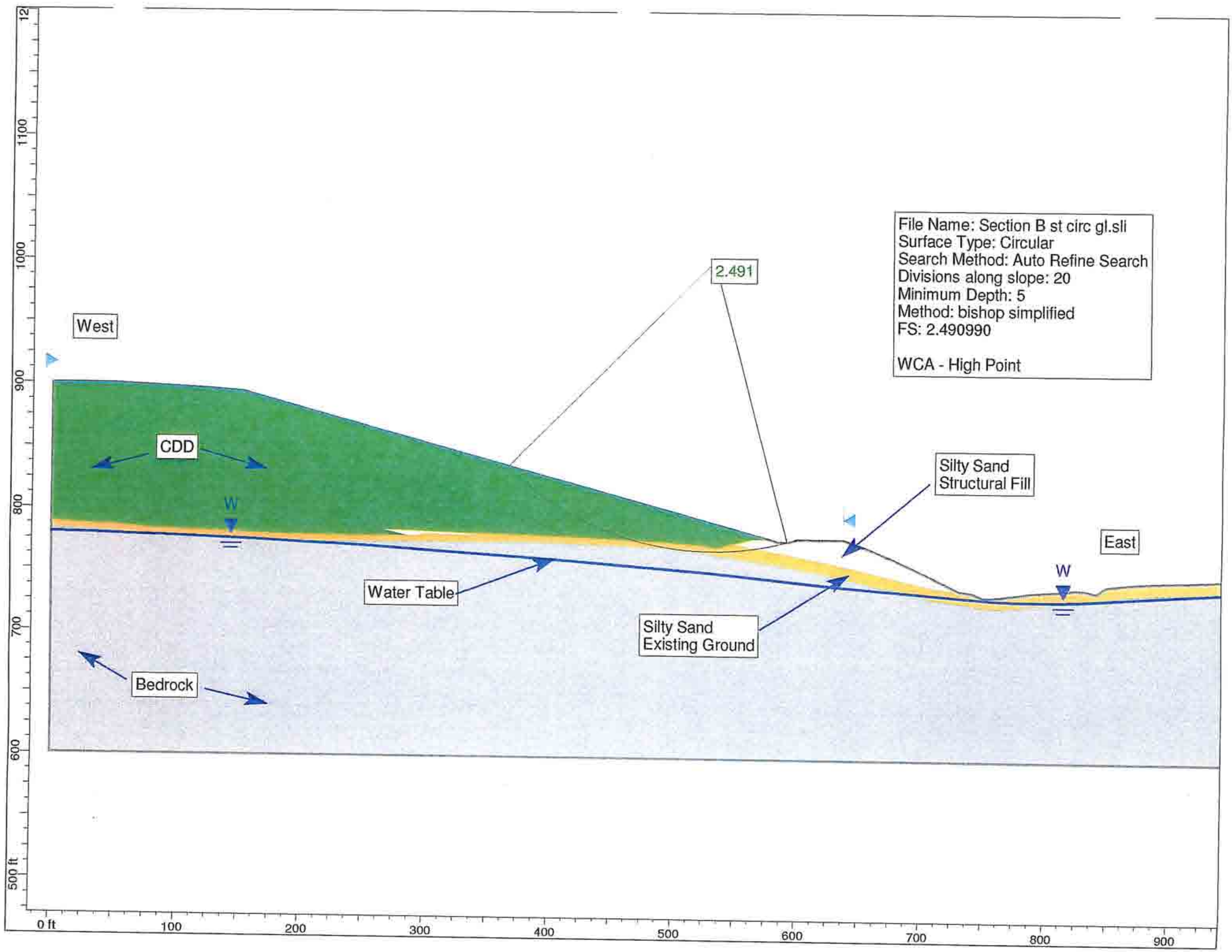
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unit Weight: 114 lb/ft3
Cohesion: 0 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Bedrock
Strength Type: Infinite strength
Unit Weight: 160 lb/ft3

Material: Existing Soil
Strength Type: Mohr-Coulomb
Unit Weight: 110 lb/ft3
Cohesion: 0 psf
Friction Angle: 28 degrees
Water Surface: Water Table
Custom Hu value: 1

MISSING REST OF RESULTS ?



File Name: Section B st circ gl.sli
Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 20
Minimum Depth: 5
Method: bishop simplified
FS: 2.490990
WCA - High Point
2.491
West
East
CDD
W
Silty Sand Structural Fill
Water Table
Silty Sand Existing Ground
Bedrock
0 ft
100
200
300
400
500
600
700
800
900
500 ft
600
700
800
900
1000
1100
12

Slide Analysis Information

Document Name

File Name: Section B st circ gl.sli

Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
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
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 20
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: 5

Material Properties

Material: CDD
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Structural Fill

Strength Type: Mohr-Coulomb
Unit Weight: 114 lb/ft3
Cohesion: 0 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Bedrock
Strength Type: Infinite strength
Unit Weight: 160 lb/ft3

Material: Existing Soil
Strength Type: Mohr-Coulomb
Unit Weight: 110 lb/ft3
Cohesion: 0 psf
Friction Angle: 28 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 2.490990
Center: 531.036, 1000.721
Radius: 233.061
Left Slip Surface Endpoint: 366.456, 835.704
Right Slip Surface Endpoint: 591.809, 775.723
Resisting Moment=8.37829e+007 lb-ft
Driving Moment=3.36344e+007 lb-ft

Method: spencer
FS: 2.479430
Center: 531.013, 1004.244
Radius: 236.449
Left Slip Surface Endpoint: 364.685, 836.186
Right Slip Surface Endpoint: 591.731, 775.723
Resisting Moment=8.53419e+007 lb-ft
Driving Moment=3.44199e+007 lb-ft
Resisting Horizontal Force=339263 lb
Driving Horizontal Force=136831 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 5873
Number of Invalid Surfaces: 0

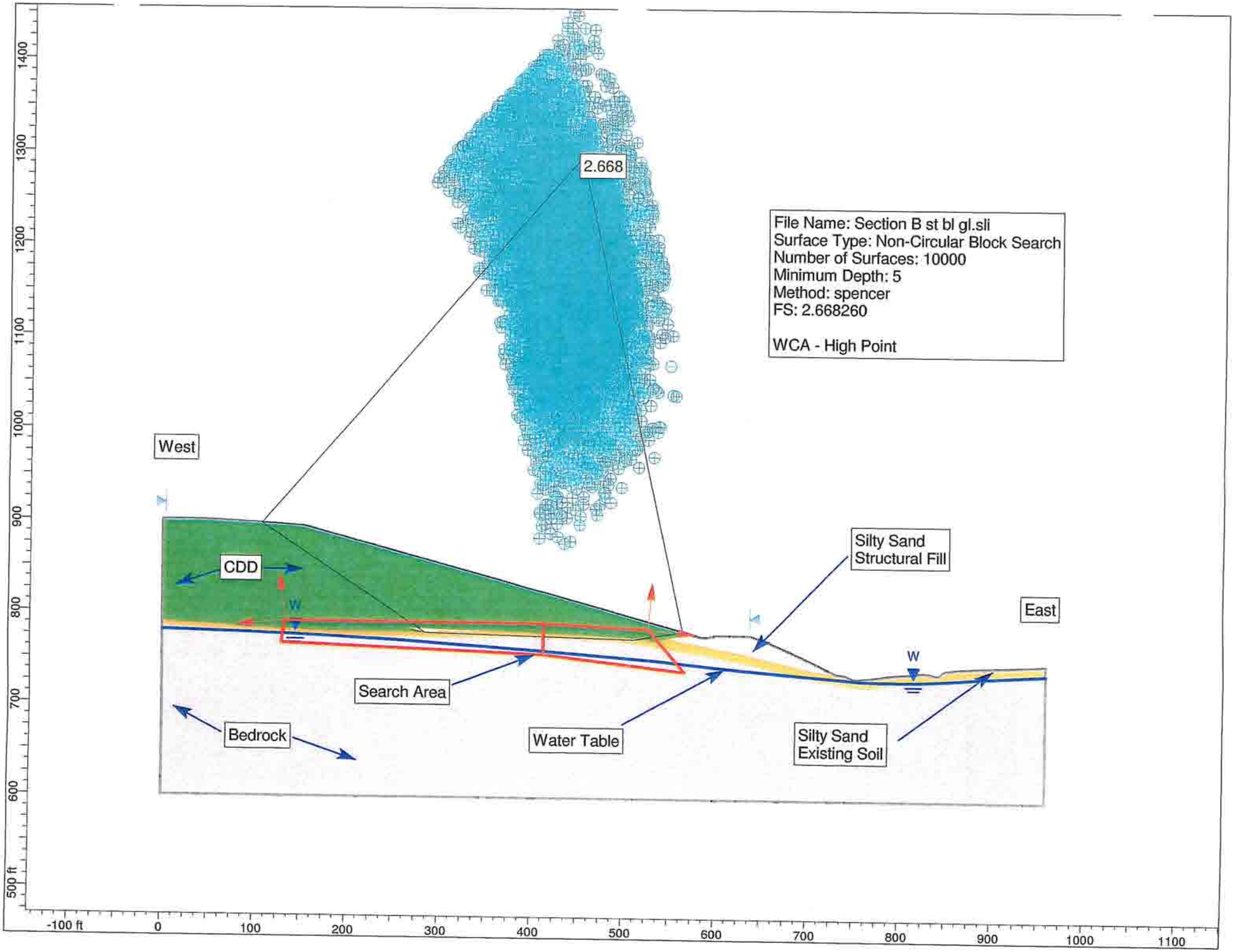
Method: spencer
Number of Valid Surfaces: 5859
Number of Invalid Surfaces: 14
Error Codes:
Error Code -108 reported for 6 surfaces
Error Code -111 reported for 8 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment
or total driving force < 0.1. This is to
limit the calculation of extremely high safety
factors if the driving force is very small
(0.1 is an arbitrary number).

-111 = safety factor equation did not converge


File Name: Section B st bl gl.sli
Surface Type: Non-Circular Block Search
Number of Surfaces: 10000
Minimum Depth: 5
Method: spencer
FS: 2.668260
WCA - High Point
2.668
West
East
CDD
Bedrock
Search Area
Water Table
Silty Sand Structural Fill
Silty Sand Existing Soil
W
1400
1300
1200
1100
1000
900
800
700
600
500 ft
-100 ft
0
100
200
300
400
500
600
700
800
900
1000
1100

Slide Analysis Information

Document Name

File Name: Section B st bl gl.sli

Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
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
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 10000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 95
Left Projection Angle (End Angle): 185
Right Projection Angle (Start Angle): -5
Right Projection Angle (End Angle): 85
Minimum Elevation: Not Defined
Minimum Depth: 5

Material Properties

Material: CDD
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unit Weight: 114 lb/ft3
Cohesion: 0 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Bedrock
Strength Type: Infinite strength
Unit Weight: 160 lb/ft3

Material: Existing Soil
Strength Type: Mohr-Coulomb
Unit Weight: 110 lb/ft3
Cohesion: 0 psf
Friction Angle: 28 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 2.595300
Axis Location: 462.167, 1248.608
Left Slip Surface Endpoint: 146.891, 894.419
Right Slip Surface Endpoint: 556.353, 783.873
Resisting Moment=6.27587e+008 lb-ft
Driving Moment=2.41816e+008 lb-ft

Method: spencer
FS: 2.668260
Axis Location: 450.646, 1296.079
Left Slip Surface Endpoint: 107.161, 896.912
Right Slip Surface Endpoint: 563.889, 781.791
Resisting Moment=7.85554e+008 lb-ft
Driving Moment=2.94407e+008 lb-ft
Resisting Horizontal Force=1.39665e+006 lb
Driving Horizontal Force=523432 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 896
Number of Invalid Surfaces: 9104
Error Codes:
Error Code -99 reported for 8875 surfaces
Error Code -108 reported for 3 surfaces
Error Code -111 reported for 3 surfaces
Error Code -112 reported for 223 surfaces

Method: spencer
Number of Valid Surfaces: 672
Number of Invalid Surfaces: 9328
Error Codes:

Error Code -99 reported for 8875 surfaces
Error Code -108 reported for 162 surfaces
Error Code -111 reported for 47 surfaces
Error Code -112 reported for 244 surfaces

Error Codes

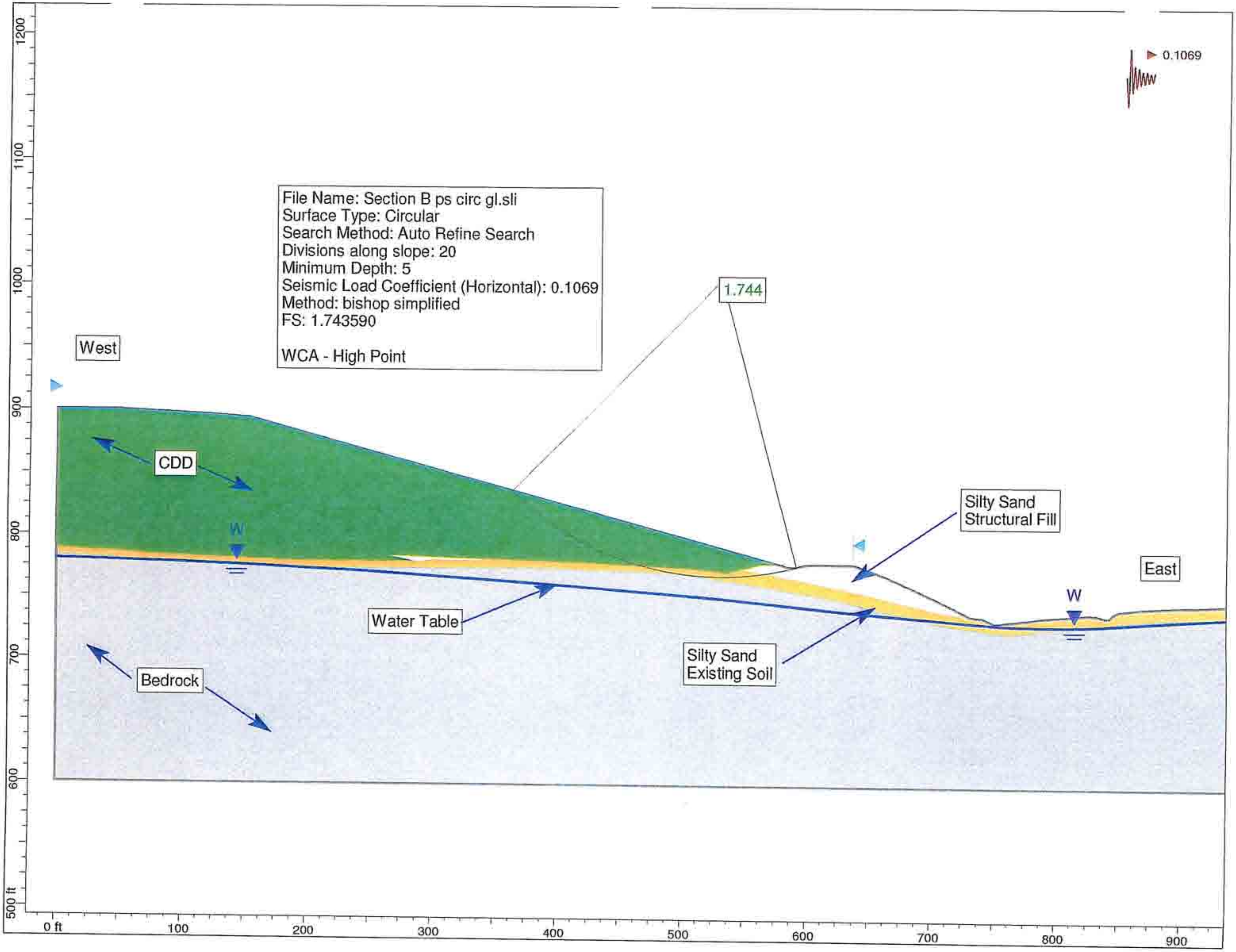
The following errors were encountered during the computation:

-99 = Slip surface intersects an infinite strength material. If infinite strength regions are defined for a model, a large number of potential slip surfaces may show this error code. This is Normal.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.



0.1069
File Name: Section B ps circ gl.sli
Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 20
Minimum Depth: 5
Seismic Load Coefficient (Horizontal): 0.1069
Method: bishop simplified
FS: 1.743590
WCA - High Point
1.744
West
East
CDD
W
Water Table
Bedrock
Silty Sand
Structural Fill
Silty Sand
Existing Soil
1200
1100
1000
900
800
700
600
500 ft
0 ft
100
200
300
400
500
600
700
800
900

Slide Analysis Information

Document Name

File Name: Section B ps circ gl.sli

Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
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
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Circular
Search Method: Auto Refine Search
Divisions along slope: 20
Circles per division: 10
Number of iterations: 10
Divisions to use in next iteration: 50%
Composite Surfaces: Disabled
Minimum Elevation: Not Defined
Minimum Depth: 5

Loading

Seismic Load Coefficient (Horizontal): 0.1069

Material Properties

Material: CDD
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf
Friction Angle: 35 degrees

Water Surface: Water Table
Custom Hu value: 1

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unit Weight: 114 lb/ft3
Cohesion: 0 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Bedrock
Strength Type: Infinite strength
Unit Weight: 160 lb/ft3

Material: Existing Soil
Strength Type: Mohr-Coulomb
Unit Weight: 110 lb/ft3
Cohesion: 0 psf
Friction Angle: 28 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 1.743590
Center: 530.718, 1004.768
Radius: 237.034
Left Slip Surface Endpoint: 363.862, 836.411
Right Slip Surface Endpoint: 591.740, 775.723
Resisting Moment=8.41541e+007 lb-ft
Driving Moment=4.82649e+007 lb-ft

Method: spencer
FS: 1.735780
Center: 530.905, 1002.937
Radius: 235.222
Left Slip Surface Endpoint: 365.121, 836.068
Right Slip Surface Endpoint: 591.763, 775.723
Resisting Moment=8.23985e+007 lb-ft
Driving Moment=4.74706e+007 lb-ft
Resisting Horizontal Force=330096 lb
Driving Horizontal Force=190171 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 5669
Number of Invalid Surfaces: 0

Method: spencer
Number of Valid Surfaces: 5625
Number of Invalid Surfaces: 44
Error Codes:

Error Code -108 reported for 11 surfaces
Error Code -111 reported for 26 surfaces
Error Code -112 reported for 7 surfaces

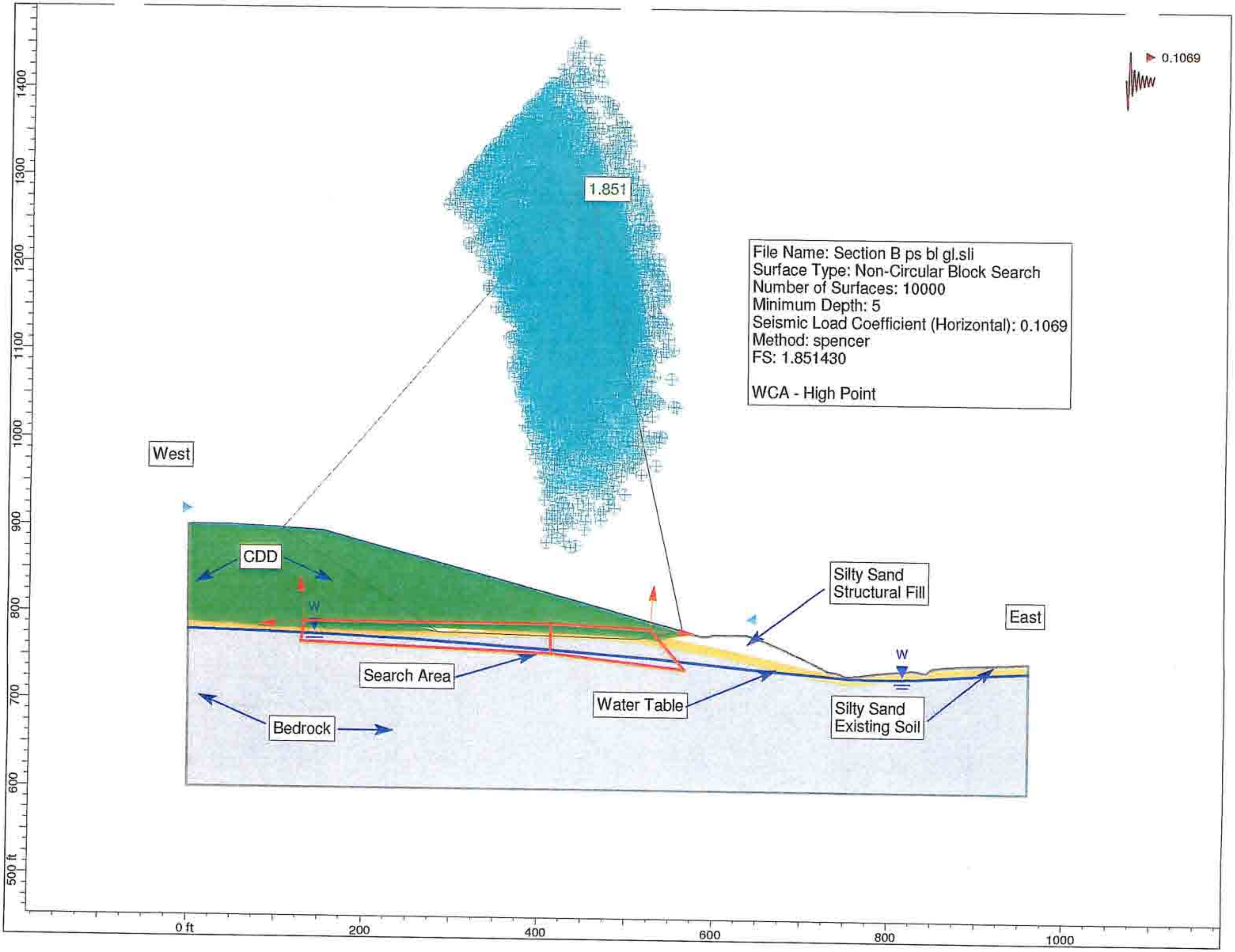
Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment
or total driving force < 0.1. This is to
limit the calculation of extremely high safety
factors if the driving force is very small
(0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F)
< 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.


0.1069
1.851
File Name: Section B ps bl gl.sli
Surface Type: Non-Circular Block Search
Number of Surfaces: 10000
Minimum Depth: 5
Seismic Load Coefficient (Horizontal): 0.1069
Method: spencer
FS: 1.851430
WCA - High Point
West
East
CDD
Silty Sand Structural Fill
Search Area
Water Table
Silty Sand Existing Soil
Bedrock
W
0 ft
200
400
600
800
1000
500 ft
600
700
800
900
1000
1100
1200
1300
1400

Slide Analysis Information

Document Name

File Name: Section B ps bl gl.sli

Project Settings

Project Title: SLIDE - An Interactive Slope Stability Program
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
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50

Surface Options

Surface Type: Non-Circular Block Search
Number of Surfaces: 10000
Pseudo-Random Surfaces: Enabled
Convex Surfaces Only: Disabled
Left Projection Angle (Start Angle): 95
Left Projection Angle (End Angle): 185
Right Projection Angle (Start Angle): -5
Right Projection Angle (End Angle): 85
Minimum Elevation: Not Defined
Minimum Depth: 5

Loading

Seismic Load Coefficient (Horizontal): 0.1069

Material Properties

Material: CDD
Strength Type: Mohr-Coulomb
Unit Weight: 125 lb/ft3
Cohesion: 0 psf

Friction Angle: 35 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Structural Fill
Strength Type: Mohr-Coulomb
Unit Weight: 114 lb/ft3
Cohesion: 0 psf
Friction Angle: 34 degrees
Water Surface: Water Table
Custom Hu value: 1

Material: Bedrock
Strength Type: Infinite strength
Unit Weight: 160 lb/ft3

Material: Existing Soil
Strength Type: Mohr-Coulomb
Unit Weight: 110 lb/ft3
Cohesion: 0 psf
Friction Angle: 28 degrees
Water Surface: Water Table
Custom Hu value: 1

Global Minimums

Method: bishop simplified
FS: 1.799340
Axis Location: 450.646, 1296.079
Left Slip Surface Endpoint: 107.161, 896.912
Right Slip Surface Endpoint: 563.889, 781.791
Resisting Moment=7.66859e+008 lb-ft
Driving Moment=4.2619e+008 lb-ft

Method: spencer
FS: 1.851430
Axis Location: 450.646, 1296.079
Left Slip Surface Endpoint: 107.161, 896.912
Right Slip Surface Endpoint: 563.889, 781.791
Resisting Moment=7.63373e+008 lb-ft
Driving Moment=4.12315e+008 lb-ft
Resisting Horizontal Force=1.36452e+006 lb
Driving Horizontal Force=737010 lb

Valid / Invalid Surfaces

Method: bishop simplified
Number of Valid Surfaces: 848
Number of Invalid Surfaces: 9152
Error Codes:
Error Code -99 reported for 8875 surfaces
Error Code -108 reported for 3 surfaces
Error Code -111 reported for 6 surfaces
Error Code -112 reported for 268 surfaces

Method: spencer
Number of Valid Surfaces: 610
Number of Invalid Surfaces: 9390
Error Codes:
Error Code -99 reported for 8875 surfaces
Error Code -108 reported for 145 surfaces
Error Code -111 reported for 84 surfaces
Error Code -112 reported for 286 surfaces

Error Codes

The following errors were encountered during the computation:

-99 = Slip surface intersects an infinite strength material. If infinite strength regions are defined for a model, a large number of potential slip surfaces may show this error code. This is Normal.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

VENEER STABILITY

Project Name: WCA of High Point C&D Landfill, Phase 2 Expansion
Project Number: 063-6526
Date: 12/19/06

Made by: CLK
Checked by: SKS
Reviewed by: DBM

Check static veneer stability.

Use method developed by Koerner and Hwu (1991)

where

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

and where

$$a = (W_a - N_a \cos\beta)(\cos\beta)$$

$$b = -\{(W_a - N_a\cos\beta)\sin\beta\tan\varphi + (N_a\tan\beta + Ca)\sin\beta\cos\beta + \sin\beta(C + W_p\tan\varphi)\}$$

$$c = (N_a\tan\delta + C_a)\sin^2\beta\tan\varphi$$

For

β =	slope angle	=	18.4	degrees	
φ =	internal friction angle cover soil	=	15	degrees	
δ =	interface friction angle	=	21	degrees	(geonet and soil)
c_a =	adhesion along interface	=	300	psf	(geonet and soil)
c =	cohesion of cover soil	=	1000	psf	
L =	slope length between benches	=	442	ft	(140v. feet w/o benches on 3H:1V sideslope)
h =	depth to failure surface	=	2	ft	
γ =	unit weight of cover soil	=	115	pcf	

Then

$W_A = \gamma h^2(L/h - 1/\sin\beta - (\tan\beta)/2)$ = 100126

$N_a = W_a\cos\beta$ = 95007.3

$C_a = c_a(L - h/\sin\beta)$ = 130699.2

$W_p = \gamma h^2/\sin 2\beta$ = 767.9

$C = ch/\sin\beta$ = 6336.2

and

$a = (W_a - N_a \cos\beta)(\cos\beta)$ = 9466.0 ✓

$b = -\{(W_a - N_a\cos\beta)\sin\beta\tan\varphi + (N_a\tan\beta + Ca)\sin\beta\cos\beta + \sin\beta(C + W_p\tan\varphi)\}$ = -52977.8 ✓

$c = (N_a\tan\delta + C_a)\sin^2\beta\tan\varphi$ = 4462.9 ✓

$$\boxed{\mathbf{FS = \frac{-b + (b^2 - 4ac)^{0.5}}{2a} = 5.51}}$$ ✓

Made by: CJX
Checked by: SKS
Reviewed by: DBM

Project Name: WCA of High Point C&D Landfill, Phase 2 Expansion
Project Number: 063-6526
Date: 12/19/06

Check veneer stability during a seismic event.

Use method developed by Matasovic[1] where:

$$FS = \frac{c/\gamma z\cos^2\beta + \tan\varphi\{1-\gamma_w(z-d_w)/\gamma z\} - n_g\tan\beta\tan\varphi}{n_g + \tan\beta}$$

where

c	=	cover soil cohesion	=	250	psf
γ	=	unit weight of cover soil	=	115	pcf
z	=	depth to failure surface	=	2	ft
β	=	slope angle	=	18.4	degrees
γ_w	=	unit weight of water	=	62.4	pcf
d_w	=	depth to water	=	2	ft
n_g	=	seismic coefficient	=		
	=	$0.5(a_{max})$	=	0.055	g
φ	=	internal friction angle cover soil	=	15	degrees

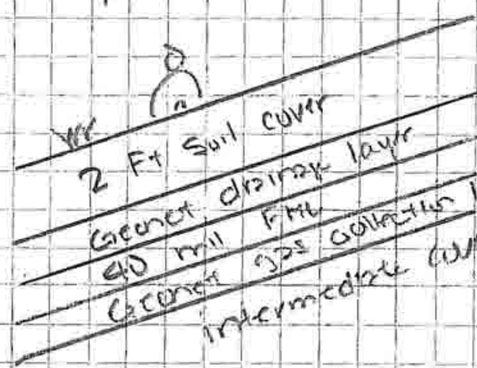
Then

FS = 3.79 ✓

1 Matasovic, N; 1991; Selection of Method for Seismic Slope Stability Analysis; Proc. 2nd International Conference on Recent Advances on Geotechnical Earthquake Engineering and Soil Dynamics

Golder Associates			
SUBJECT WCA of Highpoint C&D LF			
Job No. 063-6526	Made by CH	Date 12/19/06	
Ref.	Checked SKS	Sheet 1	of 2
	Reviewed DBM		

Cap Geosynthetic Veneer Stability



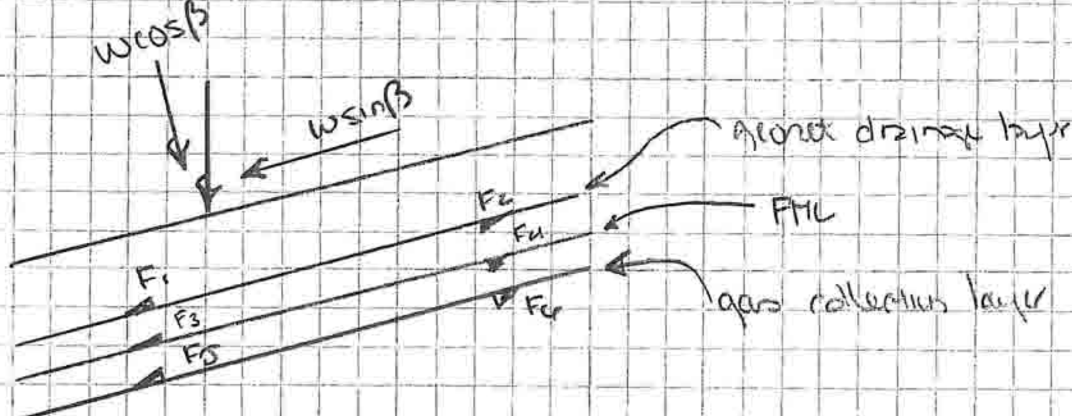
Final side slopes = 3H:1V (18.4° slope angle)

Assume
+ cover soil density = 110 pcf

interface	interface friction angle
soil / geonet	21
geonet / fml	20

values taken from test results, similar projects

Evaluate static stability using methods outlined by Koerner where



Golder Associates	SUBJECT WCA of High Park C&D LF		
	Job No. 063-6526	Made by CH	Date 12/15/06
	Ref.	Checked SKS	Sheet 2 of 2
		Reviewed DBM	

Cap Geosynthetic Veneer Stability, cont'd

weight of protective cover = $(\frac{1}{2})(2)(6)(110)$ = 660

normal force = N = $W\cos\beta$ = $(660)\cos 18.4$ = 626 lb/ft

downslope force = $W\sin\beta$ = $(660)\sin 18.4$ = 208 lb/ft

Calculate shear forces in geonet drainage layer

$F_{interface} = N \tan\phi_1$ ϕ_1 = interface friction angle

$F_{int} = (660)\tan 21 = 253$

since $F_1 > W\sin\beta$, $F_1 = W\sin\beta = 208$

$F_2 = (660)(\tan 20) = 240$

since $F_2 > W\sin\beta$, $F_2 = W\sin\beta = 208$

since $F_2 = F_1$, layer not in tension → FS = ok

Calculate shear force in FML

since upper and lower interfaces are with same material

$F_2 = F_3 = F_4$ and layer is not in tension → FS = ok

Calculate shear forces in geonet gas collection layer

interfaces (soil / geonet and fml / geonet) are same as for geonet drainage layer

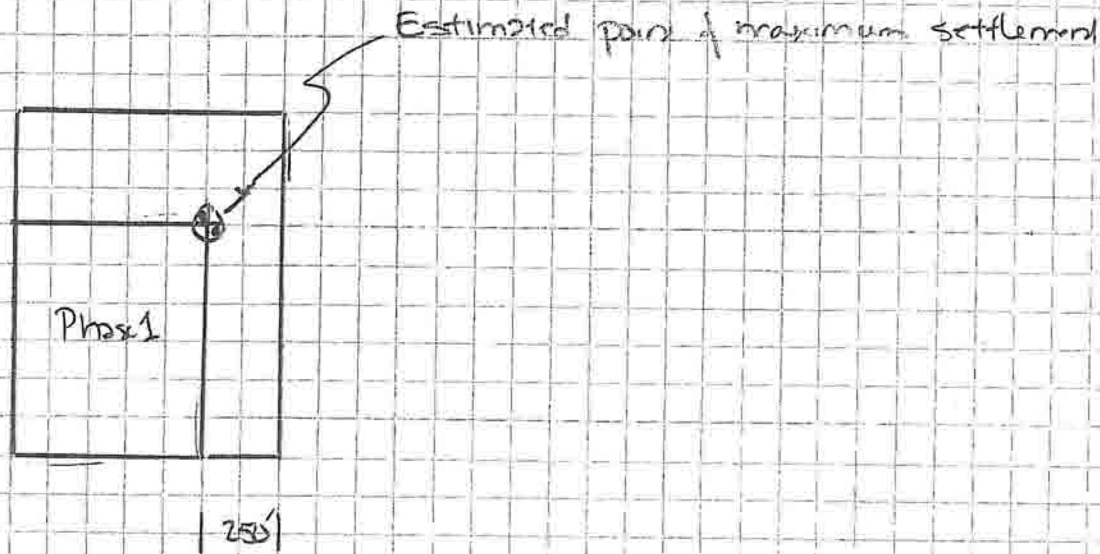
∴ the layer is not in tension and FS = ok

SETTLEMENT

Golder Associates

SUBJECT: WCA of High Point - Settlement
Job No. 0636526 | Made by CH | Date 12/10/04
Ref. | Checked SKS | Sheet 1 of 5
Reviewed NBM

Estimate Settlement



<u>Use</u>

γ_{waste} = 65 pcf

γ_{soil} = 115

max height of waste = 140 ft

<u>assume</u>

- no contribution existing Phase 1 to existing subsurface pressure
- subsurface conditions as encountered in P-24

WCA of High Point C&D Landfill - Phase 2 Settlement
Subsurface Strata

Layer Information						Layer 1				Layer 2			
location	Existing Ground Surface	Proposed base grade	Thickness Structural Fill	Proposed Final Grade	Reference Boring	Top	Depth to Mid Point	Base	Thick	Top	Depth to Mid Point	Base	Thick
1	800	800	0	880	P-24	797	2.5	792	5	792	7.5	787	5

Notes: No settlement assumed to occur in units beneath Layer 2 (in bedrock)

Made by: CJX
Checked by: SKS
Reviewed by: DBM

WCA of High Point C&D Landfill - Phase 2 Settlement
Settlement Due to Waste

Layer Information						Layer 1					Layer 2					
location	Existing Ground Surface	Proposed base grade	Thickness Structural Fill	Proposed Final Grade	Reference Boring	Depth to Center (ft)	P_o Center	ΔP	Thickness Layer	Settlement	Depth to Center (ft)	P_o Center	ΔP	Thickness Layer	Settlement	**Total Settlement (ft)**
1	800	800	0	880	P-24	2.5	287.5	9100	5	0.047	7.5	862.5	9100	5	0.045	**0.0922**

Notes: In Layers 2 and 4 (sands)

$=\Delta PH_o/mP_a(sqrt(0.5(P_o+(P_o+\Delta P))/P_a)$

where Pa = atmospheric pressure (2116 psf)

and for Layer 1 m = 300 janbu modulus number for loose sands, normally overconsolidated

Layer 2 m = 700 janbu modulus number for medium dense sands, slightly overconsolidated

use Y_{waste} 65 pcf

$Y_{layer\ 1soil}$ 115 pcf

$Y_{layer\ 2soil}$ 115 pcf

assume

Influence factor for loading is 1.0 and all subsurface units see change in pressure equal to height of waste times the unit weight of waste

depth to water 18 ft

Made by: CJX
Checked by: SCS
Reviewed by: DBM

WCA of High Point C&D Landfill - Phase 2 Settlement
Secondary Settlement

Layer Information						Layer 1		Layer 2		
location	Existing Ground Surface	Proposed base grade	Thickness Structural Fill	Proposed Final Grade	Reference Boring	Layer Thickness	Secondary Settlement	Layer Thickness	Secondary Settlement	**Total Secondary Settlement (ft)**
1	800	800	0	880	P-24	5	0.024	5.0	0.022	**0.05**

Notes: Secondary settlement in sands estimated as
Total settlement at time t = S_pC_t
where
S_p = primary settlement
c_t = time rate factor = 1.5 for 30 years (see table 5.2, Engineering Manual for Shallow Foundations)

then secondary settlement = total settlement at time t - primary settlement

Made by: CLY
Checked by: SKS
Reviewed by: DBM

WCA of High Point C&D Landfill - Phase 2 Settlement Summary

Point	Total Primary Settlement Due to	Secondary Settlement	Total Settlement
1	0.09	0.05	0.14

Secondary settlement is modeled as total settlement 30 years after loading complete

Differential Settlement

Estimate differential settlement between Point 1 and 2(estimated location maximum settlement and perimeter points)

Assume no settlement at perimeter.

Distance between
Points 1 and 2 250 ft

Differential Settlement between
Points 1 and 2 0.14 ft or 0.06%

Made by: CK
Checked by: SKS
Reviewed by: DBM

EP-3

Golder Associates	SUBJECT: Final Cover Equivalency		
	Job No.: 063 - 6526	Made By: DBM	Date: 19-Dec-06
	Reference: WCA of High Point C&D Landfill	Checked: SKS	Sheet: 1 of 2
		Reviewed: CW	

Objective:

To evaluate the hydraulic equivalency of an alternative cap section of cover utilizing a geomembrane infiltration barrier versus the regulatory minimum cap (RMC) with a low permeability ($1.0\text{x}10^{-5}$ cm/sec).

Method:

Use the results from the USEPA Hydrologic Evaluation of Landfill Performance (HELP) model version 3.07 (see HELP Evaluation Calculations, attached) to estimate the anticipated percolation/leakage rates through the final cover system using an alternative cap section with geomembrane versus the RMC, 18" of low permeability soil ($1.0\text{x}10^{-5}$ cm/sec).

The estimated rates are per plan acre and are approximations.

The two final cover systems are presented below:

Cover System	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
RMC	24" vegetative cover	18" low permeability soil ($1\text{x}10^{-5}$cm/sec)	12" intermediate cover	waste	-
Alternative Cap	24" vegetative cover	geonet drainage layer	FML membrane liner	12 " intermediate cover	waste

Once the percolation/leakage rates through the final cover systems are determined, they will be compared to determine which final cover system allows less infiltration. In addition, should the membrane final cover configuration yield a lower rate of infiltration, this shall serve as equivalency demonstration required per 15A NCAC 13B .0543(c)(3).

Assumptions:

- The SCS run-off curve number was calculated by HELP using slope and soil texture information.
- Climatological data for Greensboro, North Carolina, was used to generate synthetic rainfall data.
- The scenarios were each run with a 10 year simulation period.
- The initial soil water content was estimated by the model.
- The geomembrane has 4 manufacturing defects and 4 installation defects per acre.
- The scenarios were modeled using a 5% slope with 200 ft length and give a per acre estimate.
- The geonet gas collection layer will have the same effect on both scenarios. Therefore, to facilitate modeling, this layer was removed from both scenarios.

	SUBJECT: Final Cover Equivalency					
Golder Associates	Job No.:	063 - 6526	Made By:	DBM	Date:	19-Dec-06
	Reference:	WCA of High Point C&D Landfill	Checked:	SKS	Sheet: 2 of 2	
			Reviewed:	CLK		

Results:

The following percolation/leakage rates through the bottom of the cover system were calculated by the HELP model (see attached results of HELP model):

	Peak Daily (cf/day/ac)	Avg. Daily (cf/day/ac)	Peak Daily (gal/day/ac)	Avg. Daily (gal/day/ac)
Soil	1756.91	105.3	13142.6	787.5
Membrane	0.0670	0.0062	0.501	0.0466

Conclusion:

The maximum expected leakage is reduced significantly when an altrenate liner section containing a geomembrane liner is used as opposed to using the regulatory minimum cap including 18" of 1.0×10^{-5} cm/sec soil.

This should serve as adequate demonstration to meet the criteria set forth in 15A NCAC 13B .0543 that the alternative cap achieve a reduction in infiltration equivalent to or greater than the low-permeability barrier specified in the regulations.

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**            FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP\wca\GRNSBRO.D4
TEMPERATURE DATA FILE:       C:\HELP\wca\GRNSBRO.D7
SOLAR RADIATION DATA FILE:   C:\HELP\wca\GRNSBRO.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\wca\GRNSBRO.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\wca\SOIL.D10
OUTPUT DATA FILE:            C:\HELP\wca\SOIL.OUT

TIME:  12:22     DATE:  12/19/2006

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     TITLE:  WCA High Point C&D Landfill - Soil Cover

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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  10
          THICKNESS                    =     24.00    INCHES
          POROSITY                     =      0.3980 VOL/VOL
          FIELD CAPACITY               =      0.2440 VOL/VOL
          WILTING POINT                =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2489 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC


                                 LAYER  2
                                 --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =     18.00    INCHES
          POROSITY                     =      0.4750 VOL/VOL
          FIELD CAPACITY               =      0.3780 VOL/VOL
          WILTING POINT                =      0.2650 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.4750 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                                 LAYER  3
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TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 10

THICKNESS	=	12.00 INCHES
POROSITY	=	0.3980 VOL/VOL
FIELD CAPACITY	=	0.2440 VOL/VOL
WILTING POINT	=	0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3198 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	100.00 INCHES
POROSITY	=	0.1680 VOL/VOL
FIELD CAPACITY	=	0.0730 VOL/VOL
WILTING POINT	=	0.0190 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0727 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	90.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	9.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.314	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.582	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.224	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	25.636	INCHES
TOTAL INITIAL WATER	=	25.636	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
GREENSBORO NORTH CAROLINA

STATION LATITUDE	=	35.13 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	90
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	9.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00 %

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 74.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 70.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.51	3.37	3.88	3.16	3.37	3.93
4.27	4.19	3.64	3.18	2.59	3.38

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
37.50	39.90	48.00	58.30	66.50	73.50
77.20	76.30	69.90	58.40	48.50	40.20

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR GREENSBORO NORTH CAROLINA
AND STATION LATITUDE = 35.13 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.01	3.14	4.14	2.51	3.56	4.49
	5.44	5.30	3.69	2.84	2.09	3.82
STD. DEVIATIONS	2.22	1.31	1.75	1.15	1.59	3.13
	1.77	2.81	2.02	1.83	1.29	1.71
RUNOFF						
TOTALS	0.281	0.358	0.307	0.140	0.338	0.545
	0.741	0.887	0.697	0.503	0.049	0.466
STD. DEVIATIONS	0.406	0.422	0.317	0.393	0.418	0.863
	0.755	0.962	0.761	0.601	0.079	0.548
EVAPOTRANSPIRATION						
TOTALS	1.431	1.770	2.852	2.407	2.771	3.122
	3.872	3.141	2.411	1.878	1.334	1.231
STD. DEVIATIONS	0.304	0.434	0.520	0.741	0.930	1.940

	0.731	1.239	0.986	0.880	0.464	0.309

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	1.6791	0.7365	1.1669	0.2492	0.6515	0.6959
	1.0109	0.9072	0.8506	0.6274	0.3625	1.6051
STD. DEVIATIONS	1.8859	0.5657	1.0528	0.4804	0.6890	1.0031
	0.6291	1.0291	0.6557	0.6350	0.5471	1.1654

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	2.0102	0.6183	1.1322	0.6737	0.4966	0.7406
	0.9271	0.7043	0.9949	0.8118	0.3755	1.1073
STD. DEVIATIONS	2.1131	0.5505	0.7224	0.5707	0.6197	0.8824
	0.5821	0.7515	1.0723	0.6381	0.4176	1.0188

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.2205	0.1002	0.1045	0.0286	0.0726	0.0956
	0.1144	0.1340	0.1245	0.0833	0.0219	0.2308
STD. DEVIATIONS	0.3351	0.1126	0.1142	0.0789	0.0966	0.1779
	0.0949	0.1892	0.1374	0.1040	0.0346	0.2538

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES		CU. FEET	PERCENT
PRECIPITATION	44.04	(7.015)	159858.0	100.00
RUNOFF	5.312	(2.1860)	19284.34	12.063
EVAPOTRANSPIRATION	28.220	(2.6755)	102439.51	64.082
PERCOLATION/LEAKAGE THROUGH LAYER 2	10.54274	(3.07231)	38270.133	23.94009
AVERAGE HEAD ON TOP OF LAYER 2	0.111	(0.045)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	10.59242	(3.51709)	38450.496	24.05292
CHANGE IN WATER STORAGE	-0.087	(1.2416)	-316.39	-0.198

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SOIL.OUT

PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	3.73	13539.900
RUNOFF	1.907	6921.6714
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.484000	1756.91833
AVERAGE HEAD ON TOP OF LAYER 2	7.612	
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.478085	1735.44714
SNOW WATER	1.73	6282.1865

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3586
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1360

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	5.5991	0.2333
2	8.5500	0.4750
3	3.3348	0.2779
4	7.2802	0.0728
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP\wca\GRNSBRO.D4
TEMPERATURE DATA FILE:       C:\HELP\wca\GRNSBRO.D7
SOLAR RADIATION DATA FILE:   C:\HELP\wca\GRNSBRO.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\wca\GRNSBRO.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\wca\MEMBRNE.D10
OUTPUT DATA FILE:            C:\HELP\wca\MEMBRNE.OUT

TIME:  12:23     DATE:  12/19/2006

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     TITLE:  WCA High Point C&D Landfill - Geosynthetic Cover

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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  10
          THICKNESS                    =     24.00    INCHES
          POROSITY                     =      0.3980 VOL/VOL
          FIELD CAPACITY               =      0.2440 VOL/VOL
          WILTING POINT                =      0.1360 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2980 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC


                                  LAYER  2
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER  34
          THICKNESS                    =      0.60    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                        =      5.00    PERCENT
          DRAINAGE LENGTH              =    200.0     FEET
```

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

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.	=	0.399999993000E-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 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 10

THICKNESS	=	12.00 INCHES
POROSITY	=	0.3980 VOL/VOL
FIELD CAPACITY	=	0.2440 VOL/VOL
WILTING POINT	=	0.1360 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2435 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 19

THICKNESS	=	100.00 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

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	90.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	9.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.631	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.582	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.224	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	17.336	INCHES
TOTAL INITIAL WATER	=	17.336	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
GREENSBORO NORTH CAROLINA

STATION LATITUDE	=	35.13 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	90
END OF GROWING SEASON (JULIAN DATE)	=	305
EVAPORATIVE ZONE DEPTH	=	9.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	68.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	74.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	70.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.51	3.37	3.88	3.16	3.37	3.93
4.27	4.19	3.64	3.18	2.59	3.38

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
37.50	39.90	48.00	58.30	66.50	73.50
77.20	76.30	69.90	58.40	48.50	40.20

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR GREENSBORO NORTH CAROLINA
AND STATION LATITUDE = 35.13 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.01	3.14	4.14	2.51	3.56	4.49
	5.44	5.30	3.69	2.84	2.09	3.82

```
  STD. DEVIATIONS          2.22     1.31     1.75     1.15     1.59     3.13
                           1.77     2.81     2.02     1.83     1.29     1.71

RUNOFF
------
  TOTALS                   0.415    0.398    0.387    0.135    0.395    0.663
                           0.806    0.988    0.750    0.546    0.061    0.589

  STD. DEVIATIONS          0.605    0.424    0.390    0.361    0.456    1.042
                           0.793    1.089    0.778    0.647    0.096    0.692

EVAPOTRANSPIRATION
------------------
  TOTALS                   1.445    1.781    2.870    2.455    2.806    3.206
                           3.903    3.230    2.460    1.923    1.359    1.227

  STD. DEVIATIONS          0.287    0.432    0.516    0.752    0.931    1.937
                           0.753    1.231    0.977    0.875    0.451    0.311

LATERAL DRAINAGE COLLECTED FROM LAYER  2
----------------------------------------
  TOTALS                   1.8328   0.6800   0.9607   0.7018   0.3884   0.5789
                           0.7267   0.7193   0.7082   0.7186   0.3869   0.9257

  STD. DEVIATIONS          1.7860   0.5608   0.7188   0.4939   0.4897   0.6377
                           0.4719   0.6244   0.7691   0.5244   0.3376   0.8210

PERCOLATION/LEAKAGE THROUGH LAYER  3
------------------------------------
  TOTALS                   0.0001   0.0000   0.0001   0.0001   0.0000   0.0000
                           0.0001   0.0001   0.0000   0.0001   0.0000   0.0001

  STD. DEVIATIONS          0.0001   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


-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


DAILY AVERAGE HEAD ON TOP OF LAYER  3
-------------------------------------
  AVERAGES                 0.0013   0.0005   0.0007   0.0005   0.0003   0.0004
                           0.0005   0.0005   0.0005   0.0005   0.0003   0.0007

  STD. DEVIATIONS          0.0014   0.0004   0.0005   0.0004   0.0003   0.0005
                           0.0003   0.0004   0.0006   0.0004   0.0002   0.0006

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


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   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   10
```

	INCHES		CU. FEET	PERCENT
PRECIPITATION	44.04	(7.015)	159858.0	100.00
RUNOFF	6.133	(2.5326)	22261.57	13.926
EVAPOTRANSPIRATION	28.667	(2.6951)	104060.53	65.096
LATERAL DRAINAGE COLLECTED FROM LAYER 2	9.32792	(2.85242)	33860.348	21.18152
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00063	(0.00015)	2.276	0.00142
AVERAGE HEAD ON TOP OF LAYER 3	0.001	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	-0.089	(1.1089)	-324.47	-0.203

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	3.73	13539.900
RUNOFF	2.095	7605.7959
DRAINAGE COLLECTED FROM LAYER 2	0.48375	1755.99609
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000018	0.06696
AVERAGE HEAD ON TOP OF LAYER 3	0.013	
MAXIMUM HEAD ON TOP OF LAYER 3	0.024	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00000
SNOW WATER	1.73	6282.1865
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.3576
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1360

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

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

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□
****

FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	6.2511	0.2605
2	0.0067	0.0111
3	0.0000	0.0000
4	2.9224	0.2435
5	7.2616	0.0726
SNOW WATER	0.000	

****
****

EP-4

EROSION AND SEDIMENT CONTROL PLAN

WCA OF HIGH POINT
CONSTRUCTION AND DEMOLITION LANDFILL
PHASE 2 EXPANSION
PERMIT NO. 41-16
GUILFORD COUNTY, NORTH CAROLINA

Prepared for:

WCA of High Point , LLC
5830 Riverdale Drive
Jamestown, North Carolina 27282

Prepared by:

Golder Associates NC Inc.
4900 Koger Boulevard, Suite 140
Greensboro, North Carolina 27407

March 2007

Project No.: 063-6526

Erosion and Sediment Control Plan
WCA of High Point C&D Landfill
Phase 2 Expansion

Table of Contents

DRAWINGS

APPENDICIES

1.0 PROJECT DESCRIPTION

The Phase 2 Expansion of the WCA of High Point C&D Landfill is located along the eastern border of the City of High Point, along the west side of Riverdale Drive, SR 1145, in southern Guilford County, North Carolina. The C&D landfill facility property consists of approximately 154 acres, of which 49.2 acres will be used for C&D waste disposal. Development of Phase 1 included construction of a 12.1 acre disposal cell, Stormwater conveyance channels, sediment traps and sediment basins. The proposed Phase 2 expansion is located immediately adjacent to the northern and eastern limits of the first five year phase developed at the site and includes a 9.4 acre disposal cell plus additional access roads and sediment and erosion control features. A total of approximately 13.2 acres will be disturbed during construction of Phase 2.

This Erosion and Sediment Control (E&S) Plan contains drawings that specifically relate to the E&S features for the Phase 2 development. Additional site development and phasing drawings are provided as part of the Permit to Construct Application and are referenced in this report.

2.0 EXISTING SITE CONDITIONS

The site is characterized by gently sloping hillsides ranging in elevation from 710 to 810 feet above mean sea-level (MSL) The primary use of the site has historically been for farming and forestry, but since developing the site for waste disposal purposes, one landfill cell, a material recovery facility, office buildings, maintenance buildings and other support structures have been built.

There are three small unnamed streams that traverse the site that flow into an unnamed tributary of Richland Creek, which forms the southern property boundary. The first unnamed tributary is a southwest trending stream that forms the northwestern property boundary. The second tributary is a southwest trending drainage feature in the center of the property and lies just east of the proposed Phase 2 waste unit. The third tributary is a southwest trending drainage in the eastern portion of the site. A large man-made pond is located near the eastern property boundary. A small stormwater basin was constructed in the northwest corner of the facility and a larger stormwater basin was constructed along the southwestern part of the site during the construction of Phase 1. Channels designed as part of the development of the Phase 2 expansion have been designed to convey run-off away from the landfill cells and into the existing sediment basins or proposed sediment traps.

2.1 Adjacent Areas

The site is bounded to the west and south by unnamed tributaries of Richland Creek; to the east by Riverdale Drive; and to the north by privately owned properties. Properties adjacent to the site are generally residential and rural farmland; however, the site is immediately adjacent to the potential expansion area of the Kersey Valley Landfill, and is west of the Riverdale Drive Landfill, the High Point Material Recovery Facility, and one of the city's wastewater treatment plants.

2.2 Soils

According to the soil survey map for Guilford County, North Carolina, (USDA Natural Resources Conservation Service, 1977), the surficial soils at the site belong to the Enon and Wilkes groups. These soils are characteristic of Piedmont uplands where poor to moderate drained soils with a coarse sandy loam surface layer predominate on gently sloping to moderately sloping land.

Grass-lined channels shall be checked after every rainfall while grass in the channel is being established. After grass is established, the channel shall be checked after each significant rainfall event, and repairs made immediately. Accumulated sediment shall be removed as necessary to maintain the design capacity of the channel, and deposited on the stockpile for weekly cover. Grass lined channels shall be kept in a healthy and vigorous condition at all times.

4.4 Outlet Protection, OP, (Reference NCESCPDM 6.40, 6.41)

Outlet stabilization structures will reduce erosion at the outlet of the culverts and/or channels by reducing the velocity of flow and dissipating the energy. Calculations are provided in Appendix 1.

Maintenance after heavy rains may be required to check on erosion around or below the riprap, or to see if any stones have been dislodged. Repairs will be made immediately.

4.5 Temporary Sediment Trap (Reference NCESCPDM 6.60)

Sediment traps will be established around the perimeter of the landfill to collect and trap sediment. Calculations are provided in Appendix 1. Accumulated sediment will be removed from the sediment trap on as-needed basis to maintain the design storage capacity. The embankments, spillways, and outlets shall be inspected regularly for signs of piping and settlement. Repairs shall be made as quickly as practicable.

4.6 Sediment Basin (Reference NCESCPDM 6.61)

The site has one existing basin used to retain sediment. Accumulated sediment will be removed from the sediment basin on a semiannual basis to maintain the design storage capacity. The embankments, spillways, and outlets shall be inspected regularly for signs of piping and settlement. Repairs shall be made immediately. The riser and pool areas shall be kept free of trash and other debris.

4.7 Sediment Fence (Reference NCESCPDM 6.62)

Sediment fences will be provided down gradient of the proposed roadway embankment as shown on Drawing No. 1, Phase 2 Erosion and Sediment Control plan. The sediment fence will prevent sediment from traveling off site as vegetation is established. Sediment fences will also be placed up gradient of down-slope diversion berms. Sediment fences will **not** be placed across concentrated flow channels.

Fences will be checked and maintained after every significant rain event, or weekly, and will be removed when disturbed areas have a good stand of vegetation.

5.0 VEGETATIVE STABILIZATION

Construction practices and on site operations that can further prevent or reduce erosion from occurring include limiting the size of clearing activities, limiting the exposure time through proper scheduling, reducing runoff over the exposed areas, limiting the grades and lengths of slopes, and reestablishing vegetation.

As required by 15A NCAC 04B .0107, vegetative cover shall be re-established within 15 working days or 90 calendar days following completion of construction or development, whichever period is shorter. Temporary and permanent seeding specifications are attached in Appendix 2.

6.3 Temporary Sediment Traps

With the Phase 2 expansion, four new sediment traps are anticipated. Each trap was designed to have a drainage area of less than five acres.

Phase 2 Sediment Trap Drainage Areas

Trap ID	Trap Drainage area (ac.)	Volume Required (CF)	Q_{10} (CFS)	Weir Length (ft)
ST-1	1.07	3868	4.66	5
ST-2	2.64	9,504	7.63	7
ST-3	4.41	15,876	12.76	12
ST-4	0.84	3,031	3.0	3

Calculations are included in Appendix 1 for the sediment traps, conveyance channels, and other stormwater controls.

7.0 SITE STABILIZATION

Stabilization of the site will consist of vegetative cover, access road stabilization, and other means such as silt fence, mulch or soil stabilization matting. The regulations requires that surfaces be stable and non-erosive within 15 working days or 90 calendar days of completion of activity, whichever is shorter.

Sequencing construction will help reduce stormwater runoff. For example, constructing a channel from the downstream end up will prevent large flows from entering the construction area. Disturbing areas only when needed and not mass clearing will preserve existing vegetation and prevent excess sediment transport from denuded areas.

Dust control at this site will be managed through a series of best management practices as described below:

- Scheduling construction and daily operations to limit exposed areas;
- Retaining undisturbed buffer areas between graded areas;
- Limiting soil exposure during periods of extended dry weather;
- Installing temporary or permanent soil stabilization measures immediately after grading is complete; and
- Use of water trucks or soil tackifiers to prevent dust mobilization.

Temporary control features will remain in place and will be maintained until the upgradient disturbed areas have been permanently stabilized.

8.0 CONSTRUCTION SCHEDULING

1. Install temporary sediment controls;
2. Construct the sediment traps;
3. Install stormwater conveyance channels;
4. Stabilize construction access routes;

12.0 PRECONSTRUCTION MEETING

Prior to land disturbing activities taking place for this development, a preconstruction meeting will be held. Representatives from WCA, engineering, contractors and subs, and the erosion control inspector for this site should be in attendance.

DRAWINGS

The following drawings referenced in the Erosion and Sediment Control Plan have not been reproduced herein but are included in the Engineering Plan as follows:

Drawing No. 1	Erosion and Sediment Control, See drawing EP-4, Same title
Drawing No. 2	Erosion and Sediment Control Details, Sheet 1 of 3; See drawing EP-8, Same title
Drawing No. 3	Erosion and Sediment Control Details, Sheet 2 of 3; See drawing EP-9, Same title
Drawing No. 4	Erosion and Sediment Control Details, Sheet 3 of 3; See drawing EP-10, Same title

Appendix 1 Design Calculations

Golder Associates Greensboro, North Carolina	Subject: Perimeter Channel Analysis		
	Job No. 063-6526	Made By: GGM	Date: 3/29/07 R1
		Checked: DPM 3/29/07	
	Ref:	Reviewed: JRD 4/10/07	Sheet 1 of 3

OBJECTIVE

Design the perimeter channels to adequately convey the flows of the 2-year Low Retardance (class D), 10-year High Retardance (class B) and 25-year High Retardance (class B). The 2-year flows will be analyzed for velocity, and the 10 and 25 year flows will be analyzed for channel capacity.

METHOD

Calculate the flow to each downslope pipe, using the TR-55 method. Combine flows from the downslope pipes and individual drainage areas to pipes as required to calculate the total flow in each perimeter channel. Use the iterative design method described in Appendix 8.05 of the June 2006 edition of the North Carolina Erosion and Sediment Control Planning and Design Manual to analyze the channel capacity for Low and High Retardance conditions.

REFERENCES

1. Point Precipitation Frequency Estimates from NOAA Atlas 14, Guilford County, North Carolina (Attachment 1)
2. Channel Retardance Calculations (Attachment 2)
3. North Carolina Erosion and Sediment Control Planning and Design Manual, June 2006 Edition (available online at http://www.dlr.enr.state.nc.us/pages/manualsandvideos.html)
4. WCA High Point Landfill Drawing Set, Prepared by Golder Associates Inc., March 2007, sheet EP-04
5. Channel Flow Calculations Package Prepared by Golder Associates Inc., December 2006

CALCULATIONS

The following perimeter channel information was collected from Drawing EP-04 (Reference 4) and flows calculated using the TR-55 method (Reference 5):

Label	Bottom Width (ft)	Depth (ft)	Channel X-Section	Channel Slope (ft/ft)	Left Side Slope (H : 1)	Right Side Slope (H : 1)	Contributing Drainage Areas	2-Yr Flow (cfs)	10-Yr Flow (cfs)	25-Yr Flow (cfs)
PC-1	5	3.00	Trapezoidal	0.0240	3	3	PC1	0.99	2.20	3.00
PC-2	5	3.00	Trapezoidal	0.0430	3	3	SD1, PC2 +PC-1	2.99	6.66	9.08
PC-3	5	3.00	Trapezoidal	0.0230	3	3	PC3, SD2, +PC-2	5.72	12.73	17.36
PC-4	3	3.00	Trapezoidal	0.0130	3	3	PC4, SD3, +PC-3	9.72	21.62	29.48
PC-5	3	3.00	Trapezoidal	0.0500	3	3	PC5, SD4, +PC-4	13.34	29.66	40.43
PC-6	3	3.00	Trapezoidal	0.0080	3	3	PC6, SD5, +PC-5	15.95	35.45	48.33
PC-7	3	3.00	Trapezoidal	0.0310	3	3	PC7, SD7, +PC-8	5.42	12.05	16.43
PC-8	3	3.00	Trapezoidal	0.0960	3	3	PC8	0.73	1.63	2.22
PC-9	5	3.00	Trapezoidal	0.0290	3	3	PC9	0.30	0.67	0.91
PC-10	5	3.00	Trapezoidal	0.0050	3	3	PC10, +PC-9	1.16	2.58	3.51
PC-11	5	3.00	Trapezoidal	0.0280	3	3	PC11, SD9, +PC-12	5.29	11.76	16.03
PC-12	5	3.00	Trapezoidal	0.0120	3	3	PC12	0.47	1.04	1.41

Using the Low and High Retardance procedure outlined in Appendix 8.05, an initial Manning's *n* value was used to determine an initial flow depth and velocity. The product of the velocity and hydraulic radius (VxR) was computed, and Figure 8.05c was used to select a new *n* value. The depth of flow was recomputed, and a new velocity and hydraulic radius was also computed. Again using VxR, a new *n* from figure 8.05c was selected and the process repeated. When the value of VxR remained constant, the process was completed and the resulting depth is reported as the true depth of flow.

The results of the Low Retardance (class D) analysis for the 2-year flow are presented in the table below:

Label	Flow (cfs)	Velocity (ft/s)	Flow Depth (ft)	Mannings *n*	Channel Depth (ft)	Freeboard (ft)
PC-1	0.99	0.49	0.33	0.20	3.00	2.67
PC-2	2.99	1.48	0.34	0.09	3.00	2.66
PC-3	5.72	1.76	0.50	0.07	3.00	2.50
PC-4	9.72	2.15	0.83	0.05	3.00	2.17
PC-5	13.34	4.22	0.64	0.05	3.00	2.36
PC-6	15.95	2.14	1.15	0.05	3.00	1.85
PC-7	5.42	2.33	0.51	0.06	3.00	2.49
PC-8	0.73	1.01	0.20	0.14	3.00	2.80
PC-9	0.30	0.35	0.16	0.20	3.00	2.84
PC-10	1.16	0.31	0.57	0.20	3.00	2.43
PC-11	5.29	1.84	0.45	0.07	3.00	2.55
PC-12	0.47	0.31	0.27	0.20	3.00	2.74

The results of the High Retardance (class B) analysis for the 10-year flow are presented in the table below:

Label	Flow (cfs)	Velocity (ft/s)	Flow Depth (ft)	Mannings *n*	Channel Depth (ft)	Freeboard (ft)
PC-1	2.20	0.48	0.66	0.30	3.00	2.34
PC-2	6.66	1.22	0.82	0.18	3.00	2.18
PC-3	12.73	1.36	1.12	0.14	3.00	1.88
PC-4	21.62	1.43	1.80	0.12	3.00	1.20
PC-5	29.66	3.44	1.27	0.08	3.00	1.73
PC-6	35.45	1.62	2.24	0.10	3.00	0.76
PC-7	12.05	1.62	1.15	0.13	3.00	1.85
PC-8	1.63	0.77	0.48	0.30	3.00	2.52
PC-9	0.67	0.35	0.32	0.30	3.00	2.68
PC-10	2.58	0.29	1.08	0.30	3.00	1.92
PC-11	11.76	1.36	1.06	0.15	3.00	1.94
PC-12	1.04	0.30	0.53	0.30	3.00	2.48

The results of the High Retardance (class B) analysis for the 25-year flow are presented in the table below:

Label	Flow (cfs)	Velocity (ft/s)	Flow Depth (ft)	Mannings *n*	Channel Depth (ft)	Freeboard (ft)
PC-1	3.00	0.53	0.77	0.30	3.00	2.23
PC-2	9.08	1.34	0.88	0.17	3.00	2.12
PC-3	17.36	1.65	1.21	0.12	3.00	1.79
PC-4	29.48	1.84	1.86	0.10	3.00	1.14
PC-5	40.43	3.98	1.40	0.08	3.00	1.60
PC-6	48.33	1.97	2.40	0.08	3.00	0.60
PC-7	16.43	1.86	1.28	0.12	3.00	1.72
PC-8	2.22	0.84	0.56	0.30	3.00	2.44
PC-9	0.91	0.39	0.38	0.30	3.00	2.62
PC-10	3.51	0.31	1.23	0.30	3.00	1.77
PC-11	16.03	1.69	1.13	0.13	3.00	1.87
PC-12	1.41	0.33	0.62	0.30	3.00	2.38

CONCLUSIONS

Based on the proposed design with 3 foot channel depth, the perimeter channels adequately convey the 2-year, 10-year and 25-year flows. The 2-year flows will be non-erosive with the proper channel lining selection. Grass lining will be used for channels with 2-year velocities less than 4 FPS (feet per second) and a permanent erosion control lining with grass for velocities greater than 4 FPS. There is adequate capacity for the 10-year and 25-year storm events.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

HIGH POINT, NORTH CAROLINA (31-4063) 35.9672 N 79.9722 W 816 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004

Extracted: Thu Aug 24 2006

Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | D

Precipitation Intensity Estimates (in/hr)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	4.61	3.68	3.07	2.10	1.31	0.77	0.55	0.34	0.20	0.12	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.01
2	5.47	4.38	3.67	2.53	1.59	0.94	0.67	0.41	0.24	0.14	0.08	0.05	0.03	0.02	0.02	0.01	0.01	0.01
5	6.38	5.11	4.31	3.06	1.96	1.16	0.83	0.50	0.30	0.18	0.10	0.06	0.04	0.03	0.02	0.02	0.01	0.01
10	6.97	5.57	4.70	3.40	2.22	1.33	0.95	0.58	0.35	0.21	0.12	0.06	0.04	0.03	0.02	0.02	0.01	0.01
25	7.61	6.06	5.12	3.79	2.52	1.53	1.10	0.68	0.41	0.24	0.14	0.08	0.05	0.04	0.02	0.02	0.02	0.01
50	7.99	6.37	5.37	4.05	2.74	1.69	1.21	0.75	0.46	0.27	0.15	0.08	0.05	0.04	0.03	0.02	0.02	0.01
100	8.33	6.61	5.57	4.27	2.94	1.83	1.32	0.83	0.51	0.30	0.17	0.09	0.06	0.05	0.03	0.02	0.02	0.01
200	8.58	6.80	5.72	4.45	3.12	1.97	1.42	0.90	0.57	0.33	0.18	0.10	0.06	0.05	0.03	0.02	0.02	0.02
500	8.81	6.97	5.85	4.65	3.34	2.15	1.56	1.01	0.64	0.37	0.21	0.11	0.07	0.05	0.04	0.03	0.02	0.02
1000	8.94	7.04	5.89	4.77	3.48	2.27	1.65	1.08	0.70	0.41	0.22	0.12	0.08	0.06	0.04	0.03	0.02	0.02

Text version of table

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.

Attachment 1

WCA of High Point
Guilford County, NC
Channel Retardance Calculations

Label	Discharge (cfs)	Velocity (ft/s)	Depth (ft)	Bottom Width (ft)	Channel Slope (ft/ft)	Mannings Coefficient	Left Side (H : V)	Right Side (H : V)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	VxR	Retardance Class
PC-1	0.99	1.53	0.12	5	0.0240	0.035	3	3	0.65	5.76	0.11	0.2	D
PC-2	2.99	2.76	0.19	5	0.0430	0.035	3	3	1.09	6.23	0.17	0.5	D
PC-3	5.72	2.80	0.34	5	0.0230	0.035	3	3	2.04	7.15	0.29	0.8	D
PC-4	9.72	2.91	0.67	3	0.0130	0.035	3	3	3.35	7.23	0.46	1.3	D
PC-5	13.34	5.15	0.56	3	0.0500	0.035	3	3	2.59	6.51	0.40	2.0	D
PC-6	15.95	2.79	0.97	3	0.0080	0.035	3	3	5.72	9.13	0.63	1.7	D
PC-7	5.42	3.34	0.39	3	0.0310	0.035	3	3	1.62	5.46	0.30	1.0	D
PC-8	0.73	2.50	0.09	3	0.0960	0.035	3	3	0.29	3.57	0.08	0.2	D
PC-9	0.30	1.04	0.06	5	0.0290	0.035	3	3	0.29	5.35	0.05	0.1	D
PC-10	1.16	0.98	0.21	5	0.0050	0.035	3	3	1.18	6.33	0.19	0.2	D
PC-11	5.29	2.91	0.31	5	0.0280	0.035	3	3	1.82	6.94	0.26	0.8	D
PC-12	0.47	0.94	0.10	5	0.0120	0.035	3	3	0.50	5.60	0.09	0.08	D

Label	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	Converge	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	Converge	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	Converge
PC-1	0.140	0.27	1.58	6.72	0.24	0.63	0.1	new	0.200	0.33	2.00	7.11	0.28	0.49	0.1	Conv	0.200	0.33	2.00	7.11	0.28	0.49	0.1	Conv
PC-2	0.080	0.31	1.87	6.99	0.27	1.60	0.4	new	0.090	0.34	2.02	7.13	0.28	1.48	0.4	Conv	0.090	0.34	2.02	7.13	0.28	1.48	0.4	Conv
PC-3	0.065	0.48	3.10	8.05	0.39	1.84	0.7	new	0.069	0.50	3.24	8.15	0.40	1.76	0.7	Conv	0.069	0.50	3.24	8.15	0.40	1.76	0.7	Conv
PC-4	0.055	0.84	4.64	8.32	0.56	2.09	1.2	new	0.053	0.83	4.52	8.22	0.55	2.15	1.2	new	0.053	0.83	4.52	8.22	0.55	2.15	1.2	Conv
PC-5	0.045	0.63	3.10	7.00	0.44	4.29	1.9	new	0.046	0.64	3.15	7.05	0.45	4.22	1.9	new	0.046	0.64	3.15	7.05	0.45	4.22	1.9	Conv
PC-6	0.047	1.12	7.10	10.07	0.71	2.24	1.6	new	0.050	1.15	7.43	10.28	0.72	2.14	1.5	new	0.05	1.15	7.43	10.28	0.72	2.14	1.5	Conv
PC-7	0.060	0.52	2.37	6.29	0.38	2.28	0.9	new	0.058	0.51	2.32	6.23	0.37	2.33	0.9	Conv	0.058	0.51	2.32	6.23	0.37	2.33	0.9	Conv
PC-8	0.140	0.20	0.72	4.27	0.17	1.01	0.2	new	0.140	0.20	0.72	4.27	0.17	1.01	0.2	Conv	0.140	0.20	0.72	4.27	0.17	1.01	0.2	Conv
PC-9	0.200	0.16	0.86	6.00	0.14	0.35	0.1	Conv	0.200	0.16	0.86	6.00	0.14	0.35	0.1	Conv	0.200	0.16	0.86	6.00	0.14	0.35	0.1	Conv
PC-10	0.140	0.47	2.97	7.94	0.37	0.39	0.1	new	0.200	0.57	3.80	8.59	0.44	0.31	0.1	new	0.200	0.57	3.80	8.59	0.44	0.31	0.1	Conv
PC-11	0.065	0.44	2.75	7.76	0.35	1.92	0.7	new	0.069	0.45	2.87	7.85	0.37	1.84	0.7	Conv	0.069	0.45	2.87	7.85	0.37	1.84	0.7	Conv
PC-12	0.200	0.27	1.54	6.68	0.23	0.31	0.1	new	0.200	0.27	1.54	6.68	0.23	0.31	0.1	Conv	0.200	0.27	1.54	6.68	0.23	0.31	0.1	Conv

10-Yr High Retardance (Class B)

Label	Discharge (cfs)	Velocity (ft/s)	Depth (ft)	Bottom Width (ft)	Channel Slope (ft/ft)	Mannings Coefficient	Left Side Slope (H : V)	Right Side Slope (H : V)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	VxR	Retardance Class
PC-1	2.20	2.05	0.19	5	0.0240	0.035	3	3	1.08	6.23	0.17	0.4	B
PC-2	6.66	3.63	0.31	5	0.0430	0.035	3	3	1.83	6.96	0.26	1.0	B
PC-3	12.73	3.62	0.53	5	0.0230	0.035	3	3	3.52	8.37	0.42	1.5	B
PC-4	21.62	3.61	1.00	3	0.0130	0.035	3	3	5.98	9.31	0.64	2.3	B
PC-5	29.66	6.44	0.84	3	0.0500	0.035	3	3	4.61	8.29	0.56	3.6	B
PC-6	35.45	3.44	1.42	3	0.0080	0.035	3	3	10.30	11.97	0.86	3.0	B
PC-7	12.05	4.22	0.60	3	0.0310	0.035	3	3	2.86	6.77	0.42	1.8	B
PC-8	1.63	3.32	0.14	3	0.0960	0.035	3	3	0.49	3.91	0.13	0.4	B
PC-9	0.67	1.41	0.09	5	0.0290	0.035	3	3	0.48	5.57	0.09	0.1	B
PC-10	2.58	1.29	0.33	5	0.0050	0.035	3	3	2.00	7.11	0.28	0.4	B
PC-11	11.76	3.78	0.48	5	0.0280	0.035	3	3	3.11	8.05	0.39	1.5	B
PC-12	1.04	1.25	0.15	5	0.0120	0.035	3	3	0.83	5.96	0.14	0.2	B

Label	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	New Hyd Radius	New V	VxR	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	Converge	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	Converge
PC-1	0.280	0.63	4.34	8.98	0.48	0.51	0.2	0.300	0.66	4.58	9.16	0.50	0.48	0.2	0.300	0.66	4.58	9.16	0.50	0.48	0.2	Conv	0.300	0.66	4.58	9.16	0.50	0.48	0.2	Conv
PC-2	0.150	0.70	4.96	9.42	0.53	1.34	0.7	0.200	0.82	6.08	10.16	0.60	1.09	0.7	0.180	0.82	6.08	10.16	0.60	1.22	0.7	new	0.180	0.82	6.08	10.16	0.60	1.22	0.7	Conv
PC-3	0.120	1.03	8.38	11.54	0.73	1.52	1.1	0.140	1.12	9.35	12.08	0.77	1.36	1.1	0.140	1.12	9.35	12.08	0.77	1.36	1.1	Conv	0.140	1.12	9.35	12.08	0.77	1.36	1.1	Conv
PC-4	0.090	1.56	12.00	12.88	0.93	1.80	1.7	0.100	1.64	13.03	13.39	0.97	1.66	1.6	0.120	1.78	14.86	14.26	1.04	1.45	1.5	new	0.123	1.80	15.13	14.26	1.06	1.43	1.5	Conv
PC-5	0.072	1.19	7.81	10.52	0.74	3.78	2.8	0.080	1.25	8.45	10.91	0.77	3.50	2.7	0.082	1.27	8.60	11.00	0.78	3.44	2.7	new	0.082	1.27	8.60	11.00	0.78	3.44	2.7	Conv
PC-6	0.080	2.07	19.02	16.07	1.18	1.86	2.2	0.092	2.14	20.21	16.56	1.22	1.65	2.0	0.097	2.25	21.96	17.24	1.27	1.61	2.1	new	0.096	2.24	21.79	17.24	1.26	1.62	2.0	Conv
PC-7	0.100	1.01	6.12	9.41	0.65	1.96	1.3	0.125	1.13	7.21	10.14	0.71	1.67	1.2	0.130	1.15	7.42	10.27	0.72	1.62	1.2	new	0.130	1.15	7.42	10.27	0.72	1.62	1.2	Conv
PC-8	0.280	0.46	2.03	5.92	0.34	0.80	0.3	0.300	0.48	2.13	6.03	0.35	0.77	0.3	0.300	0.48	2.13	6.03	0.35	0.77	0.3	Conv	0.300	0.48	2.13	6.03	0.35	0.77	0.3	Conv
PC-9	0.300	0.32	1.90	7.02	0.27	0.35	0.1	0.300	0.32	1.90	7.02	0.27	0.35	0.1	0.300	0.32	1.90	7.02	0.27	0.35	0.1	Conv	0.300	0.32	1.90	7.02	0.27	0.35	0.1	Conv
PC-10	0.280	1.04	8.47	11.59	0.73	0.30	0.2	0.300	1.08	8.89	11.82	0.75	0.29	0.2	0.300	1.08	8.89	11.82	0.75	0.29	0.2	Conv	0.300	1.08	8.89	11.82	0.75	0.29	0.2	Conv
PC-11	0.120	0.94	7.37	10.96	0.67	1.59	1.1	0.140	1.02	8.23	11.46	0.72	1.42	1.0	0.150	1.06	8.65	11.69	0.74	1.36	1.0	new	0.150	1.06	8.65	11.69	0.74	1.36	1.0	Conv
PC-12	0.300	0.52	3.44	8.31	0.41	0.30	0.1	0.300	0.53	3.45	8.32	0.41	0.30	0.1	0.300	0.53	3.45	8.32	0.41	0.30	0.1	Conv	0.300	0.53	3.45	8.32	0.41	0.30	0.1	Conv

25-Yr High Retardance (Class B)

Label	Discharge (cfs)	Velocity (ft/s)	Depth (ft)	Bottom Width (ft)	Channel Slope (ft/ft)	Mannings Coefficient	Left Side Slope (H : V)	Right Side Slope (H : V)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	VxR	Retardance Class
PC-1	3.00	2.28	0.23	5	0.0240	0.035	3	3	1.32	6.46	0.20	0.5	B
PC-2	9.08	4.02	0.37	5	0.0430	0.035	3	3	2.26	7.34	0.31	1.2	B
PC-3	17.36	3.98	0.63	5	0.0230	0.035	3	3	4.36	9.00	0.48	1.9	B
PC-4	29.48	3.92	1.16	3	0.0130	0.035	3	3	7.51	10.33	0.73	2.9	B
PC-5	40.43	7.00	0.98	3	0.0500	0.035	3	3	5.78	9.17	0.63	4.4	B
PC-6	48.33	3.73	1.64	3	0.0080	0.035	3	3	12.95	13.36	0.97	3.6	B
PC-7	16.43	4.60	0.70	3	0.0310	0.035	3	3	3.57	7.43	0.48	2.2	B
PC-8	2.22	3.69	0.17	3	0.0960	0.035	3	3	0.60	4.09	0.15	0.5	B
	0.91	1.58	0.11	5	0.0290	0.035	3	3	0.58	5.69	0.10	0.2	B
	3.51	1.43	0.40	5	0.0050	0.035	3	3	2.46	7.51	0.33	0.5	B
	16.03	4.16	0.57	5	0.0280	0.035	3	3	3.85	8.63	0.45	1.9	B
	1.41	1.40	0.18	5	0.0120	0.035	3	3	1.01	6.15	0.16	0.2	B

Label	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	Converge	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	New Hyd Radius	New V	VxR	Converge	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	Converge	New n (figure 8.05c)	New Depth (ft)	Flow Area (ft²)	Wetted Perimeter (ft)	Hyd Radius (ft)	New V	VxR	Converge
PC-1	0.250	0.70	4.98	9.43	0.53	0.60	0.3	new	0.300	0.77	5.66	9.89	0.57	0.53	0.3	new	0.300	0.77	5.66	9.89	0.57	0.53	0.3	Conv	0.300	0.77	5.66	9.89	0.57	0.53	0.3	Conv
PC-2	0.130	0.76	5.58	9.84	0.57	1.62	0.9	new	0.170	0.88	6.74	10.58	0.64	1.34	0.9	new	0.170	0.88	6.74	10.58	0.64	1.34	0.9	Conv	0.170	0.88	6.74	10.58	0.64	1.34	0.9	Conv
PC-3	0.100	1.10	9.18	11.98	0.77	1.89	1.4	new	0.120	1.21	10.47	12.67	0.83	1.65	1.4	new	0.120	1.21	10.47	12.67	0.83	1.65	1.4	Conv	0.120	1.21	10.47	12.67	0.83	1.65	1.4	Conv
PC-4	0.080	1.71	13.85	13.79	1.00	2.12	2.1	new	0.097	1.86	15.98	14.77	1.08	1.84	2.0	new	0.097	1.86	15.98	14.77	1.08	1.84	2.0	Conv	0.097	1.86	15.98	14.77	1.08	1.84	2.0	Conv
PC-5	0.065	1.31	9.11	11.30	0.81	4.43	3.6	new	0.072	1.38	9.82	11.71	0.84	4.10	3.4	new	0.075	1.40	10.13	11.88	0.85	3.98	3.4	new	0.075	1.40	10.13	11.88	0.85	3.98	3.4	Conv
PC-6	0.072	2.26	22.15	17.31	1.28	2.18	2.8	new	0.080	2.37	23.96	17.99	1.33	2.01	2.7	new	0.082	2.40	24.41	18.15	1.34	1.97	2.7	new	0.082	2.40	24.41	18.15	1.34	1.97	2.7	Conv
PC-7	0.093	1.14	7.29	10.19	0.72	2.25	1.6	new	0.120	1.28	8.79	11.11	0.79	1.86	1.5	new	0.120	1.28	8.79	11.11	0.79	1.86	1.5	Conv	0.120	1.28	8.79	11.11	0.79	1.86	1.5	Conv
PC-8	0.250	0.51	2.32	6.24	0.37	0.95	0.4	new	0.280	0.54	2.52	6.44	0.39	0.88	0.3	new	0.300	0.56	2.65	6.57	0.40	0.84	0.3	Conv	0.300	0.56	2.65	6.57	0.40	0.84	0.3	Conv
	0.300	0.38	2.33	7.40	0.32	0.39	0.1	new	0.300	0.38	2.33	7.40	0.32	0.39	0.1	Conv	0.300	0.38	2.33	7.40	0.32	0.39	0.1	Conv	0.300	0.38	2.33	7.40	0.32	0.39	0.1	Conv
	0.250	1.15	9.73	12.28	0.79	0.36	0.3	new	0.300	1.23	10.64	12.75	0.83	0.31	0.3	new	0.300	1.23	10.64	12.75	0.83	0.31	0.3	Conv	0.300	1.23	10.64	12.75	0.83	0.31	0.3	Conv
	0.098	1.00	7.96	11.30	0.70	2.01	1.4	new	0.120	1.11	9.21	12.00	0.77	1.74	1.3	new	0.125	1.13	9.48	12.15	0.78	1.69	1.3	new	0.125	1.13	9.48	12.15	0.78	1.69	1.3	Conv
	0.300	0.62	4.25	8.92	0.48	0.33	0.2	new	0.300	0.62	4.25	8.92	0.48	0.33	0.2	Conv	0.300	0.62	4.25	8.92	0.48	0.33	0.2	Conv	0.300	0.62	4.25	8.92	0.48	0.33	0.2	Conv

Attachment 2

Reviewed By: DPM 3/29/07
Checked By: JRW 4/16/07

Reference 5 – Channel Flow Calculations Summary

D McGrath 063-6526

WCA High Point Phase 2

Guilford County, North Carolina

Sub-Area Reach Identifier	2-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)
	Peak Flow by Rainfall Return Period		
SUBAREAS			
PC1	0.99	2.20	3.00
PC2	0.73	1.63	2.22
PC3	1.12	2.48	3.38
PC4	0.97	2.15	2.93
PC5	1.12	2.48	3.38
PC6	1.11	2.46	3.36
PC7	0.94	2.09	2.85
PC8	0.73	1.63	2.22
PC9	0.30	0.67	0.91
PC10	0.86	1.91	2.60
PC11	1.86	4.13	5.63
PC12	0.47	1.04	1.41
SD1	1.27	2.83	3.86
SD2	1.61	3.59	4.90
SD3	3.03	6.74	9.19
SD4	2.50	5.56	7.57
SD5	1.50	3.33	4.54
SD6	2.48	5.52	7.52
SD7	3.75	8.33	11.36
SD8	3.02	6.72	9.16
SD9	2.96	6.59	8.99

OBJECTIVE

Design the drop inlets around the perimeter of the landfill to convey the flow into it with a maximum head of 1.5 feet. This 1.5 foot depth limit will keep the water in the channel.

METHOD

Calculate the capacity of the designed inlet as a weir and as an orifice, using the appropriate formulas for each. Choose the lower of the two calculated flows as the true capacity.

REFERENCES

Square Drop Inlet Calculation Sheet Prepared by Golder Associates Inc.

ASSUMPTIONS

1. Each inlet will operate in a 20% clogged condition (80% open unless otherwise specified).

CALCULATIONS

The following nomenclature is used:

Q =	Flow (ft^3/sec)	Cd =	Orifice Discharge Coefficient	g =	Acceleration due to gravity (ft/sec^2)
H =	Head (ft)	Cw =	Weir Discharge Coefficient	L =	Weir Length (ft)
W=	Width (ft)				

The following formulas are used.

Orifice Discharge:

$Q = A * C_d \sqrt{2 * g * H}$, where $A = L * W$ of the rectangular opening.

Weir Discharge:

$Q = Cw * L * H^{1.5}$

A rectangular precast drop inlet is proposed. The following sample calculation for a rectangular inlet is used for illustration. The inlet is assumed to be 80% open (0.8) and have a head of 1.5' above the opening. Both types of flow are calculated for the inlet, and the smaller value chosen. A grate inlet measuring 3.4' x 3' is used. This grate has an open area of 6 ft^2, which will be further reduced to 80% for clogging.

Orifice Discharge:

$Q = 0.8 * (6) * 0.6\sqrt{2 * 32.2 * 1.5} = 28.3 cfs$

Weir Discharge:

$$Q = 3.33 * 0.8 * 10.2 * 1.5^{1.5} = 49.9cfs$$

Choose the smaller of the two values as the true capacity, Q = 28.3 cfs.

For the grating of these inlets, a standard DI-7 grating was chosen, with a nominal 3.4' x 3' dimension and a nominal open area of 59% (6.0 ft^2). A spreadsheet was used to size the area of grating required, then sized up to the nearest whole grating section. In all dimensional arrangements at a head of 1.5' for the drop inlet, orifice flow controls and this equation was used to size the inlets.

From Reference 1, the flows to each inlet were determined:

DI #	Flow (cfs)	H (ft)	Min A req, (ft^2)	Clogging Factor	Min A, Design	# grates	Open Area (ft^2)	Nominal Grating Dimensions (x 3.4')
DI-1	10.44	1.5	1.53	0.8	1.92	1	6	3
DI-2	17.39	1.5	2.55	0.8	3.19	1	6	3

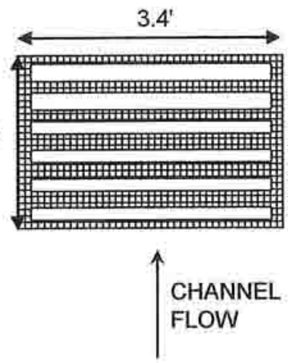
CONCLUSIONS

The inlets DI-1 and DI-2 are adequately sized to accept the flow from a 25-Yr storm event at a maximum depth of 1.5 feet above the inlet. This will prevent the water from overtopping the channel.

WCA High Point Drop Inlet Sizing (Attachment 1)

DI #	Flow, cfs	HW, ft	Min A req, (ft^2)	Clogging Factor	Min A, Design	# grates	Open Area (ft^2)	Nominal Grating Dimensions (x 3.4')	Nominal Q	Actual F.S.
DI-1	10.44	1.5	1.77	0.8	2.21	1	4.8	3	28.31	2.71
DI-2	17.39	1.5	2.95	0.8	3.69	1	4.8	3	28.31	1.63

DI-7 standard grate
3' L x 3.4' W, 6.0 sq. ft. open area
(59% OA)



3' x 3.4' rectangular inlet, 59% open area (6 ft^2 nominal), 80% open (4.8 ft^2)

Weir Length 10.24
Area 4.8

Head, ft	Weir	Orifice	Controlling	
0.1	1.1	8.2	1.1	WEIR
0.2	3.0	10.3	3.0	WEIR
0.3	5.6	12.7	5.6	WEIR
0.4	8.6	14.6	8.6	WEIR
0.5	12.1	16.3	12.1	WEIR
0.6	15.8	17.9	15.8	WEIR
0.7	20.0	19.3	19.3	ORIFICE
0.8	24.4	20.7	20.7	ORIFICE
0.9	29.1	21.9	21.9	ORIFICE
1	34.1	23.1	23.1	ORIFICE
1.1	39.3	24.2	24.2	ORIFICE
1.2	44.8	25.3	25.3	ORIFICE
1.3	50.5	26.4	26.4	ORIFICE
1.4	56.5	27.3	27.3	ORIFICE
1.5	62.6	28.3	28.3	ORIFICE
1.6	69.0	29.2	29.2	ORIFICE
1.7	75.6	30.1	30.1	ORIFICE
1.8	82.3	31.0	31.0	ORIFICE
1.9	89.3	31.9	31.9	ORIFICE
2	96.4	32.7	32.7	ORIFICE

Made By: DPM
Checked: DPM 3/29/07
Reviewed: JRD 4/10/07

Golder Associates Greensboro, North Carolina	Subject: Downslope Pipe Capacity Analysis		
	Job No. 063-6526	Made By: GGM	Date: 3/29/07 R1
		Checked: DPM 3/29/07	
	Ref:	Reviewed: JRD 4/10/07	Sheet 1 of 1

OBJECTIVE

Analyze each segment of the downslope pipe for the 25-year peak flow, and design the downslope pipes to adequately convey the 25-year flow in a non-erosive manner.

METHOD

Use TR-55 to calculate the Peak Flow in each downslope pipe (Reference 2.) Combined flows to the downslope pipes are compared to the maximum capacity of the downslope pipe segment to determine adequacy.

REFERENCES

1. Perimeter Channel and Downslope Pipe Calculations, WinTR-55 output files, March 2007 (Attachment 1)
2. WCA of High Point Landfill Drawing Set, Prepared by Golder Associates Inc., March 2007, sheet EP-04

CALCULATIONS

1. Determine Drainage Area of each Slope Drain Pipe
2. Assume T_c = 0.1 hours, Curve Number = 69
3. Calculate Q_{25} using TR-55
4. Calculate Capacity of 18" pipe at a given slope using manning's equation: n = 0.012, s = as given, assumed flowing full
5. Compare Q_{25} with capacity.

Slope Drain #	Area Drain "A"	Runoff Curve #	Tc	Runoff Cum. Q: 25-Yr	Invert Elevations		Length	Slope	Diameter	Capacity
	Acres	C	Hr.	C.F.S.	Upper End	Lower End	Ft.	Ft./Ft.	In.	C.F.S.
SD1	0.98	69	0.1	3.86	860	800	258	0.23	18	54.88
SD2	1.24	69	0.1	4.9	860	790	235	0.30	18	62.11
SD3	2.33	69	0.1	9.19	866	780	252	0.34	18	66.48
SD4	1.92	69	0.1	7.57	866	774	274	0.34	18	65.94
SD5	1.15	69	0.1	4.54	802	776	109	0.24	18	55.58
SD6	1.91	69	0.1	7.52	830	756	247	0.30	18	62.29
SD7	2.88	69	0.1	11.36	864	770	281	0.33	18	65.82
SD8	2.32	69	0.1	9.16	890	776	342	0.33	18	65.70
SD9	2.28	69	0.1	8.99	890	806	249	0.34	18	66.10

CONCLUSIONS

Based on the proposed design, the 18" downslope pipes adequately convey the 25-year peak flow with sufficient capacity.

D McGrath

063-6526
WCA High Point Phase 2
Guilford County, North Carolina

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
PC1	3.00 11.93
PC2	2.22 11.93
PC3	3.38 11.93
PC4	2.93 11.93
PC5	3.38 11.93
PC6	3.36 11.93
PC7	2.85 11.93
PC8	2.22 11.93
PC9	0.91 11.93
PC10	2.60 11.93
REACHES	
OUTLET	26.86

D McGrath

063-6526
WCA High Point Phase 2
Guilford County, North Carolina

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
PC11	5.63 11.93
PC12	1.41 11.93
SD1	3.86 11.93
SD2	4.90 11.93
SD3	9.19 11.93
SD4	7.57 11.93
SD5	4.54 11.93
SD6	7.52 11.93
SD7	11.36 11.93
SD8	9.16 11.93
REACHES	
OUTLET	65.15

D McGrath

063-6526
WCA High Point Phase 2
Guilford County, North Carolina

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 25-Yr (cfs) (hr)
SUBAREAS	
SD9	8.99 11.93
REACHES	
OUTLET	8.99

Attachment 1 Page 3/3

OBJECTIVE

To analyze the capacity of the proposed drop inlets for the downslope pipes. The inlets are a circular drop inlet, either 18" or 24", depending on the underlying pipe size. Assume they will operate with some degree of debris clogging (80% open). Determine the maximum area a particular inlet can serve while maintaining at least one foot of freeboard in the channel.

METHOD

Use a spreadsheet model to calculate the capacity of a given inlet, under conditions of weir flow and orifice flow. Choose the lower of the two flows (Q) as the actual flow. Back-calculate, using the previously-determined Q and previously-determined *i* to calculate an area using the rational formula. All flows will be based on the 25-year event.

REFERENCE

1. WCA of High Point Landfill Drawing Set, prepared by Golder Associates Inc., March 2007, sheet EP-04
2. Calculation package "Downslope Pipe Capacity", prepared by Golder Associates Inc., 3/29/07.

CALCULATION

The following nomenclature is used:

Q =	Flow (ft^3/sec)	Cd =	Orifice Discharge Coefficient	g =	Acceleration due to gravity (ft^2/sec)
H =	Head (ft)	Cw =	Weir Discharge Coefficient	L =	Weir Length
D=	Pipe Diameter (ft)				

The following formulas are used.

Orifice Discharge:

$$Q = A * C_d \sqrt{2 * g * H} \text{ , where } A = \pi * \frac{D^2}{4}$$

Weir Discharge:

$$Q = Cw * L * H^{1.5}$$

Calculate the discharge for each type, assuming a head (H) of one foot. The sample calculations are for a 2-foot diameter inlet.

Orifice Discharge:

$$Q = 0.8 * \left(\pi * \frac{2^2}{4} \right) * 0.6 \sqrt{2 * 32.2 * 1} = 12.1 cfs$$

Weir Discharge:

$$Q = 3.33 * 0.8 * \pi * 2 * 1.0^{1.5} = 16.7 cfs$$

The lower Q value results from the Orifice equation, so the maximum flow (Q_{max}) is taken as 12.1 CFS.

Now back calculate, using the Rational Formula to find an area A_{max}.

$$A_{max} = \frac{Q_{max}}{Ci}; \; where$$

$$A_{max} = drainage\ area, acres$$

$$Q_{max} = 12.1 cfs$$

$$C = 0.50$$

$$i = 7.25 \frac{in}{hr}$$

$$A_{max} = 3.3 ac$$

The following table summarizes the results for single 18" and 24" inlets, as well as multiples (of three).

Inlet Type	Capacity (cfs)	Max Drainage Area (ac)
Single 24"	12.1	3.3
Single 18"	6.8	1.9
Multiple 24"	36.3	10.0
Multiple 18"	20.4	5.6

CONCLUSIONS

The individual drainage areas for each inlet will be evaluated for the drainage area to each inlet. The inlet type will be chosen based on the above maximum area, depending on whether the downslope pipe at that point is 18" or 24". See the attached worksheet, "Downslope Pipe Capacity" for the results showing that for each pipe inlet is sufficient for the drainage area draining to it.

WCA High Point Phase 2
Downslope Pipe Capacity
(Reference 2)

Downslope #	Area Drain "A"	Runoff Coef.	Tc	Runoff Cum. Q: 10-Yr	Runoff Cum. Q: 25-Yr	Invert Elevations		Length	Slope	Dia.	Pipe Capacity	Inlet Analysis		Max Individual Area	Inlet Capacity: Max Drain Area
	Acres	C	Min.	C.F.S.	C.F.S.	Upper End	Lower End	Ft.	Ft./Ft.	In.	C.F.S.	Ho	Hw	Acres	Acres
SD1	0.98	69	0.1	2.83	3.86	860	800	258	0.23	18	54.88	6.80	12.43	0.25	1.84
SD2	1.24	69	0.1	3.59	4.9	860	790	235	0.30	18	62.11	6.80	12.43	0.33	1.84
SD3	2.33	69	0.1	6.74	9.19	866	780	252	0.34	18	66.48	6.80	12.43	0.77	1.84
SD4	1.92	69	0.1	5.56	7.57	866	774	274	0.34	18	65.94	6.80	12.43	0.62	1.84
SD5	1.15	69	0.1	3.33	4.54	802	776	109	0.24	18	55.58	6.80	12.43	0.51	1.84
SD6	1.91	69	0.1	5.52	7.52	830	756	247	0.30	18	62.29	6.80	12.43	0.55	1.84
SD7	2.88	69	0.1	8.33	11.36	864	770	281	0.33	18	65.82	6.80	12.43	0.66	1.84
SD8	2.32	69	0.1	6.72	9.16	890	776	342	0.33	18	65.70	6.80	12.43	0.49	1.84
SD9	2.28	69	0.1	6.59	8.99	890	806	249	0.34	18	66.10	6.80	12.43	0.64	1.84

Golder Associates Greensboro, North Carolina	Subject: Culvert Design		
	Job No. 063-6526	Made By: GGM	Date: 3/29/07 R1
		Checked: DPM 3/29/07	
	Ref:	Reviewed: JRD 4/10/07	Sheet 1 of 1

OBJECTIVE

Design the culverts that run from drop inlets DI-1 and DI-2 to sediment traps ST-2 and ST-3. The culverts will be adequately sized to convey the 25-year storm event flow from the expansion area of the WCA High Point Sanitary Landfill.

METHOD

Using Culvert Master, select the culvert dimensions, material, and slope specifications. Check that the culvert will not cause excessive headwater that would impede the drop inlet grating with the 25-year storm event. Revise the design as necessary to achieve desired results.

REFERENCES

1. North Carolina WCA High Point Landfill Drawing Set, Prepared by Golder Associates Inc., March 2007
2. Calculations Package "Culvert Calculator Report", prepared by Golder Associates Inc., January 2007 (Attached)

CULVERT DESIGN

Using Class III RCP material for circular pipes with square edge headwall and a manning's n of 0.013, culverts have been designed with the specifications shown below:

From Drop Inlet #	To Sediment Trap #	Q_{25} (cfs)	Culvert Length (ft)	Culvert Diameter (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Calculated Headwater Elevation (ft)	Drop Inlet Grating Elevation (ft)
DI-1	ST-2	10.44	72	2	801.5	800.0	803.4	806.0
DI-2	ST-3	17.39	136	2	768.0	752.0	770.6	776.0

CONCLUSIONS

The calculated headwater is sufficiently low such that it will not impede the flow through the drop inlet grating, and the culverts are adequately sized to handle the 25-year storm event.

Culvert Calculator Report
WCA High Point

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	0.00 ft	Headwater Depth/Height	0.94
Computed Headwater Elev:	803.37 ft	Discharge	10.44 cfs
Inlet Control HW Elev.	803.22 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	803.37 ft	Control Type	Entrance Control

Grades

Upstream Invert	801.50 ft	Downstream Invert	800.00 ft
Length	72.00 ft	Constructed Slope	0.020833 ft/ft

Hydraulic Profile

Profile	S2	Depth, Downstream	0.79 ft
Slope Type	Steep	Normal Depth	0.78 ft
Flow Regime	Supercritical	Critical Depth	1.16 ft
Velocity Downstream	9.02 ft/s	Critical Slope	0.005281 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	803.37 ft	Upstream Velocity Head	0.48 ft
Ke	0.50	Entrance Loss	0.24 ft

Inlet Control Properties

Inlet Control HW Elev.	803.22 ft	Flow Control	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	3.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Reference 2 Page 1/2

Culvert Calculator Report
WCA High Point

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	0.00 ft	Headwater Depth/Height	1.30
Computed Headwater Eleva	770.60 ft	Discharge	17.39 cfs
Inlet Control HW Elev.	770.45 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	770.60 ft	Control Type	Entrance Control

Grades

Upstream Invert	768.00 ft	Downstream Invert	752.00 ft
Length	136.00 ft	Constructed Slope	0.117647 ft/ft

Hydraulic Profile

Profile	S2	Depth, Downstream	0.64 ft
Slope Type	Steep	Normal Depth	0.64 ft
Flow Regime	Supercritical	Critical Depth	1.50 ft
Velocity Downstream	19.91 ft/s	Critical Slope	0.007072 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	770.60 ft	Upstream Velocity Head	0.73 ft
Ke	0.50	Entrance Loss	0.37 ft

Inlet Control Properties

Inlet Control HW Elev.	770.45 ft	Flow Control	Transition
Inlet Type	Square edge w/headwall	Area Full	3.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Reference 2 Page 2/2

OBJECTIVE

Design the sediment traps ST-1, ST-2, ST-3 and ST-4 to receive the stormwater flow from the expansion area of the WCA High Point Sanitary Landfill. The basins will be sized as wet detention basins to adequately handle the 10-year storm event.

METHOD

Calculate the total flow to the basin for the 10-year storm event. Select a basin size and volume to meet the minimum requirements of volume for drainage area and surface area based on the 10-year storm event. Revise the design as necessary to achieve desired results.

REFERENCES

1. North Carolina Erosion and Sediment Control Planning and Design Manual, June 2006 Edition
2. North Carolina WCA High Point Landfill Drawing Set, Prepared by Golder Associates Inc., March 2007

PERFORMANCE CRITERIA

At a minimum, the sediment traps are designed to:

1. Have a minimum surface area of 435 square feet (SF) per cfs of Q_{10} peak inflow;
2. Have a minimum volume of 3,600 cubic feet (CF) per acre of drainage area;
3. Have a minimum depth of 3.5 feet, 1.5 feet excavated below grade;

TRAP DESIGN

The following nomenclature is used:

Q_{10} =	10-Yr Flow (ft^3/sec)	L =	Weir Length (ft)	H =	Head (ft)
Cw =	Weir Discharge Coefficient				

Required Volume = 3600 ft^3/Acre * Drainage Area;

Surface Area = 435ft^2/cfs * Q_{10};

Weir Length (L) must pass the 10-year storm event at a flow depth of H = 0.5 ft.

$$Q_{10} = C_w * L * H^{3/2};\ C_w = 3.087$$

Based on these requirements, the sediment traps have been designed with the specifications shown below:

Trap #	Drainage Area	Volume Required	Volume Provided	Q_{10}	Surface Area Required	Surface Area Provided	Weir Length (L)
	(Acres)	(ft^3)	(ft^3)	(cfs)	(ft^2)	(ft^2)	(ft)
ST-1	1.0745	3868	4020	4.66	2027	2400	5
ST-2	2.6400	9504	10498	7.63	3320	4039	7
ST-3	4.4100	15876	16577	12.76	5551	5989	12
ST-4	0.8419	3031	4284	3.00	1305	1888	3

CONCLUSIONS

The sediment traps are adequately sized to handle the 10-year storm event.

Appendix 2 Seeding Specifications

SECTION 02936

SEEDING

PART 1 – GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this Section includes the furnishing of all labor, materials, equipment and incidentals required for preparations and placement of seeding as directed by the OWNER and as shown on the Drawings. This work shall include maintenance of established vegetation until final acceptance. The CONTRACTOR shall be expected to provide and place all erosion materials and topsoil necessary to complete the work.

B. CONTRACTOR shall revegetate all areas disturbed by his operations. All areas disturbed or not having sufficient vegetation to prevent erosion shall be revegetated.

1.02 RELATED SECTIONS

A. Section 02220 – Excavation

B. Section 02225 – Structural Fill

C. Section 02905 – Erosion Layer

1.03 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

B. The ENGINEER reserves the right to test, reject, or accept all materials before application.

1.04 MAINTENANCE DATA

A. Submit maintenance data for continuing OWNER maintenance.

B. Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Transport and handle products in accordance with the Manufacturer's instructions.

B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging will not be acceptable.

C. Deliver fertilizer in waterproof bags showing weight, chemical, analysis, and name of manufacturer.

D. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.

E. Store and protect products in accordance with the Manufacturer's instructions with seals and labels intact and legible.

1.06 TEMPORARY VEGETATION

A. Refer to the North Carolina Erosion and Sediment Control Planning and Design Manual, Section 6.10 – Practice Standards and Specifications, Temporary Seeding.

B. When earth moving activities are completed more than 21 days prior to installation of permanent control measures, or final grading is completed during a season not favorable for immediate establishment of permanent vegetation, stabilize with rapid growing annual grasses of a seasonally appropriate species.

C. Temporary seeding applies on any cleared, unvegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than one (1) year.

1.07 PERMANENT SEEDING

A. Refer to the North Carolina Erosion and Sediment Control Planning and Design Manual, Section 6.11 – Practice Standards and Specifications, Permanent Seeding.

PART 2 – PRODUCTS

2.01 SOIL MATERIALS

A. Erosion control material shall be free of weeds as specified in Technical Specification Section 02905.

2.02 FERTILIZER

A. Fertilizer shall comply with applicable state laws of North Carolina and shall be delivered in unopened bags or other unopened convenient standard container, each fully labeled with the manufacturer's guaranteed analysis.

B. Fertilizer shall contain not less than 10 percent nitrogen, 10 percent available phosphoric acid and 10 percent water soluble potash (N-P-K, 10-10-10), unless otherwise needed based on fertility test of soil materials.

C. Any fertilizer which becomes caked or otherwise damaged, making it unsuitable for use, will not be acceptable and shall be immediately removed from the job site.

2.03 SEED

A. Seed shall be brought on site unmixed unless the mixture is certified and stated on the package as to the quality and mixture. Mixing shall be done at the project site from the original unopened packages.

2.04 AGRICULTURAL GROUND DOLOMITIC LIMESTONE

A. Lime shall comply with applicable state laws of North Carolina and shall be delivered in unopened bags or other unopened convenient standard containers, each fully labeled with the manufacturer's guaranteed analysis.

B. Lime shall be ground limestone containing not less than 85 percent total carbonates and shall be ground to such fineness that 90 percent by weight will pass through a No. 20 mesh sieve and 50 percent by weight will pass through a No. 100 mesh sieve, unless otherwise needed based on fertility test of soil material.

2.05 SEED MULCH

A. Refer to the North Carolina Erosion and Sediment Control Planning and Design Manual, Section 6.14 – Practice Standards and Specifications, Mulching.

B. Seeding mulch shall be wood fiber, straw, or non-woven fibers free from weeds and foreign matter detrimental to plant life.

PART 3 – EXECUTION

3.01 GENERAL

A. Areas to be seeded include all areas disturbed during construction that are not to be paved.

B. Verify that prepared soil base is ready to receive the work of this section.

3.02 FERTILIZER AND LIME

A. Apply lime at the rate of 2000 - 3000 lbs/acre (45 - 70 lbs/1000 ft^2), and fertilizer at the rate of 700 - 1000 lbs/acre (16 - 23 lbs/1000 ft^2), or apply lime and fertilizer per soil specific test data.

B. Mix thoroughly into upper four to six inches of topsoil.

C. Lightly water to aid the dissipation of fertilizer and lime.

3.03 SEEDBED PREPARATION

A. Remove loose rocks, roots, and other obstructions so that they will not interfere with the establishment and maintenance of vegetation.

B. Prepare seedbed to a depth of four to six inches.

C. The areas shall be made friable and receptive to seeding by approved methods, which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.

D. Fine grade areas to a firm even surface, free from lumps or stones 1 inch or more in any dimension. Installation of grass areas may be done immediately after finish grading provided the seeding bed is in a good condition and not muddy or hard. If it is hard, till to a friable condition again.

3.04 TEMPORARY SEEDING

A. Provide temporary seeding on any cleared, non-vegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than one year or when seeding dates will prevent the establishment of vegetative cover if permanent seeding is attempted.

Seed in accordance with the following schedule and application rates:

Seeding Dates	Seeding Mixture	Rate (lbs/acre)
January 1 – May 1	Rye (grain) Kobe lespedeza	120 50
May 1 – August 15	German millet OR Small-stemmed Sudangrass	40 OR 50
August 15 – December 30	Rye (grain)	120

B. To amend soil, follow recommendations of soil tests or apply 2000 lbs/acre ground agricultural limestone and 750 - 1000 lbs/acre 10-10-10 fertilizer, as recommended in the North Carolina Erosion and Sediment Control Planning and Design Manual, Section 6.10 – Practice Standards and Specifications, Temporary Seeding.

C. Mulch with three inch straw applied at the rate of 4000 lbs/acre. Anchor by tacking with asphalt, netting, or a mulch anchoring tool.

D. Refertilize if growth is not fully adequate.

E. Reseed, refertilize, and mulch immediately following erosion or other damage.

3.05 PERMANENT SEEDING – STEEP SLOPES (3:1)

A. Seed steep slopes (3:1) in accordance with the following schedule and application rates:

Seeding Dates	Seeding Mixture	Rate (lbs/acre)
August 20 – October 25 February 1 – April 15	Tall fescue Sericea lespedeza Kobe lespedeza Pensacola Bahiagrass	100 30 10 25

B. After August 15, use unscarified sericea seed.

C. Where a neat appearance is desired, omit sericea and substitute 40 lb/acre Bahiagras or 15 lb/acre Bermudagrass. Use common Bermudagrass only where it is unlikely to become a pest.

D. Between May 1 and August 15, add 10 lb/acre German millet or 15 lb/acre Sudangrass as a nurse plant. Prior to May 1 or after August 15, add 40 lb/acre rye (grain).

E. Fall is best for tall fescue, and lespedezas in late winter. Overseeding of Kobe lespedeza over fall-seeded tall fescue is effective. Use unhulled Bermudagrass seed in fall.

F. Apply lime and fertilizer according to soil tests, or apply 4,000 lbs/acre ground agricultural limestone and 1,000 lbs/acre 10-10-10 fertilizer.

G. Apply 4,000-5,000 lb/acre grain straw or equivalent cover of another suitable mulching material. Anchor straw by tacking with asphalt, roving, netting, or by crimping with a mulch anchoring tool. Netting is the preferred anchoring method on steep slopes.

H. Refertilize in the second year unless growth is fully adequate.

I. May be mowed once or twice a year, but mowing is not necessary.

J. Reseed, fertilize, and mulch damaged areas immediately.

3.06 PERMANENT SEEDING – GRASS LINED CHANNELS

A. Seed grass lined channels in accordance with the following schedule and application rates:

Seeding Dates	**Seeding Mixture**	**Rate (lbs/acre)**
August 25 – October	Tall fescue	200 (4-5 lb/1,000 ft^2)

B. Between May 1 and August 15, add 15 lb/acre German millet or 15 lb/acre Sudangrass as a nurse plant. Prior to May 1 or after August 15, add 40 lb/acre rye (grain).

C. Avoid seeding from November to January. If seeding must be done at this time, add 40 lb/acre rye grain and use a channel lining that offers protection.

D. Apply lime and fertilizer according to soil tests, or apply 4,000 lbs/acre ground agricultural limestone and 1,000 lbs/acre 10-10-10 fertilizer. Operate tillage equipment across the waterway.

E. Use a rolled erosion control product to cover the bottom of channels and ditches, and staple securely. The lining should extend above the highest calculated depth of flow. On channel side slopes above this height, and in drainages not requiring temporary linings, apply 4,000 lb/acre grain straw, and anchor straw by stapling netting over the top. Mulch and anchoring materials must not be allowed to wash down slopes where they can clog drainage devices.

F. Refertilize in late winter of the following year; use soil tests or apply 150 lb/acre 10-10-10.

G. Inspect and repair mulch frequently.

H. Mow regularly to a height of 2-4 inches.

3.07 PERMANENT SEEDING – LOW MAINTENANCE AREAS

A. Seed low maintenance areas in accordance with the following schedule and application rates:

Seeding Dates	Seeding Mixture	Rate (lbs/acre)
August 20 – October 25	Tall fescue	80
	Sericea lespedeza	20
February 1 – April 15	Kobe lespedeza	10

B. After August 15, use unscarified sericea seed.

C. Where periodic mowing is planned or a neat appearance is desired, omit sericea and increase Kobe lespedeza to 40 lb/acre.

D. Between May 1 and August 15, add 10 lb/acre German millet or 15 lb/acre Sudangrass as a nurse plant. Prior to May 1 or after August 15, add 40 lb/acre rye (grain).

E. Fall is best for tall fescue, and lespedezas in late winter. Overseeding of Kobe lespedeza over fall-seeded tall fescue is effective.

F. Apply lime and fertilizer according to soil tests, or apply 4,000 lbs/acre ground agricultural limestone and 1,000 lbs/acre 10-10-10 fertilizer.

G. Apply 4,000 lb/acre grain straw or equivalent cover of another suitable mulching material. Anchor straw by tacking with asphalt, roving, netting, or by crimping with a mulch anchoring tool.

H. Refertilize in the second year unless growth is fully adequate.

I. May be mowed once or twice a year, but mowing is not necessary.

J. Reseed, fertilize, and mulch damaged areas immediately.

3.08 REPLANTING

A. The CONTRACTOR shall be required to replant areas damaged by water, wind, fire, equipment or pedestrian traffic as necessary or when ordered by the OWNER at no cost to the OWNER.

B. All areas and spots that do not show a prompt catch of vegetation shall be reseeded at fifteen day intervals until a growth of grass is established. CONTRACTOR shall reseed as required to establish a minimum of 95% vegetation coverage within 1 year of initial planting. Remedial seeding, fertilizer and lime will be applied at no additional cost to the OWNER.

3.09 COMPACTION

A. The CONTRACTOR shall keep all equipment and vehicular and pedestrian traffic off areas that have been seeded to prevent excessive compaction and damage to young plants. Where such compaction has occurred, the CONTRACTOR shall rework the soil to make a suitable seedbed; then reseed and reblanket such areas with the full amounts of the specified materials, at no extra expense to the OWNER.

3.10 MULCHING

A. If seeding is done with hydromulching, then seeding mixture shall be increased 10 percent.

B. Petroleum-based binders are not allowed.

C. Hydromulching of seeding areas shall have approved mulch applied at a rate as recommended by the manufacturer for tacking agent.

D. Other methods of mulching shall not be applied prior to approval by the ENGINEER.

3.11 MAINTENANCE OF GRASS AREAS

A. Water, weed, and reseed throughout the construction contract and/or acceptance by the OWNER after seeding areas are substantially established turf areas.

B. Install and maintain temporary protection fences, barriers, and signs where deemed necessary.

* * * * * END OF SECTION * * * * *

Appendix 3 E&S Checklist

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT, AND NATURAL RESOURCES LAND QUALITY SECTION

EROSION AND SEDIMENTATION CONTROL PLAN CHECKLIST

The following items shall be incorporated with respect to specific site conditions, in an erosion and sedimentation control plan

LOCATION INFORMATION

- X Project location
- X Roads, street
- X North arrow
- X Scale
- X Adjoining lakes, streams or other major drainage ways

GENERAL SITE FEATURES

- X North arrow
- X Scale-
- X Property line
- X Legend
- X Existing contours
- X Proposed contours
- X Limit and acreage of disturbed area
- X Planned and existing building locations and elevations
- X Planned and existing road locations and elevations
- N/A Lot and/or building numbers
- X Land use of surrounding areas
- N/A Rock outcrops
- N/A Seeps or springs
- N/A Wetland limits
- N/A Easements
- X Streams, lakes, ponds, drainage ways, dams
- X Boundaries of the total tract
- X If the same person conducts the land-disturbing activity and any related borrow or waste activity, the related borrow or waste activity shall constitute part of the land-disturbing activity unless the borrow or waste activity is regulated under the Mining Act of 1971, or is a landfill regulated by the Division of Solid Waste Management. If the land-disturbing activity and any related borrow or waste activity are not conducted by the same person, they shall be considered separate land-disturbing activities
- N/A Stockpiled topsoil or subsoil location
- N/A Street profiles

SITE DRAINAGE FEATURES

- X Existing and planned drainage patterns (include off-site areas that drain through project)
- X Size of Areas to be disturbed (Acreage)
- X Size and location of culverts and sewers
- X Soils information (type, special characteristics)
- X Design calculations for peak discharges of runoff (including the construction phase and final runoff coefficients of the site)
- X Design calculations and construction details for culverts and storm sewers
- X Design calculations cross-sections and method of stabilization of existing and planned channels (include temporary linings)
- N/A Design calculations and construction details of energy dissipators below culvert and storm sewer outlets (for rip-rap aprons, include stone sizes (diameters and apron dimensions)
- N/A Soil information below culvert storm outlets
- N/A Design calculations and construction details to control ground-water, i.e., seeps, high water table, etc.
- X Names of receiving watercourse or name of municipal operator (only where stormwater discharges are to occur)

EROSION CONTROL MEASURES

- X Legend
- X Location of temporary and permanent measures
- X Construction drawings and details for temporary and permanent measures
- X Design calculations for sediment basin and other measures
- X Maintenance requirements during construction
- X Person responsible for maintenance during construction
- X Maintenance requirements and responsible person(s) of permanent measures

VEGETATIVE STABILIZATION

- X Areas and acreage to be vegetatively stabilized
- X Planned vegetation with details of plants, seed, mulch and fertilizer
- X Specifications for permanent and temporary vegetation
- X Method of soil preparation

NOTE: Should include provision for ground cover on exposed slopes within 15 working days following completion of any phase of grading, permanent ground cover for all disturbed areas within 15 working days or 90 calendar days (which- ever is shorter) following completion of construction or development.

OTHER REQUIREMENTS

- X Narrative describing construction sequence (as needed)
- X Narrative describing the nature and purpose of the construction activity
- X Completed Financial Responsibility/Ownership Form (to be signed by person financially responsible for project
- X Bid specifications regarding erosion control
- X Construction sequence related to sedimentation and erosion control (include installation of critical measures prior to initiation of the land-disturbing activity and removal of measures after areas they serve have been permanently stabilized)

Appendix 4 Financial Responsibility / Ownership Form

FINANCIAL RESPONSIBILITY /OWNERSHIP FORM
SEDIMENTATION POLLUTION CONTROL ACT

No person may initiate a land-disturbing activity on one or more acres as covered by the Act before this form and an acceptable erosion and sedimentation control plan have been completed and approved by the Land Quality Section, NC Department of Environment, and Natural Resources. (Please type or print and, if question is not applicable, place N/ A in the blank).

Part A.

1. Project Name WCA of High Point C&D Landfill, Phase 2 Expansion
2. Location of land-disturbing activity: County Guilford County
   City or Township Jamestown, and Highway/Street 5830 Riverdale Drive
3. Approximate date land-disturbing activity will be commenced: January 2008
4. Purpose of development (residential, commercial, industrial, etc.): Landfill
5. Total acreage disturbed or uncovered (including off-site borrow and waste areas):
   13.18 ACRES
6. Amount of fee enclosed $ 700
7. Has an erosion and sedimentation control plan been filed? Yes X No ______
   Enclosed X
8. Person to contact should sediment control issues arise during land-disturbing activity.
   Name Mr. Michael McFeeley Telephone 336.886.3560
9. Landowner(s) of Record (Use blank page to list additional owners):

WCA of High Point, LLC
Name(s)

5830 Riverdale Drive
Current Mailing Address

Jamestown, North Carolina 27282
City State Zip

5830 Riverdale Drive
Current Street Address

Jamestown North Carolina 27282
City State Zip

10. Recorded in Deed Book No. Page No. ______

Part B. Person(s) or firm(s) who are financially responsible for this land-disturbing activity (Use a blank page to list additional persons or firms):

WCA of High Point, LLC
Name of Person(s) or Firm(s)

5830 Riverdale Drive
Current Mailing Address

Jamestown NC 27282
City State Zip

Telephone 336.886.3560

______
Current Street Address

______
City State Zip

Telephone ______

2. (a) If the Financially Responsible Party is not a resident of North Carolina give name and street address of a North Carolina Agent.

____________________________	____________________________
Name	
Mailing Address	Street Address
City State Zip	City State Zip
Telephone ____________________	Telephone ____________________

(b) If the Financially Responsible Party is a Partnership or other person engaging in business under an assumed name, attach a copy of the certificate of assumed name. If the Financially Responsible Party is a Corporation give name and street address of the Registered Agent.

____________________________	____________________________
Name of Registered Agent	
Mailing Address	Street Address
City State Zip	City State Zip
Telephone ____________________	Telephone ____________________

The above information is true and correct to the best of my knowledge and belief and was provided by me under oath. (This form must be signed by the financially responsible person if an individual or his attorney-in-fact or if not an individual by an officer, director, partner, or registered agent with authority to execute instruments for the financially responsible person). I agree to provide corrected information should there be any change in the information provided herein.

Type or print name	Title or Authority
____________________________	____________________________
Signature	Date

I, ____________________________, a Notary Public of the County of ________

State of North Carolina, hereby certify that ________________________________
appeared personally before me this day and being duly sworn acknowledged that the above form was executed by him.

Witness my hand and notarial seal, this __________ day of ________, 20___

	____________________________
Seal	Notary
	My commission expires ______________

CQA PLAN

CONSTRUCTION QUALITY ASSURANCE PLAN

WCA OF HIGH POINT

CONSTRUCTION AND DEMOLITION LANDFILL

PHASE 2 EXPANSION

PERMIT NO. 41-16

GUILFORD COUNTY, NORTH CAROLINA

Prepared for:

WCA of High Point , LLC
5830 Riverdale Drive
Jamestown, North Carolina 27282

Prepared by:

Golder Associates NC Inc.
4900 Koger Boulevard, Suite 140
Greensboro, North Carolina 27407

March 2007

Project No.: 063-6526

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SECTION PAGE

1.0 INTRODUCTION

This Construction Quality Assurance and Quality Control (CQA/QC) Plan (Plan) was prepared by Golder Associates NC Inc. (Golder) to assist WCA of High Point, LLC (WCA of High Point), in performing construction at the WCA of High Point C&D Landfill, Guilford County, North Carolina, according to the Construction Plans and Construction Specifications.

To implement the construction project, a CONTRACTOR, familiar with earthwork and geomembrane construction, will serve as a general contractor (CONTRACTOR) providing construction services. In addition, a CQA Consultant will be retained to serve as an independent third party to ensure project conformance of all construction activities to established CQA standards. In most instances, the CONTRACTOR will perform all earthwork activities, and will retain a geomembrane subcontractor for installation of geosynthetic materials as necessary. The CQA Plan provides guidance information and procedures that should be undertaken by WCA of High Point, the ENGINEER, and the CONTRACTOR, so the work will be of the quality necessary to meet the project objectives and will be responsive to the requirements of WCA of High Point.

This CQA Plan is a supplemental document to the Construction Plans and Specifications for each project. Where a conflict arises, the Contract Documents will govern.

1.1 Project Description

The activities addressed under this CQA Plan include the following activities:

- Placement of structural fill;
- Soil cap construction or Installation of a geosynthetic cap and drainage layer;
- Placement of soil protective cover and vegetative support layer; and
- Seeding.

1.2 Definitions

- Quality Control: A planned system of activities, or the use of such a system, whose purpose is to provide a level of quality that meets the needs of users. The objective of quality control is to provide quality that is safe, adequate, dependable, and economical. The overall system involves integrating the quality factors of several related steps including: the proper specification of what is wanted, production to meet the full intent of the specification, inspection to determine whether the resulting material, product, service, etc. is in accordance with the Construction Specifications, and review of usage to determine necessary revisions of the Construction Specifications.

  In practice, Quality Control refers to those procedures, criteria, and tests employed and paid for by the CONTRACTOR(s) to confirm that the work satisfies the CONTRACTOR's standards and is in compliance with the Construction Plans and Specifications. This plan does not address quality control procedures, criteria, and/or tests employed by the CONTRACTOR.

- Quality Assurance: A planned system of activities whose purpose is to provide assurance that the overall quality control program is in fact being effectively implemented. The system involves a continuing evaluation of the adequacy and effectiveness of the overall quality control program with the ability to have corrective measures initiated where necessary. For a specific material, product, service, etc., this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production, inspection, and use of the product, service, system, or environment.

In practice, Quality Assurance refers to those procedures, criteria, and tests required and paid for by the OWNER to confirm that the work performed by the CONTRACTOR(s) is in compliance with the approved Construction Plans and Specifications and any additional requirements of this Plan.

- Lot: A quantity of resin (usually the capacity of one rail car) used in the manufacture of polyethylene geomembrane rolls. The finished roll will be identified by a roll number traceable to the resin lot used.

- Panel: The unit area of geomembrane that will be seamed in the field. A panel is identified as a roll or portion of a roll that is larger than 100 square feet.

- Subgrade Surface: The soil layer surface which immediately underlies the structural fill, compacted clay cap, or geomembrane cap.

1.3 Parties

- OWNER: The OWNER is the individual, entity, public body, or authority with whom the CONTRACTOR has entered into the Agreement and for whom the Work is performed. For this project, the OWNER is WCA of High Point, LLC.

- ENGINEER: The ENGINEER is the official representative of the OWNER. The ENGINEER is responsible for the preparation of the Construction Plans and Specifications of the project and for preparation of the CQA Plan. The ENGINEER is also responsible for the interpretation of those documents and for resolution of Construction matters that arise during construction.

- CONTRACTOR: The CONTRACTOR has the primary responsibility for ensuring that the landfill is constructed in accordance with the Construction Plans and Specifications developed by the ENGINEER and approved by the permitting agency. Other responsibilities include the performance of all construction activities at the site including site facilities, administration, material purchasing, procurement, supervision, construction quality control, installation, and subcontracting. The CONTRACTOR is responsible for the protection of completed work until it is accepted by the OWNER. The CONTRACTOR is also responsible for informing the OWNER and CQA Consultants of the scheduling and occurrence of all construction activities.

- CQA Consultant: The CQA Consultant is an agency, independent from the OWNER, CONTRACTOR(s), Manufacturer, and Installer, that is responsible for observing, testing and documenting activities related to the quality assurance at the site. This party will perform laboratory testing of soils and other earth materials for material evaluation and verification purposes. This party will also observe installation of the geosynthetic cap and coordinate sampling and testing of the geosynthetics with the Geosynthetic CQA Laboratory. The CQA Consultant is also responsible for issuing a certification report, sealed by a registered Professional Engineer, licensed in North Carolina. The OWNER maintains the right to assign the responsibilities of the ENGINEER identified in this Plan to the CQA Consultant.

- Geomembrane Manufacturer (Manufacturer): The party responsible for manufacturing the geomembrane rolls.

- Geosynthetic CQA Laboratory (Testing Laboratory): Party, independent from the OWNER, Manufacturer and Installer, responsible for completing laboratory tests on samples of geosynthetics obtained at the site or during manufacturing usually under the direction of the OWNER or CQA Consultant.

- Geotechnical CQA Laboratory: Party, independent from the OWNER or CONTRACTOR, responsible for completing laboratory tests on soil samples obtained at the site or source usually under the direction of the OWNER or CQA Consultant.

- Geomembrane Installer (Installer): The Installer is responsible for field handling, sorting, placing, seaming, loading (against wind), and other aspects of the geosynthetics installation, including geomembranes, geotextiles, geonets, and geonet composites.

2.0 CQA PERSONNEL

WCA of High Point, LLC, (the OWNER) will retain an engineering consulting firm (CQA Consultant) to assure that proper construction techniques and procedures are used and to verify that the materials used meet the Contract Specifications. The CQA Consultant must employ engineers licensed to practice engineering in the State of North Carolina and experienced in the field of solid waste management and landfill construction. At the completion of the work, the program requires certification reports indicating that the facility has been constructed in accordance with the Construction Specifications and approved design. It is the responsibility of the certifying Engineer(s) to prepare these reports.

3.0 CQA LABORATORIES

3.1 Geotechnical CQA Laboratory

Experience and Qualifications

The Geotechnical CQA Laboratory must have experience in testing granular fills and aggregates, and be familiar with ASTM International (ASTM) test standards and other applicable test standards as required in the Construction Specifications. The geotechnical laboratory must have proven their abilities on previous work with the ENGINEER and/or with their Qualifications and Experience (Q&E) package demonstrating their experience as it relates to the Construction Specifications. The Q&E package shall include a project list showing the name, address, and telephone number of the appropriate party to contact. The Geotechnical CQA Laboratory must be capable of providing preliminary permeability test results within 48 hours and final permeability test results within 72 hours of receipt of sample. The laboratory must be capable of providing all other test results within five days of receipt of samples.

The Geotechnical CQA Laboratory shall provide a project manager for the project as the responsible person to contact. This person shall oversee the analytical procedures and testing as well as review and reporting of the results.

Responsibilities

The Geotechnical CQA Laboratory is responsible for performing all geotechnical laboratory tests and formally submitting results to the ENGINEER as required in the Construction Specification. These tests may include, but are not limited to, those indicated in the Construction Specifications.

3.2 Geosynthetic CQA Laboratory

Experience and Qualifications

The Geosynthetic CQA Laboratory must have experience in testing geosynthetics, and must conform to ASTM, National Sanitation Foundation (NSF), Geosynthetic Research Institute (GRI), and other applicable test standards, as required in the Construction Specifications. The geosynthetic laboratory must have proven their abilities on previous work with the ENGINEER or shall provide the ENGINEER with their Qualifications and Experience (Q&E) package demonstrating their experience as it relates to the Specifications. The Q&E shall include a project list showing the name, address, and telephone number of the appropriate party to contact. The Geosynthetic CQA Laboratory must be capable of providing test results within 48 hours from receipt of samples.

The Geosynthetic CQA Laboratory shall provide a project manager for the project as the responsible person to contact. This person shall oversee the analytical procedures and testing as well as review and reporting of the results.

Responsibilities

The Geosynthetic CQA Laboratory is responsible for performing all geosynthetic material test procedures in accordance with the Construction Specifications and formally submitting results to the ENGINEER. These tests may include, but are not limited to, those indicated in the Construction Specifications.

4.0 CQA TESTING AND INSPECTION CRITERIA

This section of the CQA Plan describes the inspection activities (observations and tests) that will be performed during construction. The scope of this section addresses the construction, including material installation and the manufacture/fabrication of the following specific components:

- Compacted Clay Cap;
- Geomembrane;
- Geonet Composite;
- Soil Protective Cover;
- Vegetative Support Layer; and

- Seeding.

This section addresses the inspection activities that are necessary to ensure that the facility is constructed to meet or exceed all design criteria, plans, and specifications.

4.1 General Preconstruction Activities

Prior to the start of construction, a preconstruction meeting shall be held among the OWNER, the ENGINEER, CQA Consultant, Geomembrane Installer (Installer) and the CONTRACTOR responsible for completing the work. The topics covered at this meeting shall include, but not be limited to:

- Providing each party with all relevant CQA documents and supporting information;
- Familiarizing each organization with the site-specific CQA plan, its role relative to accomplishing the intent of the design, as well as review of the Construction Plans and Specifications;
- Reviewing the responsibilities of each party;
- Reviewing lines of authority and communication for each organization;
- Discussing the established procedures or protocol for construction, change orders, deficiencies, repairs and retesting;
- Reviewing methods of documenting and reporting inspection data;
- Reviewing work area security and safety protocol;
- Discussing procedures for the location and protection of construction materials, and for the prevention of damage of the materials from inclement weather or other adverse events;
- Conducting a site walk to review site conditions as well as material staging and storage locations;
- Discussing the proposed construction plan, schedule and procedures; and
- Clarifying installation, testing, and acceptance criteria and procedures.

4.2 Subgrade

Any earthen surface upon which structural fill, compacted clay cap, or geomembrane cap is to be installed shall be prepared and compacted in accordance with the Construction Plans and Specifications. The surface shall be smooth, firm, unyielding, and free of: vegetation, construction debris, sticks or roots, sharp rocks, void spaces, ice, abrupt elevation changes, standing water, desiccation cracks or other puncture hazards.

Immediately before placement of structural fill, compacted clay cap construction or geosynthetic deployment, grade the subgrade to fill in all voids and cracks, and then smooth-roll to provide the best practicable surface for the geosynthetic. At the completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. All protrusions extending more than one-half inch from the surface shall be removed, crushed or pushed into the surface with a smooth-drum compactor.

4.3 Compacted Clay Cap

4.3.1 General

Compacted clay cap material generally consists of native cohesive soils with low hydraulic conductivity used as a barrier element in lining systems. Soils used in compacted clay caps shall consist of clean, select material free of debris, excessive coarse particles or other deleterious matter. Cap material shall be clayey soil, classified according to the United Soil Classification System as SC, CL, CH, SM, ML, or MH (ASTM D2487). This Section does not address quality assurance procedures for bentonite admixtures or geosynthetic clay liners (GCL).

4.3.2 Material Evaluation

Pre-construction material evaluations shall be performed on samples from potential sources to ascertain their acceptability as construction materials. Construction testing shall be performed during the course of the work to verify material compliance with the Construction Specifications.

Criteria to be used for determination of acceptability of materials for use during construction shall be as defined in the Construction Specifications, and/or as detailed in this Plan. All evaluation tests are to be performed in a geotechnical laboratory that has been approved for use by the ENGINEER or CQA Consultant. Test reports will verify compliance with or state deviation from applicable ASTM International, Inc. (ASTM) standards as outlined below.

4.3.2.1 Preconstruction Material Evaluation

Soils proposed for use in construction of the soil cap should be tested in accordance with the Construction Specifications.

At a minimum, the following tests to determine the properties of the soil cap materials shall be completed:

- Soil classification – ASTM D2487;
- Particle size analysis – ASTM D422;
- Atterberg limits – ASTM D4318;
- Hydraulic conductivity – ASTM D5084;
- Moisture-density relationship – ASTM D698; and
- Moisture content – ASTM D2216.

The moisture-density curves shall be developed for each type of soil determined suitable as cap material and shall be used during the construction phase as a performance reference for compaction and moisture control.

As a general rule, a minimum of one series of pre-construction tests (including hydraulic conductivity tests) should be performed for every 20,000 to 25,000 cubic yards of soil to be used in cap construction, unless soil types are limited and easily distinguished. As soil is usually made available subsequent to excavation during cap construction, additional pre-construction samples should be taken and tests performed when soils vary or as soon as the initial pre-construction test results appear inappropriate or questionable. Any time the liquid limit or plasticity index changes by more than 15 points, a new compaction series should be run to determine the density/moisture content/permeability relationship. If and when the same borrow source is used for the soil supply of more than one cap area, results from previous tests may be used to supplement the pre-construction data.

4.3.2.2 Construction Quality Assurance Material Evaluation

Soils used to construct the compacted clay cap should be tested in accordance with the Construction Specifications following schedule during the course of the work to verify material compliance At a minimum, the following tests shall be used to determine material conformance:

- Soil classification – ASTM D2487;
- Particle size analysis – ASTM D422;
- Atterberg limits – ASTM D4318;
- Hydraulic conductivity – ASTM D5084;
- Moisture-density relationship – ASTM D698; and
- Moisture content – ASTM D2216.

4.3.3 Subgrade Preparation

The CONTRACTOR shall be responsible for preparing the subgrade soil for placement of overlying materials including all fill and recompacted separation layers as applicable. Upon completion of the subgrade preparation work, the CQA Consultant shall examine the subgrade and verify, at a minimum, that:

- The surveyor has verified all lines and grades; and
- The CQA Consultant has verified that the subgrade soil meets the criteria in the Construction Specifications.

At any time during construction of the cap, the CQA Consultant shall indicate to the ENGINEER any locations which are not adequate for placement of the soil cap. Such defects in the subgrade soil shall be repaired by the CONTRACTOR, at the direction of the ENGINEER, such that the properties of the repaired areas meet the Construction Specifications.

4.3.4 Construction Observation

Observation of the compacted clay cap construction shall be coordinated with construction testing. The CQA Consultant will be on-site at all times during cap construction, to observe and document all relevant activities. The ENGINEER will visit the site periodically as construction progress warrants. Such visits will be frequent enough so that the ENGINEER is fully knowledgeable of the construction methods and performance and can determine that quality assurance monitoring and testing activities are adequate to meet the terms and intent of this Plan.

Acceptance criteria for construction work shall be as identified in the Construction Specifications. At a minimum, the CQA Consultant shall observe and record the following during the construction of soil caps:

- Moisture content and consistency of the soil during processing, placement, and compaction;
- Action of compaction equipment on the soil surface (sheepsfoot penetration, pumping, cracking, etc.);
- Loose and compacted lift thickness;
- Method of bonding lifts together; and
- Areas where damage due to excess moisture, insufficient moisture, freezing, or excessive desiccation may have occurred.

Work Area Selection and Sizing: Work areas for compacted clay cap construction should be selected, sized and sequenced so that work on each lift can begin and be completed in the same day. The area worked at any one time should be of such size that placement, processing and compaction will be uniform, with minimal variation caused by weather conditions. It is critical that completed lifts be tested and covered with the next loose lift before that completed lift dries out or becomes damaged by heavy precipitation. If the surface of the lift will be exposed long enough to become dry or if there is a threat of rain, the lift surface should be compacted using a smooth-drum roller. However, the smooth-rolled surface must be scarified, as described below, prior to placement of a new lift of soil. Furthermore, the selection of size and shape of work areas shall be consistent, so that uniform construction techniques and equipment can be selected. Adequate numbers of CQA personnel will be provided to suit the pace of construction so proper monitoring and documentation is performed.

Lift Placement and Processing: Reduction of soil clods, uniform moisture distribution, and consistent placement thickness are key elements to achieving uniform compaction of soil caps. Soil cap material shall be placed in loose lifts, generally not exceeding 8 inches thick after spreading and leveling and/or processing, with the expectation that the finished lift, following compaction, will be approximately 6 inches thick or less. In no case will the loose lift thickness, after spreading and leveling, be greater than the length of the compactor feet. The intent of limiting the loose thickness is to achieve good interlift bonding and to minimize bridging or layering effects.

The loose lift of soil shall be mechanically processed, either in-place or in a separate processing area, to break down the original soil structure and to reduce clod size. Additional processing, if necessary, will be used to blend variable soil types within the loose lift and incorporate additional water. The goal of processing is to yield a relatively uniform mass of soil that is devoid of original structure that may result in an increase in hydraulic conductivity. Processing may be achieved by discing, grading, compacting, or pulverizing. Pneumatic-tired or tracked equipment will not generally be acceptable to provide processing action, although this equipment may be used to pull the other acceptable implements.

Moisture adjustment may be required, particularly during dry seasons, and reasonable practices shall be used to distribute added water uniformly within the lift. Water hauling trucks with pressure-spray capabilities are preferred over those using simple spray bars. Care shall be taken to prevent over-watering and ponding of water within the loose lift, as this excess water is difficult to redistribute. Drying back of overly wet soils during processing can result in clods having dry, crusting surfaces, which may not bond together adequately. If such drying is allowed, then additional effort will be necessary to assure even moisture distribution and hydration. Hydration times shall be evaluated by CQA Consultant who shall determine if these times are acceptable.

Minimum Compaction Requirements: Processed loose lifts shall be leveled prior to compaction to provide uniform compaction effort over the lift. Each lift shall be compacted to the moisture and density requirements established for the project and as set forth in the provisions of this Plan. Lifts shall be compacted to a density and moisture content required to achieve a permeability detailed in the Construction Specifications.

The compacted clay cap shall not be compacted with a bulldozer or any track-mobilized equipment unless it is used to pull a footed roller; however, this practice is not encouraged. All compacted clay caps shall be compacted with a pad-footed or prong-footed roller only. Bulldozers, pneumatic rollers or scrapers, and flat-wheeled rollers will not be permitted for compaction. Generally, compaction equipment shall be required to provide a minimum of 6 passes across the lift, regardless of equipment size and compaction performance to help ensure adequate remolding and lift bonding of each soil lift.

Lift Bonding and Cap Tie-In: Interlift bonding shall be accomplished by scarifying the top of the finished lift and adjusting the moisture content, if needed, prior to placement of the subsequent loose lift. When soil is scarified it is usually roughened to a depth of about 1 inch. In some cases, the surface may not require scarification if the surface is already rough after compaction of the previous lift. Compactors shall be of sufficient weight and foot length to penetrate the current lift when loose and provide bonding to the previous lift.

When lifts of the compacted clay cap are not constructed continuously, a vertical construction joint may occur. To remove the vertical construction joint(s), the edge of the adjoining cap section shall be cut back to form a "stair step" or flattened, forming a slope, to permit offsetting of the tie-in for subsequent lifts. For each 6-inch lift, the edge should be cut back at least 2.5 feet or graded to a maximum 5:1 slope. The corresponding adjoining lift should be placed against the existing finished lift. The new loose lift and at least 2 feet of the adjoining existing lift will be processed together and recompacted so that the existing cap edge is tied to new construction without superimposed vertical construction joints. This tie-in procedure shall be repeated lift-by-lift until all corresponding adjacent lifts are constructed to the required elevation. The cut back edge of the existing cap may be conducted all at once or one lift at a time. If the 5:1 slope tie-in method is used, the CQA Consultant shall observe that proper compaction and bonding of the tie-in is achieved.

4.3.5 Construction Testing

All construction quality assurance testing shall be conducted in accordance with the Construction Specifications. All field and laboratory tests shall be conducted on samples taken from the compacted clay cap during the course of the construction work. Testing and sampling procedures shall be observed and documented by the CQA Consultant.

Quality assurance of the compacted clay cap shall consist of monitoring the work as compacted clay cap construction proceeds and laboratory and field testing to assure that cap material conformance and construction performance specifications are achieved.

Construction Testing: During compacted clay cap construction, field moisture/density testing will be performed using a nuclear density gauge (ASTM D2922 and D3017) at a minimum frequency of five tests per acre per lift. A minimum of every fifth test completed with a nuclear density gauge shall also be tested in accordance with either the sand cone method (ASTM D1556) or the drive cylinder method (ASTM D2937). In the event of differing results, the results of the field moisture/density testing completed using either the sand cone method or the drive cylinder method shall govern.

The in-place hydraulic conductivity of the constructed cap shall be tested at a minimum frequency of once per acre per lift of soil placed. The lab permeability test shall conform to ASTM D5084. Samples shall be taken in accordance with ASTM D1587.

If a permeability test result fails to meet the permeability requirements, two additional samples shall be taken in the vicinity of the failed sample, and replicate tests conducted. If the replicate tests pass, the section represented by the samples shall be considered as having passed. If either of the replicate tests fails, then the section shall be considered as having failed and shall be removed, replaced and retested.

Compacted Clay Cap Perforations: When taking field densities and undisturbed samples, all holes dug or created in the cap for density probes or samples must be backfilled with bentonite or a 50% bentonite/50% soil mix. The backfill shall be tamped in the hole to remove pockets of air or loose soil, and to assure a tight, compact seal.

Compacted Clay Cap Thickness Verification: Compacted clay cap thickness verification shall be determined by instrument survey method only; no test probes that create holes will be allowed. The verification points for record purposes shall be on a grid not exceeding 10,000 square feet per grid. If the area under evaluation is less than 10,000 square feet, a minimum of two grid points is required for verification. The selected grid shall be the same for both beginning and finished elevations of the compacted clay cap, so that minimum thicknesses can be calculated and verified.

Post-Construction Care of Compacted Clay Cap: The integrity of the compacted clay cap shall be maintained by moistening the material to prevent desiccation. Conversely, the compacted clay cap shall be kept free of standing water by providing sufficient surface water run-on controls and adequately pumping to remove run-off after rainfall events. Damage caused by rain shall be repaired, and if the lift must be reworked as determined by the CQA Consultant, then appropriate retesting (including field moisture-density and permeability tests) shall be performed.

4.3.6 Defects and repairs

4.3.6.1 Identification

Acceptability criteria for testing shall be as identified in the Construction Specifications. At locations where the testing indicates the requirements of the Construction Specifications are not met, the CQA Consultant shall determine the extent and the nature of the defect and recommend corrective actions to the ENGINEER.

If the compacted clay cap has been subject to adverse weather conditions, the CQA Consultant shall reexamine the soil for possible damage.

4.3.6.2 Notification

After determining the extent and nature of any defect, the CQA Consultant shall promptly notify the CONTRACTOR and ENGINEER.

4.3.6.3 Repairs and Retesting

The CONTRACTOR shall correct all deficiencies to meet the Construction Specifications. The CQA Consultant shall schedule appropriate retests when the work defect has been corrected. All retests by the CQA Consultant shall verify that the defect has been corrected before any additional work is performed by the CONTRACTOR in the area of the deficiency.

The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the ENGINEER.

Sections of compacted clay cap that do not pass either the density or moisture requirements in the field shall be reworked and retested until the section in question passes. All field density results shall be reported, whether they indicate passing or failing values.

In the event of a failed moisture-density test, additional tests will be performed between the failed test and the nearest adjacent passing test locations. If those additional tests pass, then the area between the failed test and the additional passing tests will be reworked and retested until passing. If the additional tests fail, then additional tests will be performed halfway between the initial additional tests and the adjacent passing tests to further define the failing area. This procedure will be repeated until the failing area is defined, reworked, and retested with passing results. If reworking consistently fails and the section does not pass the criteria, the non-conforming area will be removed and replaced.

All reworked areas should be tested and confirmed to satisfy the hydraulic conductivity criterion. The reporting of retests should clearly indicate the number and location of the non-conforming test and the subsequent conforming retest. Retests should be taken near the location of the original non-conforming test.

4.4 Geomembrane

Stringent quality assurance and careful documentation are required in the production and installation of all geosynthetic materials. The work addressed under this section shall facilitate proper construction of all geosynthetic components of the cap for the landfill. All work shall be constructed to the lines, grades, and dimensions indicated on the project plans, in accordance with the Construction Specifications, or as required by the OWNER or ENGINEER.

The CQA Consultant shall issue a written daily report of activities to the ENGINEER. These reports shall include, at a minimum, observations and test results as well as problems encountered and solutions achieved. Construction reports summarizing significant events, as well as addressing all problems encountered and their solutions, shall be issued to the ENGINEER. The format of these reports and frequency shall be established prior to the start of construction.

4.4.1 Manufacture of Geomembrane

The Geomembrane Manufacturer shall provide the ENGINEER and the CQA Consultant with a Manufacturer's Installation Guide and a written certification signed by an officer or the Manufacturer's Quality Control Manager indicating that the geomembrane actually delivered has properties which meet or exceed the guaranteed properties for the type of geomembrane specified. The certification shall be signed by a responsible party employed by the Manufacturer shall include the following:

- Product identification,
- Lot number,
- Geomembrane roll numbers, and
- Manufacturer's quality control test results.

The Manufacturer shall perform quality conformance testing on the natural resin for the required physical properties prior to shipping material to the site. At a minimum, the following tests shall be used to determine material physical properties:

- Density – ASTM D792 or D1505
- Melt flow index – ASTM D1238
- OIT – ASTM D3895

In addition, the Manufacturer shall perform quality conformance testing on the geomembrane for the required physical properties indicated below prior to shipping material to the site:

- Minimum Thickness - ASTM D5994
- Minimum Density - ASTM D792 or D1505
- Asperity Height - GRI GM-12
- Carbon Black Content - ASTM D1603
- Carbon Black Dispersion - ASTM D5596
- Tensile Properties - ASTM D6693
  - Strength @ Break
  - Elongation @ Break
- Tear Resistance - ASTM D1004
- Puncture Resistance - ASTM D4833
- Oxidative Induction Time
  - Std. OIT - ASTM D3895
  - High Pressure OIT - ASTM D5885
- Oven aging at 85° C – ASTM D5721
- UV resistance – GRI – GM11
- 2% Secant modulus – ASTM D5323

Prior to the installation, the Manufacturer will provide the CQA Consultant with the following:

- A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the Construction Specifications or equivalent methods approved by the ENGINEER and CQA Consultant;

- A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane;
- The sampling procedure and results of testing; and
- A certification that property values given in the properties sheet are minimum or maximum values and are guaranteed by the Manufacturer.

The CQA Consultant will verify that:

- The property values certified by the Manufacturer meet all of the Specifications; and
- The measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the geomembrane meets the Manufacturer specifications and the Construction Specifications.

4.4.2 Conformance Testing

The CQA Consultant or a designated independent Geosynthetics CQA Laboratory will perform quality assurance testing to verify that the geomembrane meets the requirements of the Construction Specifications. These tests are indicated below. Samples of the geomembrane material shall be taken from the leading edge of the roll and shall be three feet wide by the length of the roll. Samples shall be taken at the factory prior to shipment or upon delivery at the site:

- Minimum Thickness - ASTM D5994
- Minimum Density - ASTM D792 or D1505
- Asperity Height - GRI GM-12
- Carbon Black Content - ASTM D1603
- Carbon Black Dispersion - ASTM D5596
- Tensile Properties - ASTM D6693
- Strength @ Break
- Elongation @ Break
- Tear Resistance - ASTM D1004
- Puncture Resistance - ASTM D4833

4.4.3 Transportation and Delivery

All handling on-site is the responsibility of the CONTRACTOR or Installer. The CONTRACTOR or Installer is responsible for the submittal of shipping manifests and all other relevant documents to the CQA Consultant.

Upon delivery at the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site and those rolls with minor flaws.

The CONTRACTOR will be responsible for the storage of the geomembrane on-site upon arriving at the site. The OWNER will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, etc.

The CQA Consultant will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water in the event of rainfall.

4.4.4 Construction

The Installer shall submit proposed panel layouts to the CQA Consultant and ENGINEER at least seven days prior to mobilization of installation crews. In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented with, not across, the slope. In corners and other geometrically complex locations, the number of seams should be minimized. No base seam or tee seam will be less than five feet from the toe of slopes, or areas of potential stress concentrations, unless otherwise authorized by the CQA Consultant.

Once the panel layout is approved, the Installer may not substantially change the layout without permission of the CQA Consultant, ENGINEER or OWNER. The Installer shall submit a drawing of proposed seam completion details at panel corners of three or more sheets to the ENGINEER and the OWNER prior to shipment of the geomembrane.

Subgrade surfaces to receive geomembrane installation shall be relatively smooth and even and free of ruts, voids, protrusions, and deleterious material. The Installer shall provide written certification that the subgrade surface on which the geomembrane will be installed is acceptable. During placement, the CQA Consultant will verify that:

- Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;
- Any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and are free of debris;
- All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;
- The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, the loading should be continuous along the edges of panels to minimize the risk of wind flow under the panels);
- Direct contact of equipment with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected; and
- Portable generators may not be placed directly on the geomembrane, but shall be placed on a rub sheet.

The CQA Consultant will notify the ENGINEER and Installer if the above conditions are not fulfilled.

After placement and prior to seaming, the CQA Consultant will visually examine each panel for damage. The CQA Consultant will advise the geomembrane installer which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected will be marked, and their removal from the work area recorded by the CQA Consultant.

Prior to seaming, the CQA Consultant shall verify that the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material. The CQA Consultant shall verify that the bonding surfaces are thoroughly cleaned by mechanical abrasion for extrusion welds. Testing of the seams shall be conducted by the Installer under the observation of the CQA Consultant. The Installer shall supply qualified personnel and testing equipment. The CQA Consultant or Geosynthetic CQA Laboratory may perform additional testing to verify that the seams meet the requirements of the specifications.

4.4.4.1 Trial Seams

Trial seams shall be made each day prior to commencing field seaming. The seams shall be made on fragment pieces of geomembrane under the same surface and environmental conditions as the production seams to verify that seaming conditions are adequate. The trial seams shall be made at the beginning of each seaming period; at changes of equipment, equipment settings, operator, weather, or sheet temperature; at the CQA Consultant's discretion, and at least once every four to six hours during continuous operation of each welding machine; or at change in material type (i.e., smooth-to-smooth seam versus smooth-to-textured seam). Each seamer shall make at least two test seams each day.

The trial seam sample shall be at least five feet long by one foot wide with the seam centered lengthwise. For dual track fusion welds nine, one-inch wide by six-inch long test strips shall be cut from the trial seam. Quantitatively test three specimens for inside peel adhesion (peel), three for outside peel, and then three specimens for bonded seam strength (shear). For extrusion welds six, one-inch wide by six-inch long test strips shall be cut from the trial seam. Quantitatively test three specimens for peel and three specimens for bonded seam strength (shear).

A trial seam sample shall pass when the results of the tests shown below are achieved in both peel and shear test and when the break can be described as a film tear bond. A film tear bond is defined as a failure in the ductile mode of one of the bonded sheets by tearing prior to complete separation to the bonded area.

- Peel strength (fusion) – ASTM D6392
- Peel strength (extrusion) – ASTM D6392
- Shear strength (fusion & extrusion) – ASTM D6392

Trial seams shall be repeated, in its entirety, when any of the trial seam samples fail in either peel or shear. If additional trial seams fail, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved. No welding equipment or welder shall be allowed to begin production welds until equipment and welders have a successfully completed trial seam. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the cap installation. Installer shall demonstrate that acceptable seaming can be achieved by completing passing trial seams.

The remainder of the successful trial seams shall be assigned a number and marked accordingly by the CQA Consultant, who shall also log the date, hour, ambient temperature, number of seaming apparatus, name of seamer, and pass or fail description. The sample itself should be archived until project completion.

4.4.4.2 Non-destructive Testing

Production seams shall be tested by the Installer continuously using non-destructive techniques. The Installer shall perform all air pressure (fusion welded seams) and vacuum testing (extrusion welded seams) under the observation of the CQA Consultant as follows:

- Extrusion Weld Testing – Non-destructive testing of the extrusion weld shall be conducted with a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft gasket attached to the bottom or valve assembly and a vacuum gauge. The assembly shall be capable of maintaining at least a 5 psi vacuum. A passing extrusion seam shall exhibit at least a 5 psi vacuum for at least 15 seconds when using a soapy solution to seal the gasket to the seam. The presence of soap bubbles in rapid succession is indicative of a leak. The viewing window should be regularly cleaned to ensure a clear view of the seam section being tested. All areas where soap bubbles appear in rapid succession shall be marked, repaired and retested.

- Fusion Weld Testing – Non-destructive testing of the fusion weld shall be conducted with an air pump or tank capable of generating and sustaining pressure over 30 psig; a sharp, hollow needle, or other approved pressure feed device equipped with a pressure gauge; a utility knife with hook blade; hot air gun or other device and clamp to seal the ends of the air channel. After sealing both ends, the fusion seam shall be pressurized to 30 psig and the pressure allowed to stabilize. A passing fusion seam shall have a maximum 4 psig vacuum loss over a five minute time period.

  Once the seam passes the opposite end of the seam shall be punctured to release the air, confirming that the entire seam length had been tested. If air is not released once the channel has been punctured, a blockage is present. Locate faulty area where the blockage is and retest seam on both sides of blockage. A pressure gauge at both ends of the seam will also be acceptable.

4.4.4.3 Destructive Testing

Extrusion and fusion welded field seams shall be destructively tested at a minimum frequency of one test per 500 linear feet of seamed length per welding machine. Destructive test samples shall be located by the CQA Consultant as seaming progresses and shall be removed by the Installer to obtain laboratory test results before the geomembrane is covered. Samples shall be 12-inches wide by minimal length (typically 60 inches) with the seam centered lengthwise (minimum of six inches on either side of the seam). The sample shall be cut into five parts for distribution to the Installer for field testing (12-inches), to the Testing Laboratory for conformance testing (12 inches), to the CQA Engineer (12-inches), to the Geosynthetic Installer for off-site testing, and to the OWNER for archive (12-inches). Sample size should be reduced to 12-inches by 48-inches when the Geosynthetics Installer elects not to test off-site.

Each sample shall be tested five times each for outer peel, inner peel, and shear. The average values of each set of five tests must meet the specification, and four of the five tests must meet the specifications for the seam to be considered a passing seam. If the average of the five tests is adequate, but one of the tests is failing, values for the failing test must be at least 80 percent of the values required for the seam for the sample to pass. All tests must exhibit a FTB failure and meet the strength requirements provided in the Construction Specifications.

Samples which do not pass the shear and peel tests shall be re-sampled from locations at least ten feet on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then additional samples shall continue to be obtained until the questionable seam area is defined.

4.4.4.4 Repairs

Any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test shall be repaired. Damaged geomembrane shall be removed and replaced with acceptable geomembrane materials if damage cannot be satisfactorily repaired. Installer shall be responsible for repair of damaged or defective areas. Agreement upon the appropriate repair method shall be decided between the OWNER, ENGINEER or CQA Consultant, and the Installer. Procedures available include the following:

- Patching - Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter;
- Spot Welding - Used to repair pinholes, other localized flaws (minor) or where geomembrane thickness has been reduced;
- Capping - Used to repair large lengths of failed seams; and
- Replacement - Used to remove the unacceptable seam and replace with new material.

In addition, surfaces of the geomembrane which are to be repaired by extrusion welds shall be lightly abraded with disc grinder or equivalent to assure cleanliness. All geomembrane surfaces shall be clean and dry at the time of repair. Patches or caps shall be extended at least six inches for extrusion weld and four inches for wedge weld beyond the edge of the defect. All corners of patch material shall be rounded.

The CQA Consultant shall number and log each patch repair, and the Installer shall non-destructively test each repair using methods specified in this plan.

4.4.4.5 Final Inspection

A final inspection shall be completed by the Installer, ENGINEER, CQA Consultant and OWNER prior to the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA Consultant prior to the Installer demobilizing from the site.

4.5 Geonet Composite

4.5.1 Manufacture of Geonet Composite

The Geonet Composite Manufacturer shall provide the ENGINEER and the CQA Consultant with a list of guaranteed properties for the type of geonet composite to be supplied. The Geonet Composite Manufacturer shall provide the ENGINEER and the CQA Consultant with a Manufacturer's Installation Guide and a written certification signed by an officer or the Manufacturer's Quality Control Manager indicating that the geonet composite actually delivered has properties which meet or exceed the guaranteed properties for the type of geonet composite specified. The certification shall be signed by a responsible party employed by the Manufacturer shall include the following:

- Product identification,
- Lot number,
- Geonet composite roll numbers affected by shipment, and
- Manufacturer's quality control test results.

At a minimum, the Geonet Composite Manufacturer's quality control testing shall be as follows:

Geonet Composite
- Transmissivity – ASTM D4716
- Ply adhesion – GRI GC-7

Net Component
- Thickness – ASTM D5199
- Density – ASTM D1505
- Tensile Strength – ASTM D5035
- Carbon black content – ASTM D1603

Geotextile Component
- Mass per unit area – ASTM D5261
- Apparent opening size – ASTM D4751
- Flow rate – ASTM D4491
- Grab tensile strength – ASTM D4632
- Puncture strength – ASTM D4833

Geonet Composite Resin
- Density – ASTM D1505
- Melt flow Index – ASTM D1238

The CQA Consultant shall examine all the Geonet Composite Manufacturer's certifications to ensure that the property values listed on the certifications meet or exceed those specified.

4.5.2 Conformance Testing

The CQA Consultant or a designated independent geosynthetics laboratory may perform additional quality assurance testing to verify that the geonet composite drainage fabric meets the requirements of the specifications. The minimum testing is indicated below. Testing frequency shall be as listed in the Construction Specifications. Samples of the geonet composite drainage fabric shall be taken from the leading edge of the roll and shall be three feet wide by the length of the roll. Samples shall be taken at the factory prior to shipment or upon delivery at the site.

Geonet Composite
- Transmissivity – ASTM D4716
- Ply adhesion – GRI GC-7

Net Component
- Thickness – ASTM D5199
- Density – ASTM D1505
- Tensile Strength – ASTM D5035
- Carbon black content – ASTM D1603

Geotextile Component
- Mass per unit area – ASTM D5261
- Apparent opening size – ASTM D4751
- Flow rate – ASTM D4491
- Grab tensile strength – ASTM D4632
- Puncture strength – ASTM D4833

4.5.3 Transportation and Delivery

All handling on-site is the responsibility of the CONTRACTOR or Installer. The CONTRACTOR or Installer is responsible for the submittal of shipping manifests and all other relevant documents to the CQA Consultant.

Upon delivery at the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site and those rolls with minor flaws.

The CONTRACTOR will be responsible for the storage of the geonet composite drainage fabric on-site. The OWNER will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Storage space should be protected from theft, vandalism, passage of vehicles, etc.

The CQA Consultant will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water in the event of rainfall.

4.5.4 Construction

During deployment, the CQA Consultant shall inspect the geonet composite for damage due to equipment, deployment across the geomembrane, or other potentially damaging activities. The Installer shall handle all geonet composites in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:

- On slopes, the geonet composites shall be secured and rolled down the slope in such a manner as to continually keep the geonet composite sheet in tension. If necessary, the geonet composites shall be positioned by hand after being unrolled to minimize wrinkles. Geonet composites shall not be placed in the horizontal direction (i.e., across the slope).
- In the presence of excessive wind, geonet composites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

Adjacent geonet composites shall be joined according to the Geonet Composite Manufacturer's recommendations, the Geonet Composite Manufacturer's Installation Guide, Construction Plans and Construction Specifications. At a minimum, the following requirements shall be met:

- Adjacent rolls shall overlap the geonet component by at least 6 in. and shall provide a minimum 2 ft overlap down the slope;
- These overlaps shall be secured by tying;
- Tying can be achieved by plastic fasteners or polymer braids. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed;
- Tying shall be every 5 ft. along the slope or floor and every 6 inches in the anchor trench; and
- The edges of the geotextile component shall be sewn (to ensure no fines get into the drainage medium) using UV stabilized polypropylene thread with chemical properties equal to or exceeding those of the geotextile. A two-thread type 401k double-locked stitch shall be used for all sewing work. The thread color should contrast with the geotextile color.

The CQA Consultant shall verify the above.

Holes or tears in the geonet composite shall be repaired by placing a patch of geonet composite extending a minimum of 2 feet beyond the edges of the hole or tear. The patch shall be fastened to the original roll with approved fasteners spaced every 6 inches around the patch. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be tied together every 6 inches

4.6 Soil Protective Cover

Protective soil covers consist of soils used to protect the components of the caping systems. Protective cover soil shall be free of rubble, wood, stumps, brush, metal, cinders, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge and other deleterious materials. The maximum stone size shall be two inches in any dimension and shall not comprise more than five percent of the total soil mass. Protective cover soil shall be classified according to the United Soil Classification System as SC, CL, CH, SM, ML, or MH (ASTM D2487).

4.6.1 Construction Observation

Observation of the soil protective layer shall be coordinated with construction testing. Acceptance criteria for construction work shall be as identified in the Construction Specifications. At a minimum, the CQA Consultant shall observe and record the following during the construction of the soil protective layer:

- Moisture content and consistency of the soil during processing, placement, and compaction;
- Loose and compacted lift thickness;
- Stones which may damage underlying geosynthetic components; and
- Areas where damage due to excess moisture, insufficient moisture, freezing, or excessive dessication may have occurred.

The CQA Consultant shall also verify that:

- Placement of the soil protective layer does not proceed at an ambient temperature below 32°F (0°C) nor above 104 F (40°C) unless otherwise approved;
- Equipment used for placing soil is not driven directly on any underlying geomembrane; and
- A minimum thickness of 12-inches loose or 9 inches compacted soils are between a light dozer, ground pressure of 5 psi (35 kPa) or lighter, and the underlying geomembrane/ geonet composite drainage fabric. (or as required by the Construction Specifications).

When placing overlying material on the geonet composite drainage fabric every effort must be made to minimize wrinkle development. Small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the CQA Consultant to ensure that wrinkle formation is minimized and, in all cases that the geonet composite drainage fabric is not folded over on itself. The minimum thickness shall be certified by the surveyor in accordance with the Construction Specifications.

4.6.2 Construction Testing

All construction quality assurance testing shall be conducted in accordance with the Construction Specifications. All field and laboratory tests shall be conducted on samples taken from the soil protective layer materials during the course of the construction work. Testing and sampling procedures shall be observed and documented by the CQA Consultant.

Quality assurance of the soil protective layer shall consist of monitoring the work as soil protective layer construction proceeds and laboratory and field testing to assure that the protective cover layer materia l conformance and construction performance specifications are achieved.

Construction Observation: The CQA Consultant will be on-site at all times when soil protective layer construction is ongoing, so that all relevant activities can be observed and documented. The

ENGINEER will visit the site periodically as construction progress warrants. Such visits will be frequent enough so that the ENGINEER is fully knowledgeable of the construction methods and performance and can determine that CQA observation and testing activities are adequate to meet the terms and intent of this Plan.

Visual observation shall include, but not be limited to, the following:

- Moisture content and distribution, particle size, and other physical properties of the soil during processing, placement, and compaction;
- Maximum clod size and breakdown of soil structure;
- Stones or other inclusions, which may damage underlying geosynthetics components or adversely affect compaction, lift bonding, and in-place testing/sampling; and
- Areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.

Construction Testing: During protective cover layer construction, field moisture/density testing may be performed using a nuclear density gauge (ASTM D2922 and D3017) at a frequency as detailed in the Construction Specifications.

Protective Cover Layer Thickness Verification: Protective cover layer thickness verification shall be determined by instrument survey method only; no test probes that create holes will be allowed. The verification points for record purposes shall be on a grid not exceeding 10,000 square feet per grid. If the area under evaluation is less than 10,000 square feet, a minimum of two grid points is required for verification. The selected grid shall be the same for both beginning and finished elevations of the soil cap, so that minimum thicknesses can be calculated and verified.

Post-Construction Care of Protective Cover Layer: The integrity of the protective cover layer shall be maintained by moistening to prevent the material from desiccating. Conversely, the protective cover layer shall be kept free of standing water by providing sufficient surface water run-on controls and adequately pumping to remove run-off after rainfall events. Damage caused by rain shall be repaired, and if the lift must be reworked as determined by the CQA Consultant, then appropriate retesting (including field moisture-density) may be performed.

4.6.3 Defects and Repairs

4.6.3.1 Identification

If a defect is identified in the protective cover layer, the CQA Consultant shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate.

4.6.3.2 Notification

After determining the extent and nature of the defect, the CQA Consultant shall promptly notify the CONTRACTOR and the ENGINEER.

4.6.3.3 Repairs and Retesting

The CONTRACTOR shall correct all deficiencies to meet the Construction Specifications. The CQA Consultant shall schedule appropriate retests when the work defect has been corrected. All retests by the CQA Consultant must verify that the defect has been corrected before any additional work is performed by the CONTRACTOR in the area of the deficiency. The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the ENGINEER.

4.7 Vegetative Support Layer

Vegetative support layer material generally consists of medium-textured soils capable of supporting vegetative growth. Establishment of vegetation reduces cover erosion due to water and wind, and protects the soil and/or geosynthetic cover against damage. Site-specific criteria for the vegetative support layer shall be specified in the Construction Specifications.

4.7.1 Quality Control Documentation

Prior to the construction of a vegetative support layer, any required tests shall be conducted to verify that proposed sources meet the Construction Specifications. Testing shall be performed by the CQA Consultant or other laboratory approved by the ENGINEER.

The CONTRACTOR shall submit the results of these tests to the ENGINEER. The ENGINEER shall accept or reject the material based on these test results.

4.7.2 Construction Observation

The vegetative support layer shall be compacted to the specified thickness. The firmness of the compacted vegetative support layer varies with the type of vegetation specified for the cover, and should be indicated in the Construction Specifications.

The CQA Consultant shall:

- Observe the quantity and the uniformity of any soil amendment incorporated within the tilled depth before seeding;
- Ensure that the seeding application equipment is appropriate for the job. The rate of seed and mulch application, amount and uniformity of coverage, and watering instructions as provided in the Construction Specifications shall be closely observed; and
- Examine the perimeter areas to ensure that no unseeded area remains.

The CQA Consultant shall report any nonconformance to the ENGINEER.

Thickness verification of the vegetative support layer shall be determined by instrument survey method only; no test probes that create holes will be allowed. The verification points for record purposes shall be on a grid not exceeding 10,000 square feet per grid. If the area under evaluation is less than 10,000 square feet, a minimum of two grid points is required for verification. The selected grid shall be the same for both beginning and finished elevations of the vegetative support layer, so that minimum thicknesses can be calculated and verified.

4.7.3 Defects and Repairs

4.7.3.1 Identification

If a defect is identified in the vegetative support layer, the CQA Consultant shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate. If the vegetative support layer has been subject to adverse weather conditions during construction, the CQA Consultant shall reexamine the vegetative support layer for possible damage in overly wet or windblown areas.

4.7.3.2 Notification

After determining the extent and nature of the defect, the CQA Consultant shall promptly notify the CONTRACTOR and the ENGINEER.

4.7.3.3 Repairs and Retesting

The CONTRACTOR shall correct all deficiencies to meet the Construction Specifications. The CQA Consultant shall schedule appropriate retests when the work defect has been corrected. All retests by the CQA Consultant must verify that the defect has been corrected before additional work is performed by the CONTRACTOR in the area of the deficiency. The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the ENGINEER.

5.0 FINAL CERTIFICATION

Certification shall be prepared by the CQA Consultant and submitted upon completion of the work. This report shall include all reports prepared by the CQA personnel, summarize the activities of the project, and document all aspects of the quality assurance program performed. The CQA report shall contain the results of all the construction quality assurance testing, including documentation of any failed test results, descriptions of procedures used to correct the improperly installed material, and the results of all retesting performed. The CQA report shall also contain as-built drawings noting any deviation from the approved plans and shall contain a comprehensive narrative including, but not limited to, regular reports from the project engineer, a series of color photographs of major project features, and documentation of proceedings of all progress meetings. The Certification shall be sealed and signed by a professional engineer registered in the State of North Carolina.

Certification reports required by regulatory agencies will also be prepared and submitted as required. Subconsultants and testing laboratories shall also prepare certification reports for their respective areas of responsibility.

5.1 Construction Certification

The Final Certification Report shall include assessments of the CONTRACTOR's compliance with the Construction Plans and Specifications and physical sampling and testing. The Final Certification Report shall also include statements summarizing the extent of construction, with special attention given to changes from the design plans. The report will certify the results of the various field tests and laboratory tests performed, and assess whether or not the constructed project is in compliance with the Construction Plans and Specifications.

5.2 Geosynthetics Certification

The Final Certification Report shall include as a minimum the following information:

- Personnel involved with the project (with experience listed);
- Scope of work;
- Summaries for the installation of the geosynthetics;
- Conformance test results;
- Trial weld test results; and
- Field seaming test results (including laboratory tests, as applicable);

6.0 RECORD DRAWINGS

The preparation of Record Drawings is the responsibility of the CONTRACTOR. They shall be sealed and signed by a professional engineer or surveyor registered in the State of North Carolina. Also, all drawings shall be included in digital format, prepared in a program agreed upon prior to the start of construction. Record Drawings should be included by the CQA Consultant with the Final Certification Report.

They shall include drawings from the Installer showing:

- Layout of all geomembrane field panels to scale relative to the surveyed anchor trench;
- Identification of all seams and panels with appropriate numbers or "identification codes";
- Location of all patches and repairs; and
- Location of all destructive test samples.

The Record Drawings shall address the geomembrane layer and, if necessary, applicable cross-sections shall show layouts of geosynthetics that are unusual or differ from the Construction Plans.

In addition, Record Drawings shall show:

- Final surveyed construction grades for the different layers of construction including, base grades, intermediate grades and final soil grades, if applicable;
- The as-built thickness of the compacted soil cap throughout the cell;
- Piping and appurtenances; and
- Locations of key features

(end)

OPERATION PLAN

OPERATIONS PLAN

WCA OF HIGH POINT
CONSTRUCTION AND DEMOLITION LANDFILL
PHASE 2 EXPANSION
PERMIT NO. 41-16
GUILFORD COUNTY, NORTH CAROLINA

Prepared for:

WCA of High Point , LLC
5830 Riverdale Drive
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March 2007

Project No.: 063-6526

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DRAWINGS

APPENDICES

1.0 INTRODUCTION

This Operations Plan describes how the Facility, Engineering, and Closure Plans prepared for the WCA of High Point, LLC, Construction and Demolition (C&D) Landfill will be implemented during the life of the facility. The plan has been prepared in compliance with Rules .0535 and .0542 of the North Carolina Solid Waste Management Regulations and consists of drawings and accompanying text that illustrates existing conditions, cell progression, waste placement and daily operations, stormwater control, special waste management, buffer zones and soil borrow procedures.

2.0 OPERATION DRAWINGS

2.1 Existing Conditions

WCA of High Point, LLC, owns and operates the WCA of High Point C&D Landfill in Guilford County. Approximately 700 tons of C&D solid waste is managed daily at the site, which is located at 5830 Riverdale Drive; High Point, NC. Based on their experience at the facility, approximately 40% of the C&D waste brought to the facility will be reclaimed; the remaining 60% will be disposed of in the proposed Phase 2 Expansion. The facility began accepting waste in February 2001 and contains a 12.1-acre, active, unlined landfill (Phase 1).

On-site development consists of a C&D disposal area, a main entrance road, access roads, scale and scale-house, recycling processing area, material storage area, and erosion and sediment control features. See Drawing OP-1 for an illustration of existing conditions at the site.

2.2 Proposed Phase 2

The Phase 2 disposal area described in the Engineering Plan consists of 9.4 acres immediately north and east of the active Phase 1 area. The Phase 2 area shall be filled using the area method. The initial waste placement area, transition contours, cell access, and final contours for Phase 2 are detailed on Drawing OP-2.

Uncontaminated stormwater will be collected and conveyed along the perimeter of the active cells to the existing sediment basin and proposed sediment trap(s) as shown on Drawing OP-3.

2.3 Proposed Future Development

Five additional phases of development for C&D solid waste disposal are proposed for the site. The proposed development is located in areas that have previously been designated as suitable for landfill development and has been described in more detail in the previously submitted Site Plan Application (Joyce Engineering, Inc, last revised April 2003). Development of subsequent phases (3 through 7) will progress west to east.

3.0 SITE OPERATION

3.1 Owner and Operator

The facility is owned and operated by WCA of High Point, LLC; 5830 Riverdale Drive; Jamestown, North Carolina. WCA of High Point, LLC, will be responsible for operations and notifying the Solid Waste Section of the identity of the operator in charge. Mr. Michael R. McFeeley, a certified landfill operator, will be directing the contained landfill operations; his phone number is 336.886.3560. In accordance with Rule .0542(j)(2) and N.C.G.S.130A-309.25, Mr. McFeeley or another individual trained in landfill operations shall be on duty at the site while the facility is open for public use and at all times during active waste management operations to ensure compliance with operational requirements.

3.2 Operating Hours

The landfill is open to private waste haulers and the public from 7:00 a.m. to 4:30 p.m. Monday through Friday, and on Saturday from 7:00 a.m. to 1:00 p.m. The facility will be closed on the following major holidays: New Years Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day. If the facility will be closed during other holidays, third party haulers will be notified in advance.

3.3 Site Access and Safety

Access to the landfill is controlled through a single access road with a secure gate to prevent access when the landfill is not open. A sign containing information required in Rules .0542(j)(5) and .0542(j)(6)(i.e., dumping procedures, hours, permit number, etc.) is posted at the landfill entrance. Traffic signs or markers shall be provided as necessary to promote orderly traffic patterns to and from the disposal area and to maintain efficient operating conditions. During operating hours, traffic is routed from the entrance gate and scale house to a paved and gravel road leading to the disposal area. The road is maintained so that it is passable during all weather conditions.

3.4 Landfill Equipment

Operation and maintenance of the site will be the responsibility of the landfill operator. The minimum operations heavy equipment available to support landfill operations is as follows:

- A Dozer
- Water Truck
- Steel Wheel Compactor
- Track Excavator
- Track loader
- Articulated on-site truck

Other equipment will be purchased or rented as required for the facility operations.

3.5 Dust, Odor, Vector and Litter Control

3.5.1 Dust Control

Dust should be controlled by wetting down or placing stone in problem areas to mitigate dust problems. Oil cannot be used for dust control.

3.5.2 Odor and Vector Control

Odors and disease vectors will be controlled in order to protect human health and the environment by minimizing the working face size and by the use of weekly cover. Cover requirements are described in more detail in a Section 5.3 of this plan.

3.5.3 Litter Control

Prompt compaction of waste at the working face is the primary method used to control blowing litter. Also, temporary fencing and/or diking may be provided to contain waste which is subject to be blown by the wind during operations. In addition, windblown material resulting from the operation shall be collected and disposed of properly by the owner and operator.

3.6 Fire Control

Incoming waste loads shall be observed by site operators for evidence of fire, such as flames, smoke, or the odor of burning material. Burning loads will be extinguished before dumping, if possible. If there is evidence of fire in the landfill itself, the landfill operator will be notified immediately. If possible, the waste will be removed or segregated from other waste in the disposal area. The landfill operator will evaluate the situation to determine whether the fire can be extinguished using fire extinguishers or equipment present at the site, or if off-site equipment will be needed. If necessary, the local fire department will be called to render assistance in extinguishing the fire.

If there is a fire or explosion at the landfill, the operator must notify the Division of Solid Waste Management and report whether the fire has been controlled and what (if any) environmental damage may have occurred. The Division of Waste Management Rule .0542(i)(4) requires that fires or explosions that occur at the landfill be reported verbally to the Division within 24 hours and in writing within 15 days. Written notification shall include the suspected cause of fire or explosion, the response taken to manage the incident, and the action(s) to be taken to prevent the future occurrence of fire.

Fire extinguishers shall be located on each piece of equipment on site. Equipment operators shall be trained in the use of these extinguishers. Fire extinguishers will be used for small, localized fires. A stockpile of soil shall be maintained near the working face to be used for extinguishing small surface fires that may be too large to control with the fire extinguishers carried on the landfill equipment.

Emergency equipment will be called in the case of fires too large to be extinguished with fire extinguishers or soil as described above. Water contained in the sedimentation ponds or inactive borrow areas can be used in an emergency to aid local firefighters in extinguishing large fires.

3.7 Open Burning

Open burning of solid waste, except for the approved burning of land clearing debris generated on-site or debris from emergency clean-up operations is prohibited. (See Division of Waste Management Rule .0542(i)(2).) No instance of such burning may be undertaken without prior approval from the Division.

3.8 Scavenging/Salvaging

The unauthorized removal of waste and scavenging at the landfill is prohibited by Rule .0542(j)(8). Removal of recyclable or reusable items may be authorized by the Division when recovery of such items can be accomplished with no risk to landfill staff or the general public and must be completed prior to disposal on the working face. No removal/scavenging of recyclable or reusable items will be permitted from the working face.

4.0 WASTE ACCEPTANCE AND DISPOSAL REQUIREMENTS

The WCA of High Point C&D Landfill shall only accept those solid wastes which it is permitted to receive. The landfill owner or operator shall notify the Division within 24 hours of attempted disposal of any waste the landfill is not permitted to receive, including waste from outside the area the landfill is permitted to serve. Wastes which may be disposed of at the facility as well as prohibited wastes and a waste screening program are described as follows.

4.1 Prohibited Wastes

The following wastes shall not be disposed of in the facility:

- Containers such as tubes, drums, barrels, tanks, cans, and bottles unless they are empty and perforated to ensure that no liquid, hazardous or municipal solid waste is contained therein,
- Garbage as defined in N.C.G.S.130A-290(a)(7),
- Hazardous waste as defined in N.C.G.S.130A-290(a)(8), to also include hazardous waste from conditionally exempt small quantity generators,
- Industrial solid waste unless a demonstration has been made and approved by the Division that the landfill meets the requirements of Rule .0503(2)(d)(ii)(A),
- Liquid wastes,
- Medical waste as defined in N.C.G.S.130A-290(a)(18),
- Municipal solid waste as defined in N.C.G.S.130A-290(a)(18a),
- Polychlorinated biphenyls (PCB) wastes as defined in 40 CFR 761,
- Radioactive waste as defined in N.C.G.S. 104E-5(14),
- Septage as defined in N.C.G.S.130A-290(a)(32),
- Sludge as defined in N.C.G.S.130A-290(a)(34),
- Special wastes as defined in N.C.G.S.130A-290(a)(40),
- White goods as defined in N.C.G.S.130A-290(a)(44), and
- Yard trash as defined in N.C.G.S.130A-290(a)(45),
- The following wastes cannot be received if separate from C&D waste: lamps or bulbs including but not limited to halogen, incandescent, neon or fluorescent; lighting ballast or

fixtures; thermostats and light switches; batteries including but not limited to those from exit and emergency lights and smoke detectors; lead pipes; lead roof flashing; transformers; capacitors; and copper chrome arsenate (CCA) and creosote treated woods.

Waste accepted for disposal at the WCA of High Point C&D Landfill shall be readily identifiable as C&D waste and shall not have been shredded, pulverized, or processed to such an extent that the composition of the original waste cannot be readily ascertained except, as specified as follows.

C&D waste that has been shredded, pulverized or otherwise processed may be accepted for disposal from a facility that has received a permit from an authorized regulatory authority which specifies such activities are inspected by the authority, and whose primary purpose is recycling and reuse of the C&D material. A detailed waste screening plan and waste acceptance plan shall be made available to the Division upon request.

Further, the WCA of High Point C&D Landfill shall not knowingly dispose any type or form of C&D waste that is generated within the boundaries of a unit of local government that by ordinance:

- Prohibits generators or collectors of C&D waste from disposing that type or form of C&D waste; or
- Requires generators or collectors of C&D waste to recycle that type or form of C&D waste.

4.2 Acceptable Wastes

The proposed landfill is to receive C&D waste from Guilford County and portions of Forsyth, Davidson and Randolph Counties. The landfill will accept only C&D solid waste which, as defined in Rule .0532(8), includes only solid waste generated solely from the construction, remodeling, repair, or demolition operations on pavement, and buildings or structures. C&D waste does not include municipal and industrial wastes that may be generated by the on-going operations at buildings or structures.

Generally, wastewater treatment sludge shall not be accepted for disposal. However, wastewater treatment sludge may be accepted, with the approval of the Division, for utilization as a soil conditioner and incorporated into or applied onto the vegetative growth layer. The wastewater treatment sludge shall neither be applied at greater than agronomic rates nor to a depth greater than six inches. Prior to any placement of waste water treatment sludge, WCA will contact the Division for approval and will detail the amount of sludge to be accepted and the area upon which the sludge will be placed.

4.3 Waste Screening Program

WCA of High Point has developed a waste screening program in accordance with North Carolina's Solid Waste Management Regulations, Rule .0544(e). This Rule states that owners/operators of a C&D Landfill must implement a program at the facility for detecting and preventing the disposal of industrial, hazardous, liquid, municipal solid waste and excluded wastes, except as specifically authorized by the effective facility permit or by the Operating Plan. This program shall include, at a minimum:

- Random inspections of incoming loads or other comparable procedures;
- Records of any inspections;

- Training of facility personnel to recognize industrial, hazardous, liquid, municipal and excluded waste; and
- Development of a contingency plan to properly manage any identified industrial, hazardous, liquid, municipal or excluded waste. The plan must address identification, removal, storage and final disposition of the waste.

4.3.1 Random Selection

Random inspection of vehicles will be conducted on a regular basis. The selection must be at least one vehicle per week, but not less than one percent by weight of the waste stream based on the previous week's total. The personnel conducting the inspection will randomly select the load at the working face of the landfill; the inspection will be completed in a designated area near the working face. A random truck and time will be selected (e.g., the second load after 8:00 a.m.) on the day of inspections.

4.3.2 Record Keeping

Results of random inspections shall be recorded; sample report forms are included in Appendix OP-1. One form shall be completed for each inspection. All reports and resulting correspondence are to be maintained at the WCA of High Point C&D Landfill office for the life of the landfill and during the post-closure period. The presence of any industrial, hazardous, liquid, municipal solid waste or otherwise prohibited wastes identified during random inspections shall be reported to DENR Solid Waste Section.

4.3.3 Training

Inspections will be carried out and supervised by landfill staff trained to identify and manage hazardous and liquid waste.

4.3.4 Random Waste Inspection

The following action plan required by Rule .0544(e)(4) details the procedure for conducting random waste inspections.

- Stop the selected vehicle prior to the working face of the landfill.
- Notify the driver of the inspection.
- Direct the vehicle to the inspection area. The inspection area may be either a permanently designated location or a temporary location adjacent to the working face.
- If possible, perform a visual observation of the waste prior to unloading. If unauthorized waste is observed, or suspected, the vehicle shall be prohibited from unloading, and shall be directed out of the facility.
- If no unauthorized waste is observed or suspected from the visual observation, or if a visual observation is not possible, the vehicle shall discharge the load at the inspection area. The driver shall remain at the inspection area while the inspection is performed, unless a safety concern requires evacuation of the area. Equipment shall spread and turn the waste to facilitate a visual observation of the load contents. If no unauthorized waste is identified, the waste shall be transferred to the working face for disposal.
- If unauthorized waste is identified in the load, and the unauthorized waste is not a

regulated hazardous waste, a regulated medical waste, a regulated toxic waste, a regulated nuclear waste, or a waste which requires special handling, the waste shall be loaded back into the vehicle and removed from the facility.

- If acceptability of the waste can not be determined by visual observation, the waste can either be rejected and loaded back into the vehicle and removed from the facility, or samples of the waste can be taken to determine acceptability. Testing shall be selected based on the reason for the suspicion of unacceptability.
- Unauthorized wastes suspected of being a regulated hazardous waste, a regulated medical waste, a regulated toxic waste, or a regulated nuclear waste shall be managed in accordance with all applicable federal, state and local regulations. WCA will contact the Guilford County HAZMAT by calling 911. Response personnel shall have all appropriate licenses and/or certifications and will respond within 24 hours.

4.4 Annual Report

In accordance with NCGS 130A-309.09D, on or before August 1 of each year, WCA of High Point will report to the Solid Waste Section the amount of waste received in tons at this facility and disposed in the landfill units. Data will be transmitted on forms prescribed by the Section. The reporting period shall be for the previous year beginning July 1 and ending on June 30 and shall detail the amount of waste received and landfilled in tons, compiled on a monthly basis by county or transfer station of origin and by specific waste type if diverted to a specific unit within the permitted facility. The completed report shall be forwarded to the Regional Waste Management Specialist for the facility.

5.0 WASTE PLACEMENT

5.1 Cell Progression

The Phase 2 area will be filled using the area method in general accordance with the Annual Phasing Plan (Drawing OP-2).

Uncontaminated stormwater can be collected and removed along the western portion of the active cells as shown on Drawing OP-3. Stormwater will be diverted or pumped from the collection area into the stormwater channels that convey flow into the sediment basin or sediment traps that support the facility.

5.2 Waste Placement and Compaction

Solid wastes will be tipped as closely as possible to the working face of landfill, then spread. The size (length and width) of the working face will vary depending on the rate of waste acceptance on a given day, weather conditions and other factors, but will be maintained as small as possible. Compactors will be used to maximize in-place waste density by compacting wastes in thin flat lifts, typically less than ten (10) feet thick.

Previous estimates have determined that the approximate in-place density of waste and soil achieved at the site is approximately 1300 pounds per cubic yard. The waste density calculation will be reviewed periodically, and operational procedures may be revised to improve the efficiency of the site.

5.3 Cover Material

5.3.1 Weekly Cover

As required by Rule .0542(f), the owners or operators of all C&D Landfills must cover disposed solid waste with either six (6) inches of earthen material or an approved alternate daily cover when the waste disposal area exceeds one-half acre and at least once weekly. Cover shall be placed at more frequent intervals if necessary to control disease vectors, fires, odors, blowing litter, and scavenging. A notation of the date and time of the cover placement shall be recorded in the operating record as specified in Rule .0542(n).

5.3.2 Intermediate Cover

Areas which will not have additional wastes placed on them for three (3) months or more, but where final termination of disposal operations has not occurred, shall be covered and stabilized with vegetative ground cover or other stabilizing material as approved by the Division as specified in Rule .0542(f)(2).

5.4 Alternate Cover

Alternative materials of an alternative thickness (other than at least six inches of earthen material) may be approved by the Division if the owner or operator demonstrates that the alternative material and thickness control disease vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment.

WCA of High Point has previously requested and been given approval to use the 'fines' from their recycling/processing area (covered under a separate permit) for alternate weekly cover. These fines are a material generated during processing of C&D material and are largely composed of soil and minor fractions of the C&D waste stream.

In addition, WCA of High Point proposes to use mulch mixed with soil as an alternate weekly cover If a mixture of mulch and soil is used as an alternate cover, the mulch content of the weekly cover shall not exceed fifty percent (50%).

6.0 EROSION AND SEDIMENT CONTROL

Erosion and sediment will be controlled on the site to prevent the discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act. This includes, but is not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements, Section 402. In addition, the site shall not cause the discharge of nonpoint sources of pollution to waters of the United States, including wetlands, that violates any requirement 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. Surface water shall be diverted from the operational area and shall not be impounded over or in waste.

All vegetative and structural erosion and sediment control practices have been designed to prevent excessive on-site erosion and to prevent sediment from leaving the facility. All sediment control devices shall be constructed and maintained according to the North Carolina Erosion and Sediment Control Planning and Design Manual. A copy of the *WCA of High Point C&D Landfill, Phase 2 Expansion, Erosion and Sediment Control Plan* has been prepared and sent to the Land Quality Section for Approval. A copy of the Plan is included as Appendix EP-4 of the Engineering Plan, with drainage structures, slope drains, diversion berms and other pertinent details shown on drawings EP-4 and EP-8 through EP-10.

7.0 ENVIRONMENTAL MONITORING PLANS

Rule .0544 requires preparation of a Monitoring Plan which addresses groundwater monitoring, surface water monitoring, landfill gas monitoring, and waste acceptability program. The Monitoring Plan has been broken into several separate plans which are discussed as follows:

7.1 Groundwater Monitoring Plan

A Groundwater Monitoring Plan, including information on the proposed ground-water monitoring system(s), sampling and analysis requirements, and detection monitoring requirements that fulfills the requirements of Part (1)(A) through (1)(E) of Rule .0544(b) is included as the WCA of High Point C&D Landfill *Water Quality Monitoring Plan*, Appendix DH-E of the *Design Hydrogeologic Report*, prepared for the Phase 2 Expansion.

7.2 Surface Water Monitoring Plan

A Surface Water Monitoring Plan has been designed to detect the effects of the facility on surface water in the area in general accordance with Rule .0544(c). This plan is included as the WCA of High Point C&D Landfill *Water Quality Monitoring Plan*, Appendix DH-E of the *Design Hydrogeologic Report*, prepared for the Phase 2 Expansion.

7.3 Landfill Gas Control Plan

Landfill gas is a by-product from the decomposition of organic waste in a sanitary landfill. To protect public health and safety in the vicinity of the landfill, landfill gas produced by the decomposition of refuse will be controlled and monitored during the operational, closure, and post-closure periods. A gas management plan, including gas monitoring, will be implemented for the purpose of maintaining the concentration of methane gas below the following regulatory levels:

1) The concentration of methane gas generated is not to exceed 25 percent of the lower explosive limit (LEL) for methane in on-site structures (excluding gas control or recovery system components);
2) The concentration of methane gas is not to exceed the LEL for methane at the facility property boundary; and
3) The facility does not release methane gas or other explosive gasses in any concentration that can be detected in off-site structures.

The landfill gas management plan is currently proposed to include monitoring and passive gas vents in the landfill. Remedial measures will be implemented as required to mitigate a potential gas migration problem.

7.3.1 General

Landfill gas monitoring at the WCA of High Point C&D Landfill will be performed during the active life of the landfill and throughout the post-closure care period. At a minimum, quarterly monitoring will be conducted at all subsurface gas detection probes and in all structures located on the landfill property.

Gas detection probes will be installed on the site as shown on Drawing No. EP-5; additional probes shall be installed as additional phases are constructed. They will be designed to extend to a depth at least equal to the maximum depth of waste in the area of the monitoring point or the water table, whichever is encountered first. Probe locations will likely be field engineered due to varying topography adjacent to expansion areas that may limit access with a drill rig. A gas detection probe detail can be found on Drawing No. EP-7. Construction records for the gas probes will be submitted to the Division upon completion.

Passive landfill gas vents will be installed along with the final cover system to allow release of gas to the atmosphere. These vents will be installed at a density of approximately one per two acres of cap surface area. A construction detail of these vents is included on Drawing No. EP-7.

7.3.2 Landfill Gas Monitoring Procedure

Record Keeping: The operator will record the date, time, location, sampling personnel, atmospheric temperature, reported barometric pressure, and general weather conditions at the time of sampling, in addition to the concentration of combustible gases (See Boundary Gas Probe Monitoring Log, Appendix OP-2). The records will be maintained in the landfill operating record.

On-site Structures: Gas monitoring in on-site structures will be conducted during regular quarterly monitoring events at the earliest possible time after the structure has been unused (e.g., morning). The monitoring locations will be in corners along floors and ceilings, at cracks in the floor, and at other areas likely to accumulate gas. Gas monitoring will also be conducted in any confined space requiring the entry of personnel for maintenance or inspection. The monitoring will take place prior to entry by personnel in accordance with OSHA regulations.

Gas Detection Probes: Gas monitoring in detection probes will consist of attaching the monitor to each tubing within the probes, and recording both the initial concentration and steady state concentration of combustible gases. SWANA guidelines for purging wells and other monitoring procedures will be followed.

Equipment: A portable combustible gas monitor, measuring the concentration of combustible gases in units of percent of lower explosive limit, shall be used to conduct gas monitoring. Lower explosive limit (LEL) means the lowest percent by volume of a mixture of combustible gas in air that will propagate a flame at 25 degrees Celsius and atmospheric pressure. The gas monitor shall be calibrated to methane using the manufacturer's calibration kit and procedure before the monitoring activities begin.

7.3.3 Response to Landfill Gas Exceedances

The regulatory maximum levels for explosive gas are the LEL at the facility boundary and 25% LEL in on-site structures. At a minimum, the following actions will be taken if methane gas levels exceed those standards:

- The Solid Waste Section will be notified immediately;
- Immediate steps necessary to protect human health will be identified and implemented. If the standard in structures is exceeded, these will include:
  - Elimination of smoking materials and all ignition sources;
  - Evacuation of all personnel;
  - Ventilation of the structure;
- Personnel will not be allowed to reenter the building except to perform gas monitoring until the results of additional monitoring indicate that methane concentrations are stabilized below 25% LEL; and
- Assess the origin and pathways of the gas migration.

Within seven days of detection, the monitoring results will be placed in the Operating Record and WCA of High Point will indicate actions taken and actions proposed to resolve the problem. Within 60 days of detection, WCA of High Point will develop and implement a landfill gas remediation plan for the combustible gas releases and notify the Division that the plan has been implemented. The plan will describe the nature and extent of the problem and the proposed remedy.

8.0 SURVEY FOR COMPLIANCE

Within 60 days of the permittee's receipt of the Division's written request and as may be required by Rule .0542(m), WCA of High Point shall conduct a survey of active or closed portions of unit or units at the facility in order to determine whether operations are being conducted in accordance with the approved design and operational plans. The permittee shall report the results of such survey, including a map produced by the survey, to the Division within 90 days of receipt of the Division's request. The survey shall be performed by a registered land surveyor duly authorized under North Carolina law to conduct such activities.

The survey may be required by the Division:

1) If there is reason to believe that operations are being conducted in a manner that deviates from the plan listed in the effective permit, or
2) As a verification that operations are being conducted in accordance with the plan listed in the effective permit.

9.0 RECORDKEEPING REQUIREMENTS

The owner and operator of a C&D Landfill shall record and retain at the facility, or in an alternative location near the facility approved by the Division, in an operating record the following information which shall be furnished to the Division according to the permit or upon request, or be made available for inspection by the Division:

- Records of random waste inspections, monitoring results, certifications of training, and training procedures required by Rule .0544 and Section 4.3 of this Plan;
- Amounts by weight of solid waste received at the facility to include, County of generation, consistent with NCGS 130A-309.09D and as required by Section 4.4 of this Plan;
- Any demonstration, certification, finding, monitoring, testing, or analytical data required by Rules .0544 through .0545 and the facility *Water Quality Monitoring Plan;*
- Any closure or post-closure monitoring, testing, or analytical data as required by Rule .0543 and the facility *Closure/Post-Closure Care Plan;*
- Any cost estimates and financial assurance documentation required by Rule .0546;
- Notation of date and time of placement of cover material; and
- All audit records, compliance records and inspection reports.

The operating record shall also include:

- A copy of the approved operation plan required by 15A NCAC 13B .0542 and the engineering plan required by Rule .0539 of this Section;
- A copy of the current Permit to Construct and Permit to Operate; and
- The Monitoring Plan, in accordance with Rule .0544 of this Section.

(end.)

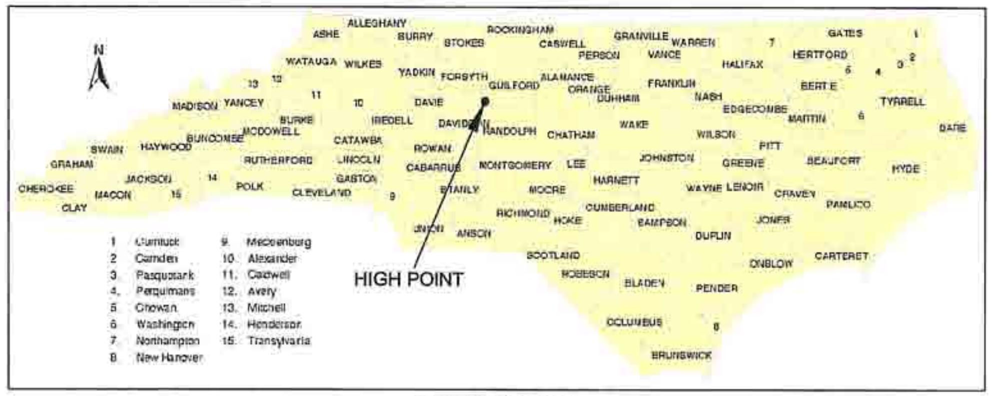
DRAWINGS

WCA OF HIGH POINT C&D LANDFILL

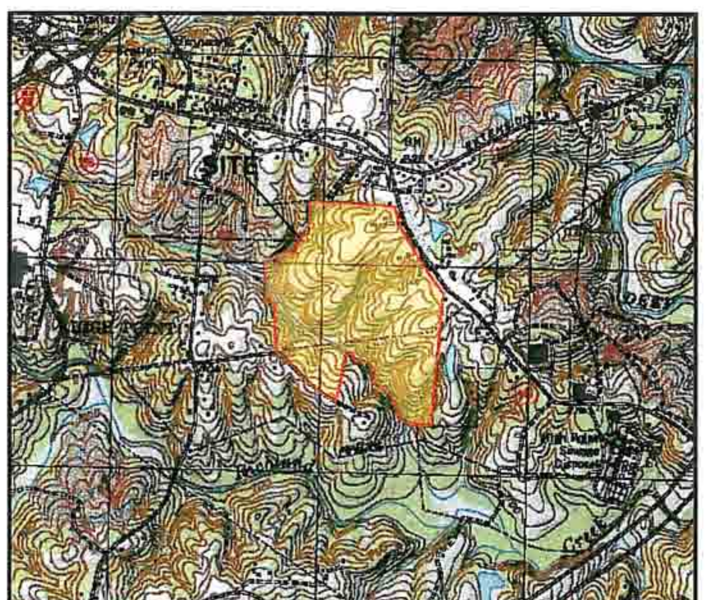
GUILFORD COUNTY, NORTH CAROLINA

APPLICATION FOR PERMIT TO CONSTRUCT PHASE 2 EXPANSION

OPERATIONS PLAN



NORTH CAROLINA
COUNTY LOCATION MAP



VICINITY MAP
NOT TO SCALE

SATELLITE IMAGE
1" = 500'

PREPARED BY:

Golder Associates
Greensboro, NC

DETAIL/SECTION IDENTIFICATION LEGEND

Section Letter — A / 05 — SECTION — TITLE OF SECTION — SCALE: 1" = 1'
Sheet on Which Above Section is Presented

Detail Number — 1 / 06 — DETAIL — TITLE OF DETAIL — SCALE: 1" = 1'
Sheet on Which Above Detail is Presented

NOTES: ABOVE REFERENCING SYSTEM ALSO APPLIES TO PLAN IDENTIFICATIONS.

DRAWING NO.	DESCRIPTION
OP-0	COVER SHEET
OP-1	EXISTING CONDITIONS PLAN
OP-2	ANNUAL PHASING PLAN
OP-3	STORMWATER MANAGEMENT PLAN

Golder Associates
Greensboro, NC

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

TITLE
COVER SHEET

PROJECT No.		063-6526
FILE No.		
REV. 1	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. OP-0

LEGEND

EXISTING 10 FT. CONTOUR	
EXISTING 2 FT. CONTOUR	
PROPERTY LINE	
STREAM	
TREELINE	
EXISTING ROAD	
LIMIT OF WASTE (PERMITTED)	
MONITORING WELL LOCATION IDENTIFICATION	MW-3
SPRINGHEAD LOCATION AND IDENTIFICATION	SPRINGHEAD
BENCH MARK	BM-1
SEDIMENT BASIN	SB-1

NOTE:

1. DRAWING BASED ON SITE PLAN PREPARED BY JOYCE ENGINEERING, INC. DATED JULY 7, 2004.

2. BASE DIGITAL MAPPING WITHIN THE BOUNDARY SHOWN BY SPATIAL DATA CONSULTANTS INC. DATE OF AERIAL FLYOVER 3/27/01.

3. DIGITAL MAPPING OUTSIDE BOUNDARY PROVIDED BY THE CITY OF HIGH POINT DEPARTMENT OF PLANNING AND DEVELOPMENT. DATE OF AERIAL FLYOVER 1998.

4. EXISTING CONDITIONS SHOW PHASE 1 FILLED TO PERMITTED GRADES.

Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

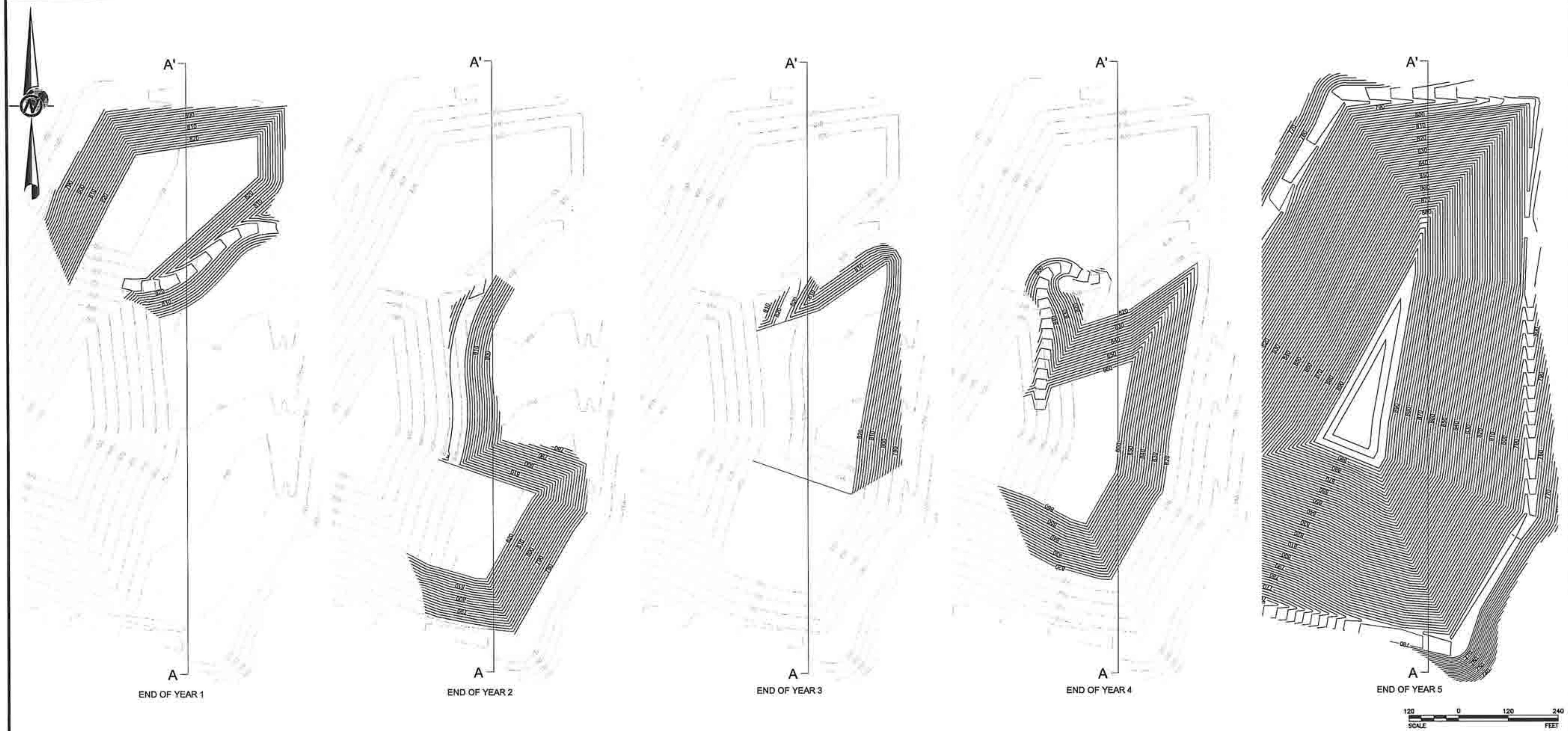
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

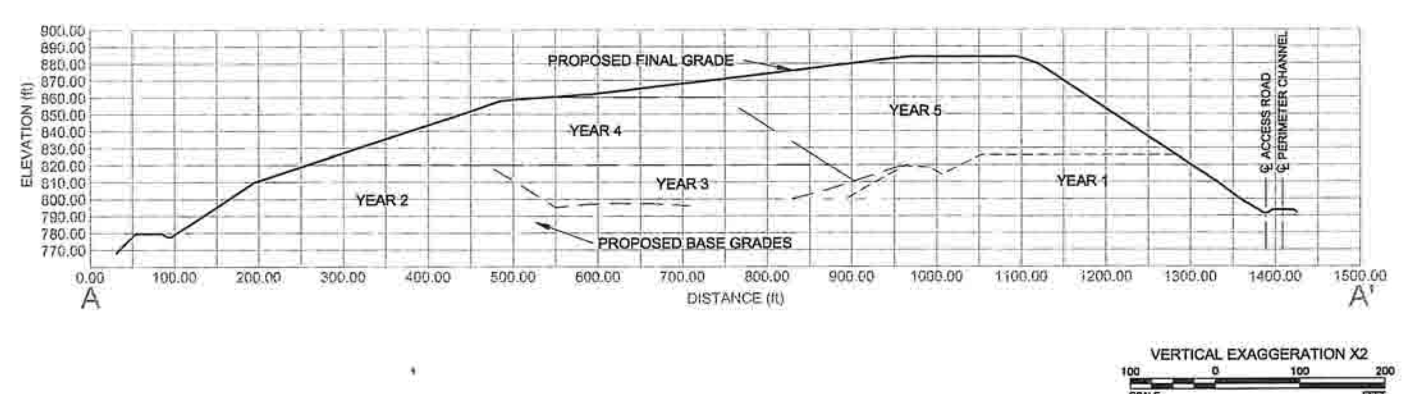
TITLE

EXISTING CONDITIONS PLAN

PROJECT No.		063-6526
FILE No.		
REV.	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. OP-1





Golder Associates
GREENSBORO, NORTH CAROLINA

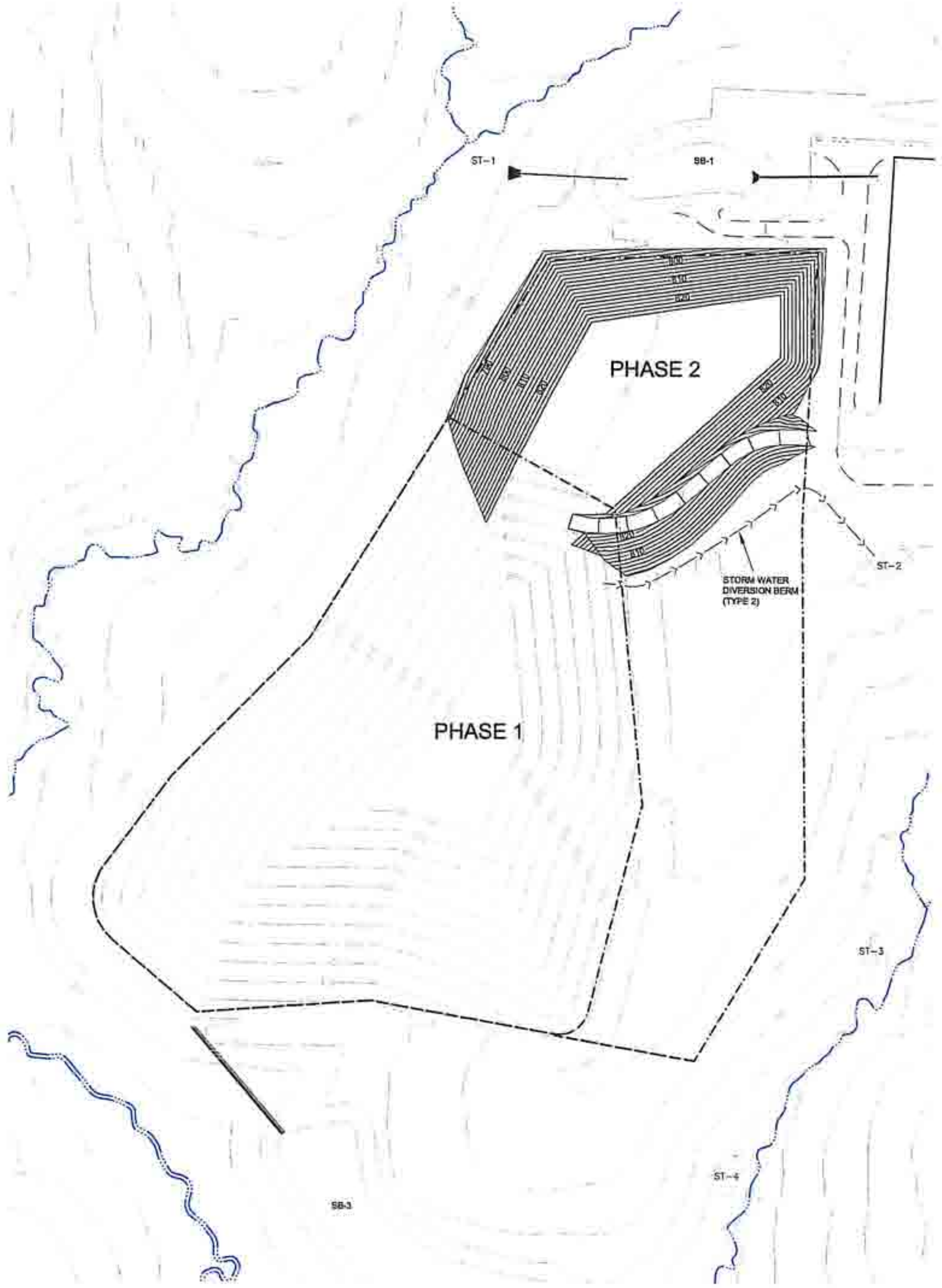
REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
WCA OF HIGH POINT
CONSTRUCTION AND
DEMOLITION DEBRIS
LANDFILL AND RECLAMATION
FACILITY
GUILFORD COUNTY, NC

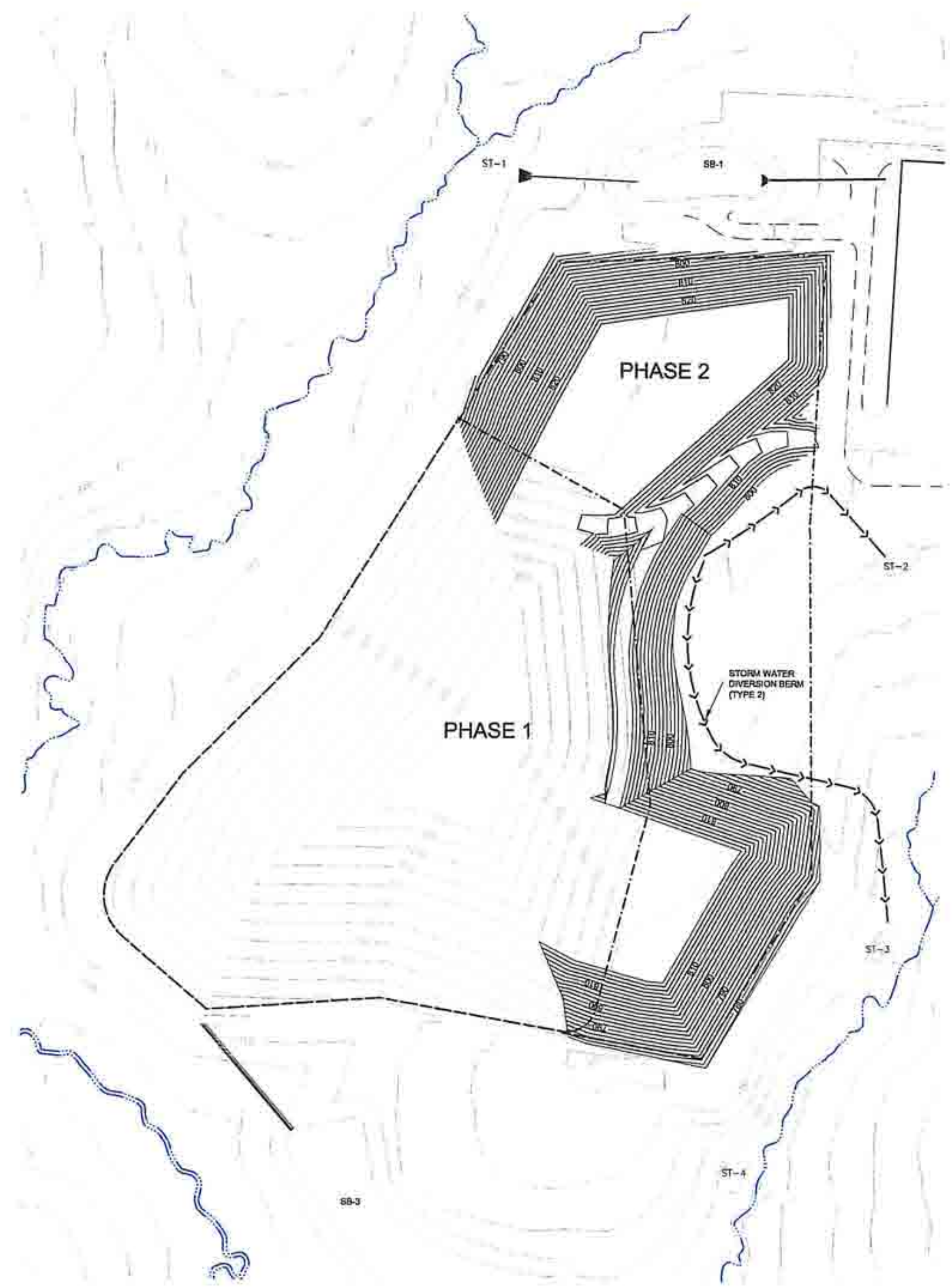
TITLE
ANNUAL PHASING PLAN

PROJECT No.		063-6526
FILE No.		
REV.	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

DWG. OP-2



END OF YEAR 1



END OF YEAR 2

Golder Associates
GREENSBORO, NORTH CAROLINA

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

WCA OF HIGH POINT CONSTRUCTION AND DEMOLITION DEBRIS LANDFILL AND RECLAMATION FACILITY
GUILFORD COUNTY, NC

TITLE

STORM WATER MANAGEMENT PLAN

PROJECT No.		063-6526
FILE No.		0636526A OP-3
REV.	SCALE	AS SHOWN
DESIGN	CH	12/19/06
CADD	JDS	12/19/06
CHECK		
REVIEW		

125 0 125 250
SCALE FEET

DWG. OP-3

OP-1

RANDOM WASTE INSPECTION FORM

FACILITY: ____________________ PERMIT NO.: ____________________

LOCATION: ____________________ DATE: ____________________

INSPECTOR: ____________________

Waste Name(s) & Address(es)

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

Waste Hauler: ____________________

Address: ____________________

Driver's Name: ____________________

Waste Accepted ☐ Waste Rejected ☐ Waste Held ☐

Notified: Waste Source ☐ Hauling Management ☐ Site Management ☐

State ☐ Federal ☐

Personnel Conducting the Inspection: ____________________

____

Supervisor Conducting the Inspection: ____________________

SIGNATURE: ____________________

Witness: ____________________

SIGNATURE: ____________________

Driver: ____________________

SIGNATURE: ____________________

Other: ____________________

Company: ____________________ Title: ____________________

SIGNATURE: ____________________

DATE: ____________________ Time: ____________ AM☐ PM☐

ADDITIONAL COMMENTS: see pages 2 - 3

RANDOM WASTE INSPECTION FORM

INSPECTION CHECK LIST: (Check all that apply)

(If "YES", please explain in the space provided below)

	YES	NO
1. Powders/Dusts	____	____
Identified: ____________________		
Unknown	____	____
2. Unacceptable Saturation	____	____
3. Odor/Fumes	____	____
Strong	____	____
Faint	____	____
Describe: ____________________		
4. Heat	____	____
Item: ____________________		
5. Battery	____	____
6. Oil	____	____
7. Biomedical	____	____
8. Radioactivity	____	____
9. Ashes/Residue	____	____
10. Sod/Soil	____	____
11. Asbestos (not properly contained)	____	____
12. PCB	____	____
13. Out of Area Waste	____	____

Explanation:

____

____

____

____

____

____

RANDOM WASTE INSPECTION FORM

REJECTED/UNIDENTIFIED WASTE

REJECTABLE WASTE DESCRIPTION: ______________________________

____

____

____

WASTE:	Rejected ☐	Accepted ☐	
NOTIFIED:	Waste Source ☐	Hauling Management ☐	
	Site Management ☐	State ☐	Federal ☐

REJECTED WASTE TRANSPORTED BY:

Hauler Address: ______________________________

____

Destination: ______________________________

____

ACCEPTED WASTE:

Contained area: ______________________________

Secured by: ______________________________

Lab to complete testing: ______________________________

ADDITIONAL COMMENTS: ______________________________

____

____

____

____

____

OP-2

BOUNDARY GAS PROBE MONITORING LOG

PROJECT NAME: WCA of High Point

PERSONNEL PERFORMING MONITORING:

SITE CONTACT:

DATE:

WEATHER CONDITIONS START (Temp. and Baro.):

WEATHER CONDITIONS END (Temp. and Baro.):

Probe No. / Structure ID	Static Pressure (inches of Water)	Methane (Percent)	Time	Comments

Monitoring Device and Serial No.:	

CLOSURE & POST
CLOSURE CARE PLAN

CLOSURE/POST CLOSURE CARE PLAN

WCA OF HIGH POINT

CONSTRUCTION AND DEMOLITION LANDFILL

PHASE 2 EXPANSION

PERMIT NO. 41-16

GUILFORD COUNTY, NORTH CAROLINA

Prepared for:

WCA of High Point , LLC
5830 Riverdale Drive
Jamestown, North Carolina 27282

Prepared by:

Golder Associates NC Inc.
4900 Koger Boulevard, Suite 140
Greensboro, North Carolina 27407

March 2007

Project No.: 063-6526

CLOSURE/POST CLOSURE PLAN
WCA OF HIGH POINT C&D LANDFILL
CONSTRUCTION AND DEMOLITION LANDFILL

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

Pursuant to the North Carolina Solid Waste Management Rules (15A NCAC 13B), this Closure and Post-Closure Plan is submitted as part of the permit amendment application to construct Phase 2 of the WCA of High Point C&D Landfill in Guilford County, North Carolina.

The permitted WCA of High Point C&D Landfill encompasses approximately 154 acres, 49.2 of which are approved for unlined capacity by the Solid Waste Section of North Carolina (Division). The approved lined capacity acreage has been subdivided into seven (7) five-year Phases. The facility is currently operating in Phase 1. Construction of Phase 1 was completed in phases; construction of the last cell of Phase 1 was completed on April 2006.

The facility will be closed in accordance with the requirements of Rule .0543 of the North Carolina Solid Waste Management Rules (15A NCAC 13 B). The facility may be capped in one construction event or in phases as described below.

2.0 CAP DESIGN

The proposed closure cap has been designed to minimize infiltration and erosion. Components of the proposed closure cap are discussed as follows. Cross sectional details of the proposed cap and the alternate cap are provided on Drawing No. EP-7.

Intermediate Cover: On-site soils will be used to provide a minimum 12 inches of intermediate cover over landfilled materials and a base for cap construction.

Passive Gas Vents – Passive gas vents will be installed at a frequency of one per two acres of cap. A typical passive gas vent is detailed on Drawing No. EP-7. Passive venting of landfill gas will protect the integrity of the cap by preventing excessive pressure buildup beneath the cap.

Gas Migration Layer – A geonet composite will be installed between the intermediate cover and the overlying infiltration layer. The geonet composite will provide a pathway for accumulated gas to move laterally and then upward through the vents at the landfill surface.

Infiltration Barrier: The infiltration layer is proposed to consist of either (1) 18 inches of compacted soil with a permeability no greater than $1x10^{-5}$ cm/sec, or (2) a 40-mil FML cap (alternate cap). This layer will be constructed over the geonet composite that will serve as the gas migration layer. In the case of soil, the permeability requirement will be achieved using laboratory test data for borrow soil material, and construction specifications developed prior to construction. Installation and testing requirements for the infiltration barrier are provided in the Specifications and the CQA Plan.

Drainage Layer: A geomembrane cap is proposed as an alternate to a soil cap. If the geomembrane alternate is used, a geosynthetic drainage layer consisting of a geonet and geotextile composite will be placed over the geomembrane to promote drainage.

Erosion Layer: The erosion layer will consist of a minimum eighteen (18) inches of moderately compacted soil. The final six inches of material will consist of topsoil or organically amended soil capable of sustaining native plant growth.

Vegetation - After placement of the erosion layer, the area will be seeded. Seeding will be accomplished in accordance with the "North Carolina Erosion and Sediment Control Planning and Design Manual", and recommendations from the Cooperative Extension Office. Mulch and erosion matting will be used as needed to control erosion and promote vegetative growth. The vegetative cover will be inspected regularly. Areas found to be sparsely covered will be revegetated.

3.0 CAP STABILITY

Stability of the final cover system will be affected by material selection, settlement, and freeze thaw and is discussed below:

3.1 Stability

Stability of the proposed cap and alternate cap was evaluated as discussed in the Engineering Plan. The proposed design was found to be stable at slopes as steep as 3 Horizontal to 1 Vertical (3H:1V).

3.2 Settlement

Non-uniform settlement can be expected over the entire waste footprint. The primary mechanism of settlement is waste consolidation due to decomposition of the landfilled material. According to Daniel, et al, long-term settlement is typically 5 to 15 percent over 20 to 30 years; however, the majority of this settlement (approximately 5%) is expected to occur in the first few months following waste placement. Post settlement slopes have been designed to be a minimum of five percent.

3.3 Freeze Thaw

Based on a published map of frost depths throughout the United States (EPA, November 1993: A530-R-93-017), the anticipated maximum depth of freeze/thaw effects on the site is less than or equal to 18 inches. Since the thickness of erosion layer is a minimum of 18 inches, freeze/thaw is not expected to affect the performance of the proposed cap or alternate cap.

3.4 Inspection

Quarterly inspections of the final cover will be conducted to look for areas of the cap that might be damaged. Should these inspections indicate problem areas, (ponding, erosion rills, cap displacement, etc.), repairs will be initiated as soon as practical.

4.0 WASTE VOLUME

The total footprint of Phase 1 is 12.1 acres. The total airspace of Phase 1 has been estimated as 797,243 cubic yards. An estimate of the total airspace in Phase 2 is 907,155 cubic yards. After allowing for daily/intermediate cover, cap and soil protective cover, an estimated total of 1,466,551 cubic yards of waste will have been disposed of at the facility. Supporting calculations are included in Appendix CP-1. The calculation is based on the volume between proposed top of base grades and final grades, and assumptions regarding the density of waste and cover soil in the fill.

5.0 CLOSURE

5.1 Closure Schedule

Prior to beginning closure of any portion of the facility, WCA of High Point will notify the Division that a notice of intent to close the facility or portion of the facility has been placed in the operating record.

WCA of High Point shall begin closure activities of each C&D landfill (LF) unit as required by Rule .0543(c)(5) no later than 30 days after the date on which the C&DLF unit receives the known final receipt of wastes, no later than 30 days after the date that a 10 acre or greater area of waste is within 15 feet of design grades, or no later than one year after the most recent receipt of wastes, if the C&DLF unit has remaining capacity. Extensions beyond the deadline for beginning closure may be granted by the Division if the owner or operator demonstrates that the portion of the C&DLF unit has the capacity to receive additional wastes and the owner and operator has taken and will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed C&DLF unit.

WCA of High Point shall complete closure activities of each C&DLF unit in accordance with this Plan within 180 days following the beginning of closure as specified above. Extensions of the closure period may be granted by the Division if the owner or operator demonstrates that closure will, if necessary, take longer than 180 days and that they will continue to take all steps necessary to prevent threats to human health and the environment from the unclosed C&DLF unit.

An itemized list of closure activities and a proposed schedule follow.

Activity	Proposed Timeframe (in days following last receipt of waste)
Grade Intermediate Cover	0 - 30
Survey	15 - 45
Place Cap	45 - 135
Place Erosion Layer	75 - 150
Seeding (Permanent)*	100 - 180
Prepare and Submit Closure Certification	150-210

*Depending on the time of year, permanent seeding may need to be delayed up to three months. In that event, temporary seeding shall be placed within the specified time frame.

5.2 Certification

Following closure of each unit or portions of units, the owner and operator shall notify the Division that a certification, signed by the project engineer verifying that closure has been completed in accordance with the closure plan, has been placed in the operating record. This Certification will state that the site was closed in accordance with the Closure Plan and applicable solid waste regulations and laws as required by Rule .0543(c)(7).

5.3 Recordation

Following closure of all C&DLF units, the owner and operator shall record a notation on the landfill facility property deed, or some other instrument that is normally examined during a title search, 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 C&DLF unit or facility and its use is restricted under the Closure Plan as required by Rule .0543(c)(8).

5.4 Closure Cost Estimate

An estimate of closure costs is provided in Appendix CP-2. All costs are given in 2006 dollars.

6.0 POST-CLOSURE ACTIVITIES

Post-closure activities will be conducted at the landfill in accordance with Rule .0543 for a period of 30 years following closure of the landfill. The Division may decrease the length of the post-closure period if the owner or operator demonstrates that the reduced period is sufficient to protect human health and the environment, and the Division approves this demonstration. The period might be increased by the Division if the Division determines that the lengthened period is necessary to protect human health and the environment.

6.1 Contact

The person responsible for the facility during the post-closure care period is:

Site Manager
5830 Riverdale Drive;
Jamestown, North Carolina 27282
336.886.3560

6.2 Post-Closure Maintenance

Post-closure maintenance and monitoring will be conducted at the WCA of High Point C&D Landfill for a period of 30 years after final closure. Monitoring will include semi-annual sampling of groundwater and surface water, quarterly gas monitoring and quarterly inspection of the final cover and monitoring and control systems. Maintenance needs identified through the monitoring program will be initiated no later than 60 days after the discovery, and within 24 hours if a danger or eminent threat to human health or the environment is indicated.

6.3 Inspection Plan

Routine inspections will be conducted throughout the post-closure care period. These inspections will be carried out quarterly unless problems are detected that indicate that more frequent visits are warranted. Potential impacts to the public and environment will be considered in determining the inspection frequency. Items to be included in the monthly inspection will be as follows:

- Access and security control;
- Cap System;

- Stormwater management;
- Erosion and sediment control;
- Gas management;
- Groundwater and landfill gas monitoring systems;
- Integrity of site benchmarks; and
- Vector control.

Sample inspection forms that can be used during each inspection are included as Appendix CP-3. Completed copies of the inspection forms will be kept by the owner, and copies will be forwarded to the Division for its records.

6.4 Cap System Integrity

WCA of High Point shall maintain the integrity and effectiveness of any and all cap systems including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cap system.

6.5 Monitoring Plan

Rule .0544 requires preparation of a Monitoring Plan which addresses groundwater monitoring, surface water monitoring, landfill gas monitoring, and waste acceptability program. The Monitoring Plan has been broken into several separate plans which are discussed as follows.

6.5.1 Groundwater Monitoring Plan

A Groundwater Monitoring Plan, including information on the proposed ground-water monitoring system(s), sampling and analysis requirements, and detection monitoring requirements that fulfills the requirements of Part (1)(A) through (1)(E) of Rule .0544(b) has been prepared. This plan is included as the WCA of High Point C&D Landfill *Water Quality Monitoring Plan*, Appendix DH-E of the *Design Hydrogeologic Report*, prepared for the Phase 2 Expansion. Groundwater monitoring shall continue throughout the Post-closure period in accordance with the approved Plan.

6.5.2 Surface Water Monitoring Plan

A Surface Water Monitoring Plan has been designed to detect the effects of the facility on surface water in the area in general accordance with Rule .0544(c). This plan is included as the WCA of High Point C&D Landfill *Water Quality Monitoring Plan*, Appendix DH-E of the *Design Hydrogeologic Report*, prepared for the Phase 2 Expansion. Surface Water monitoring shall continue throughout the Post-closure period in accordance with the approved Plan.

6.5.3 Gas Monitoring Plan

A Gas Control Plan is included as Section 7.3 of the facility *Operations Plan*. Landfill Gas monitoring shall continue throughout the Post-closure period in accordance with the approved Plan.

6.6 Post Closure Land Use

The primary land use for the site after closure of the landfill will be open dormant green space. Limited passive recreational uses may be proposed at a later time. Post-closure use of the property shall not disturb the integrity of the cap system, base liner system, or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in the Solid Waste Management Rules. The Division may approve disturbance if the owner or operator demonstrated that disturbance of the cap system, base liner system, or other component of the containment system, including removal of waste, will not increase the potential threat to human health or the environment.

6.7 Post Closure Care Costs

An estimate of post-closure care costs is provided in Appendix CP-4. All costs are given in 2006 dollars.

6.8 Completion of Post Closure Care

Following completion of the post-closure care period for the facility, WCA of High Point shall notify the Division that a certification, signed by a registered professional engineer licensed in the state of North Carolina, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record.

(end)

Waste Inventory
WCA of High Point Landfill

PHASE CAPACITIES

PHASE	AREA (acres)	AIRSPACE (cy)	CAP (cy)	DAILY AND INT. COVER (cy)	WASTE VOLUME (cy)	WASTE QUANTITY (ton)
1	12.1	797,243	92,590	33,555	671,098	458,025
2	9.4	907,155	71,929	39,773	795,453	542,897
Total	21.5	1,704,398	164,519	73,328	1,466,552	1,000,921

Design Criteria

Cap Thickness	4.5	(includes intermediate cover)
Waste to Cover Ratio	20 to 1	

CP-2

Facility Name:	WCA of High Point C&D Landfill Phase 2 Expansion
Permit No.:	41 - 16
Facility Address:	5830 Riverdale Drive Jamestown, North Carolina 27282
Facility Owner:	WCA of High Point, LLC

Date:	12/16/06
Calculated By:	CDH
Reviewed By:	CJS/DBM
Revision No.:	0
Project No.:	063-6526
Phase No.:	101

Golder Associates
4900 Koger Blvd, Suite 140
Greensboro, North Carolina 27407
phone - 336.852.4903
fax - 336.852.4904
www.golder.com

CLOSURE COSTS:

			Notes & Guidance Values	
I. Native Soil for Slope and Fill (Site Preparation)				
a.	Area to be capped	21.5	acre	22 acre
b.	Unit cost for recompacting and grading	500	/ acre	500.00 / acre
c.	*Cost for recompacting and grading*		(a x b)	$10,750
d.	Unit cost for subgrade preparation	500	/ acre	500.00 / acre
e.	*Cost for subgrade preparation*		(a x d)	$10,750.00 /yd³
o.	*Total native soil cost*		(c + e)	**$21,500.00**
II. Topsoil				
a.	Area to be capped	21.5	acres x 4840 yd2/acre =	104,060 yd²
b.	Depth of topsoil needed	6	inches x 1 yd/ 36 inches =	0.17 yd
c.	Quantity of topsoil needed		(a x b)	17,343 yd³
d.	Percentage of soil from off-site		0	0%
e.	Excavation unit cost (on-site material)		$2.50	$2.50 /yd³
f.	Purchase unit cost (off-site material)		-	- /yd³
g.	Delivery Cost (off-site material)		$8.00/yd3 for 5 mil RT	$8.00 /yd³
h.	Placement/Spreading unit cost		included in e.	included in e. /yd³
i.	Compaction unit cost		included in e.	included in e. /yd³
j.	Total on-site topsoil unit cost		(e + h + i)	$2.50 /yd³
k.	Total off-site topsoil unit cost		(f + g + h + i)	- /yd³
l.	Total on-site topsoil cost		[j x (1-d) x c]	$43,358
m.	Total off-site topsoil cost		(c x d x k)	$0
n.	Percent compaction		10%	10%
o.	*Total topsoil cost*		(l + m) * (1 + n)	**$47,694.17**
III. Drainage Layer				
a.	Area to be capped		acres x 4840 yd2/acre =	0 yd²
b.	Depth of sand or gravel needed		inches x 1yd/ 36 inches =	0.00 yd
c.	Quantity of sand or gravel needed		(a x b)	0 yd³
d.	Purchase unit cost		$6.90	$6.90 /yd³
e.	Delivery cost (for off-site material)		$7.85/yd3 for 10 mil RT	$7.85 /yd³
f.	Spreading unit cost		$1.39	$1.39 /yd³
g.	Compaction unit cost		$0.12	$0.12 /yd³
h.	Percent compaction		sand = 10%, gravel = 5%	10 %
i.	Total drainage layer unit cost		(d + e + f + g)	$16.26 /yd³
j.	*Total drainage layer cost*		[c x i x (1+h)]	**$0.00**
IV. On-Site Clay				
a.	Area to be capped	0.0	acres x 4840 yd2/acre =	0 yd²
b.	Depth of clay needed	18	inches x 1 yd/ 36 inches =	0.50 yd
c.	Quantity of clay needed		(a x b)	0 yd³
d.	Excavation unit cost		$2.50	$2.50 /yd³
e.	Placement/Spreading unit cost		$1.25	$1.25 /yd³
f.	Compaction unit cost		$0.85	$0.85 /yd³
g.	Total on-site clay unit cost		(d + e + f + g)	$4.60 /yd³
h.	Percent compaction		25%	25 %
i.	*Total on-site clay cost*		[c x g x (1 + h)]	**$0.00**
V. Off-Site Clay				
a.	Area to be capped (1acre=4840yd²)		acres x 4840 yd2/acre =	0 yd²
b.	Depth of clay needed (6" = 0.16 yd)		inches x 1yd/ 36 inches =	0.00 yd
c.	Quantity of clay needed (a x b)		(a x b)	0 yd³
d.	Purchase unit cost		$5.35	$5.35 /yd³
e.	Delivery cost (for off-site material)		$7.85/yd3 for 10 mil RT	$7.85 /yd³
f.	Spreading unit cost		$1.39	$1.39 /yd³
g.	Compaction unit cost		$0.82	$0.82 /yd³
h.	Total off-site clay unit cost		(d + e + f + g)	$15.41 /yd³
i.	Percent compaction		25%	25 %
j.	*Total on-site clay cost*		[c x h x (1 + i)]	**$0.00**
VI. Drainage Pipe				
a.	Length of pipe needed		5900	5900 LF
b.	Pipe unit cost		$22.00	$22.00 /LF
c.	Trenching and backfilling cost		$8.00	$8.00 /LF
d.	Total drainage pipe unit cost		(b + c)	$30.00 /LF
e.	*Total drainage pipe cost*		(a x d)	**$177,000.00**
VII. Synthetic Membrane				
a.	Area to be capped with FML	21.5	acres x 43560 ft2/acre =	936,540 ft²
b.	Purchase unit cost		$0.26	$0.26 /ft²
c.	Taxes unit cost		$0.02	$0.02 /ft²
d.	Installation unit cost		$0.12	$0.12 /ft²
e.	Total synthetic membrane unit cost		(b + c + d)	$0.40 /ft²
f.	*Total synthetic membrane cost*		(a x e)	**$374,616.00**
VIII. Geotextile Filter Fabric				
a.	Quantity of filter fabric needed	0.0	acres x 43560 ft2/acre =	0 ft²
b.	Purchase unit cost		$0.20	$0.20 /ft²
c.	Taxes unit cost		$0.00	$0.00 /ft²
d.	Installation unit cost		$0.00	$0.00 /ft²
e.	Total synthetic membrane unit cost		(b + c + d)	$0.20 /ft²
f.	*Total geotextile filter fabric cost*		(a x e)	**$0.00**

Notes:
Guidance values attained from similar projects.
Material Costs for Geosynthetics include Delivery.

			Notes & Guidance Values	
VIII-a. Geonet Composite				
a.	Quantity of Geonet Composite needed	43.0	acres x 43560 ft2/acre =	1,873,080 ft²
b.	Purchase unit cost		$0.24	$0.24 /ft²
c.	Taxes unit cost		$0.02	$0.02 /ft²
d.	Installation unit cost		$0.11	$0.11 /ft²
e.	Total geonet composite unit cost		(b + c + d)	$0.37 /ft²
f.	*Total geonet composite cost*		(a x e)	**$693,039.60**
VIII-b. Geosynthetic Clay Liner				
a.	Quantity of GCL needed	0.0	acres x 43560 ft2/acre =	0 ft²
b.	Purchase unit cost		$0.00	$0.00 /ft²
c.	Taxes unit cost		$0.00	$0.00 /ft²
d.	Installation unit cost		$0.09	$0.09 /ft²
e.	Total GCL unit cost		(b + c + d)	$0.09 /ft²
f.	*Total GCL cost*		(a x e)	**$0.00**
IX. Soil Admixture				
a.	Area to be capped		acres x 4840 yd2/acre =	0 yd²
b.	Soil admixture unit cost		$2.57	$2.57 /yd²
c.	*Total soil admixture cost*		(a x b)	**$0.00**
X. Protective Soil Cover / Vegetative Cover				
a.	Area to be capped	21.5	acres x 4840 yd2/acre =	104,060 yd²
b.	Depth of soil needed	18	inches x 1yd/ 36 inches =	0.50 yd
c.	Quantity of soil needed		(a x b)	52,030 yd³
d.	Percentage of soil from off-site		0	0%
e.	Excavation unit cost (on-site material)		$2.50	$2.50 /yd³
f.	Purchase unit cost (off-site material)		-	/yd³
g.	Delivery Cost (off-site material)		$8.00/yd3 for 5 mil RT	$8.00 /yd³
h.	Placement/Spreading unit cost		included in e.	included in e. /yd³
i.	Compaction unit cost		included in e.	included in e. /yd³
j.	Total on-site soil unit cost		(e + h + i)	$2.50 /yd³
k.	Total off-site soil unit cost		(f + g + h + i)	$8.00 /yd³
l.	Total on-site soil cost		[j x (1-d) x c]	$130,075
m.	Total off-site soil cost		(c x d x k)	$0
n.	Percent compaction		10%	10%
o.	*Total protective soil cover cost*		(l + m) * (1 + n)	**$143,082.50**
XI. Soil Testing / Construction Quality Assurance				
a.	Number of acres to be capped		21.5	21.5 acres
b.	Testing unit cost (Includes density & permeability tests and technician)		$5,000.00	$5,000.00 /acre
c.	*Total Soil Testing Unit Cost*		(a x b)	**$107,500.00**
XII. Vegetative Cover				
a.	Number of acres to be vegetated		21.5	21.5 acres
b.	Unit cost for preparation, seeding, and fertilization		$1,250.00	$1,250.00 /acre
c.	*Total Vegetative Cover Cost*		(a x b)	**$26,875.00**
XIII. Landfill Gas (LFG) Management System				
a.	Number of acres of landfill to be closed		21.5	21.5 acres
b.	Number of LFG detection probes to be installed		0	0 probes
c.	Average number of LFG vents required per acre		0.5	0.5 /acre
d.	Length of LFG detection probe in linear feet		0	100 LF
e.	Average cost per LFG vent		$5,000.00	$5,000 /event
f.	LFG detection probe unit cost		$40.00	$40.00 /LF
g.	Total cost for LFG vents		(a x c x e)	$53,750
h.	Total cost for LFG detection probes		(b x d x f)	$0
i.	*Total gas management cost*		(g + h)	**$53,750.00**
XIV. Groundwater monitoring system				
a.	Hydrogeologic study		$10,000 or as needed	$0
b.	Monitoring well construction/well		$1,225 per well	$1,225.00 /well
c.	Number of wells to be installed		0	0 wells
d.	Additional well length of 50'		0	0 LF
e.	Unit cost for additional well length over 50'		$22.00	$22.00 /LF
f.	Total additional cost for well length over 50'		(e x d)	$0
g.	Total monitoring well construction cost		(b x c)	$0
h.	*Total Groundwater monitoring system cost*		(a + e + f)	**$0.00**
XV. Mobilization/demobilization				
a.	*Cost for mobilization/demobilization*		assumes 1 event	**$50,000.00**
XVI. Survey and deed notation				
a.	*Cost for survey and deed notation*		assumes $2,500/acre	**$53,750.00**
XVII. Closure Certification				
a.	*Closure certification costs*		$35,500 or as needed	**$35,000.00**
XVIII. Miscellaneous Costs to Close				
a.	*Erosion Control*		$50,000 or as needed	**$50,000.00**
b.	*Storm Water Control (diversion berms and drainage ditches)*			**$50,000.00**
c.	*Drainage Layer Piping*			**$0.00**
d.	*Anchor Trench*			**$0.00**
e.	*Tie-in Seams*			**$0.00**
f.	*Geosynthetic Boots*			**$5,375.00**

Total Construction Closure Costs

Total Unadjusted Closure Costs	**$1,645,057**
City Cost Index (CCI)	**100.0**
Total Adjusted Closure Costs CCI x (I..XIV)	**$1,645,057**
Closure Cost-Estimate Subtotal (Total adj. closure costs +XV + XVI + XVII + XVIII)	**$1,889,182**
Contingency (10%)	$188,918
Engineering Fees Permitting and Construction Documents	$50,000
Total 2006 Closure Cost (through Phase 2)	$\boxed{\$2,128,100}$
Total Area to be capped	21.5 acres
Approximate closure cost per acre	**$98,981 /acre**

CP-3

POST-CLOSURE INSPECTION RECORD

FACILITY:	____________	PERMIT NO.	____________
LOCATION:	____________	DATE:	____________
INSPECTOR:	____________	COMPANY:	____________

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1. Access and Security Control

- ☐ Is a notice prohibiting the further disposal of waste materials clearly visible at the entrance to the facility?
- ☐ Is the site adequately secured by means of gates, chains, berms, fences or other security measures to prevent unauthorized entry?
- ☐ Are the access roads to and within the site maintained to provide access to the closed disposal area and to all monitoring points?

2. Erosion and Sediment Control

- ☐ Is the vegetation adequate to stabilize the site and prevent erosion?
- ☐ Are the erosion control measures adequate to prevent silt from leaving the site and to prevent_excessive on-site erosion?
- ☐ Do the sediment basins require cleaning out, as indicted by the level of sediment buildup?

3. Drainage Control Requirements

- ☐ Are all areas adequately sloped to promote surface water runoff in a controlled manner?
- ☐ Are there areas of observed settlement, subsidence, and/or displacement of the closure cap?
- ☐ Are all drainage channels free of accumulated sediment?

4. Uncontrolled Escape of Leachate or Landfill Gas

- ☐ Are there any leachate seeps observed?
- ☐ Are there any signs of uncontrolled releases of landfill gas?

5. Environmental Monitoring Systems

- ☐ Are all monitoring wells (gas and groundwater) properly maintained? (Note: Complete the Groundwater Monitoring Well Maintenance Record during semi-annual sampling events.)

6. Miscellaneous

- ☐ Are all site benchmarks marked and evident?
- ☐ Do vector control measures appear adequate?

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WELL CONDITION SUMMARY

DATE:__________

Project Name__________________

Personnel _____________________________

Project No./Task No.__________

Page______ of ________

Well ID	Protective Casing	Well Casing	Label	Lock	Pad Condition	Depth of Well (Feet)	General Turbudity	Comments/ Observations*
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	
	OK Damaged	OK Damaged	OK Inadequate	Yes No	OK Damaged		Clear Turbid	

* Note ponding water, weep holes, condition of surrounding area, including any disturbance of the ground since last inspection, evidence of contamination.

Signature:_________________________ Date:________________________

CP-4

Facility Name:	WCA of High Point C&D Landfill
	Phase 2 Expansion
Permit No.:	41 - 16
Facility Address:	5830 Riverdale Drive
	Jamestown, North Carolina 27282
Facility Owner:	WCA of High Point, LLC

Date:	12/16/06
Calculated By:	CDH
Reviewed By:	CJS / DBM
Revision No.:	0
Project No.:	063-6526
Phase No.:	101

Golder Associates
4900 Koger Blvd, Suite 140
Greensboro, North Carolina 27407
phone - 336.852.4903
fax - 336.852.4904
www.golder.com

POST-CLOSURE COSTS:

		Notes & Guidance Values		
I. Groundwater Monitoring				
a.	Total number of monitoring wells	15	8	wells
b.	Number of sampling events per year	2 sampling events per year	2	events
c.	Monitoring and analysis costs per sample	$1,500	$1,500	/sample
d.	Miscellaneous Engineering Fees	$10,000 or as required	$10,000	/year
e.	*Total annual monitoring costs*	*[(a x b x c) + d]*	**$34,000**	**/year**
f.	Post-closure period	30	30	years
g.	*Total cost for post-closure period*	*(e x f)*	***$1,020,000.00***	
II. Landfill Gas Monitoring				
a.	Frequency of testing	(4 events per year)	4	events/year
b.	Cost of sampling per event	$1,000.00	$1,000.00	/event
c.	*Total LFG Monitoring unit cost per year*	*(a x c)*	**$4,000.00**	**/year**
d.	Post-closure period	30	30	years
e.	*Total cost for post-closure period*	*(d x e)*	***$120,000.00***	
III. Leachate Management				
a.	Private disposal unit cost	$0.00	$0.00	/gal
b.	POTW disposal unit cost	$0.10	$0.10	/gal
c.	Direct discharge to a POTW unit cost	$0.00	$0.00	/gal
d.	Amount of leachate generated	0.00	0	gal/yr
e.	Load/unload unit cost	$150	$150.00	/truck
f.	Capacity of truck	5,500	5,500	gallons
g.	Number of trucks required per year	*(d ÷ f)*	0	trucks/year
h.	Distance over 5 miles of hauling (one way)	10	10	miles
i.	Cost of hauling per mile	$1.50	$1.50	/mile
j.	Total cost for loading / unloading and hauling	*[(e x g) + (h x i)]*	$15.00	/year
k.	Total annual cost for Private Disposal	*(a x d)*	$0.00	/year
l.	Total annual cost for POTW Disposal (delivered	*[(b x d) + j]*	$0.00	/year
m.	Total annual cost for POTW Disposal (direct)	*(c x d)*	$0	/year
n.	*Total leachate management cost*	*(k or l or m)*	***$0.00***	***/year***
o.	Post-closure period	5	5	years
p.	*Total cost for post-closure period*	*(n x o)*	***$0.00***	
IV. Routine Maintenance and Repairs				
a.	Mowing frequency	2	2	visits/year
b.	Area to be maintained (acres)	21.5	21.5	acres
c.	Mowing unit cost per visit	$80	$80	/acre/visit
d.	*Total mowing cost per year*	*(a x b x c)*	***$3,440***	/year
e.	Fertilizer unit cost	$500	$500	/acre
f.	*Total fertilizer cost per year*	*(b x e)*	***$10,750***	/year
g.	Number of years to reseed (max 3 years)	3	3	years
h.	Area to reseed (acres)	7.17	7.17	acres
i.	Reseeding unit cost	$1,786	$1,786	/acre
j.	*Total reseeding cost*	*(g x h x i)*	***$38,399***	
k.	Mobilization/demobilization cost per year	$150	$150	/year
l.	*Total maintenance and repairs cost per year*	*(d + f + k)*	***$14,340.00***	***/year***
m.	Post-closure period	30	30	years
n.	*Total cost for post-closure period*	*[(m x l) +j]*	***$468,599***	
V. Vector and Rodent Control				
a.	*Total vector and rodent control costs per year*	$2,000 or as required	***$2,000.00***	***/year***
b.	Post-closure period	30	30	years
c.	*Total cost for post-closure period*	*(a x b)*	***$60,000***	

Total Post-Closure Costs

Total Unadjusted Post-Closure Costs	$1,668,599.00
City Cost Index (CCI)	100
Total Adjusted Post-Closure Costs CCI x (I..V)	**$1,668,599.00**
Contingency (10%)	$166,859.90
Total Post-Closure Cost-Estimate (through Phase 2)	**$1,835,459**