Fac/Perm/Co ID #	Date	Doc ID#
44-06	11/24/08	6268

DESIGN REPORT

LANDFILL 6
AREA D SOUTH
CANTON, NORTH CAROLINA

Prepared for
BLUE RIDGE PAPER PRODUCTS – CANTON MILL
DIVISION OF EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

VOLUME II

NOVEMBER 2008

SME
Sevee & Maher Engineers, Inc.
Waste Management and Hydrogeologic Consultants
Cumberland Center, Maine

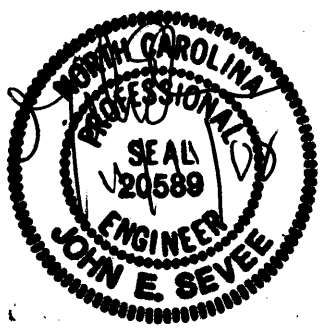

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TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Site History

Blue Ridge Paper Products Inc. – Canton Mill (Blue Ridge) owns and operates a solid waste landfill known as Landfill No. 6 under Permit #44-06[1] of the North Carolina Department of Environment and Natural Resources (NCDENR), Division of Solid Waste. The 240-acre site is used for the disposal of boiler fly ash cinders, dewatered wastewater treatment sludge, lime mud, woodwaste, and asbestos containing material (ACM).

Landfill No. 6 is divided into eight major landfilling areas designated as Areas A through H. The original design of the facility was based upon plans and specifications[2] prepared by Law Engineering and Testing Company (Law) of Charlotte, North Carolina. Areas A through E are designated for sludge, ash, lime mud, and wood waste disposal. Areas F, G, and H are designated for lime mud and ACM disposal. Areas A-East, B, C, F, G, and H have been constructed according to the original design specifications and landfilled to capacity. In addition, Areas A-East, B, C, F, and G have been capped according to the original design. The current operating area, Area A-West, will reach capacity in early 2011. Upon reaching capacity in Area A-West, the next stage of development is planned for Area D, then Area E.

In 2007, Blue Ridge retained the services of SME to conduct a hydrogeologic investigation prepare engineering drawings and specifications for Area D-South. SME has prepared this document to detail the proposed site development and construction specifications for the first phase of development, Area D-South.

1.2 Site Location

Blue Ridge's Landfill No. 6 is located approximately two (2) miles northwest of the City of Canton in Haywood County, North Carolina. The 240-acre site is situated north of the Pigeon River and south of Interstate I-40, between State Routes 1550 and 1513. A site location plan is provided as Figure 1-1.

1.3 Basis of Design

The objective of this design is to present a site development plan which will protect the environment, complement the existing operation plan and maximize landfilling volume for the plan area of the landfill.

Protection of groundwater quality is provided by the use of a geosynthetic liner. The liner proposed for use is a 60-mil textured High Density Polyethylene (HDPE) underlain along the base with a geosynthetic clay liner.

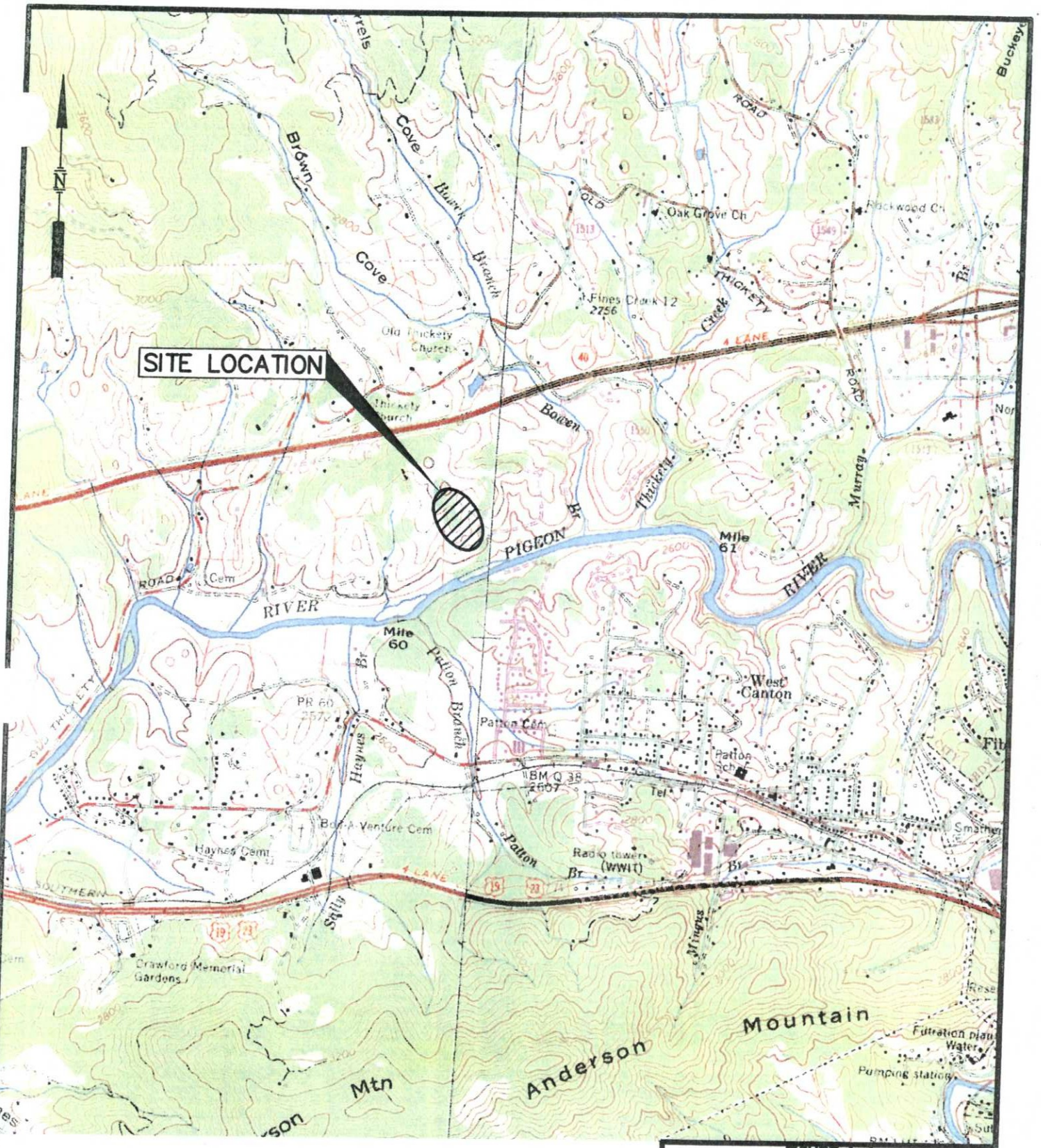
The design of Area D-South proposes to include two access roads for efficient traffic movement and a chimney drain to promote rapid internal drainage from the landfilled waste.

Landfill volume for waste is maximized through the base grading plan which includes 2H:1V sideslope grades and a minimum 5-percent base grade.

1.4 Design Support

The proposed design is supported by calculations presented herein for the following: stability of the geomembrane anchor trench; piping system design strength; maximum leachate head on the liner; geotextile cushion design to protect the geomembrane from the leachate collection stone; and erosion control measures and temporary storage of collected clean water runoff.

The design of Area D-South is based on engineering evaluations consistent with those normally employed in geotechnical engineering for landfills.



BASE MAP ADAPTED FROM 7.5 MIN USGS TOPO QUADS
CANTON, NC – 1990
CLYDE – 1978

000 0 2000 4000 FEET

DWG: 6E–SITELOC LMN: NONE CTB: SME–STD REV:

FIGURE 1–1
SITE LOCATION PLAN
BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 EXPANSION

SME
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2.0 LANDFILL DESIGN

2.1 Design Considerations

The proposed landfill facility is designed as a secure landfill for the acceptance of pulp and paper production residuals from Blue Ridge. In general, the facility will be an area-type landfill where waste will be spread and compacted to create an above-grade mound. The design of this landfill is based on the volume and characteristics of the waste and the physical characteristics of the site, with the primary objective being to provide an ultimate disposal mechanism which will not cause degradation of the environment.

2.2 Base Liner System

Area D-South will utilize a liner system consisting of a 60-mil HDPE textured geomembrane and geosynthetic clay liner (GCL) over 2 feet of compacted site soils, refer to drawing C-301 in Appendix A. The combination of the HDPE liner and GCL reduces leachate leakage rates by providing a barrier with a very low hydraulic conductivity, i.e. $1x10^{-13}$ cm/sec, between the waste and the native soils.

A textured geomembrane was selected for an increased interface friction angle between the geomembrane and the soil subgrade and the overlying non-woven geotextile. The textured geomembrane will provide stable liner sideslopes and allow for safer installation and oversight of the geomembrane installation on the 2H:1V sideslopes. Installation of the geomembrane will follow a quality assurance/quality control plan as presented in Appendix C.

2.3 Base Grading

Base grading of Area D-South will require filling (fill) and excavation (cut) of soil and weathered bedrock to meet the proposed base grades, refer to drawing C-103 in Appendix A. The

maximum excavation depth is approximately 58-feet and maximum filling depth is approximately 58 feet. The estimated volume of material filling and excavation is listed in Table 2-1 below.

TABLE 2-1

ESTIMATED CUT/FILL VOLUMES

Material Cut/Fill	Volume (cu yd)
Stripping	20,500
Soil Fill	140,000
Soil Cut	347,500
Weathered Bedrock Cut	TBD

The bedrock removal may be accomplished by ripping or other approved methods, depending on the competency of the bedrock. As part of the landfill design, SME conducted a site investigation to evaluate the depth to bedrock and competency of the bedrock. The site investigation included a total of 28 borings. The borings were drilled by AE Drilling of Greenville, South Carolina from August to October 2007. The borings were designated B-07-201 through B-07-226. Exploration logs are presented in Appendix B of the Hydrogeologic Report.

The borings generally indicate a weathered layer of varying depth over competent rock. Areas of the base grade with exposed bedrock will require additional excavation of 5 feet below the proposed base grades and the placement of 5 feet of compacted site soils prior to geomembrane installation. The removal of bedrock for landfill development is proposed to maximize landfill volume and simplify landfill operations. No blasting will be conducted on site as part of the landfill expansion.

The proposed base grades were designed to provide a minimum of 5 feet of separation between seasonal high water elevation and waste.

2.4 Leachate Collection and Transport System

Leachate collection above the geomembrane is provided through the placement of 15 inches of granular drainage material and HDPE perforated collection piping (minimum diameter 6 inches); refer to Drawing C-300 and C-301 in Appendix A. The leachate collection system is a gravity drain system that has been designed to meet the Department's design criteria for maximum head on a liner using estimated leachate generation rates predicted by the U.S.EPA Hydrologic Evaluation of Landfill Performance (HELP) model Version 3.

The leachate pipe spacing, based upon the landfill base slopes and HELP model impingement rates, will not exceed 200 feet (slope length). The main leachate collection header will run in a north/south direction and tie into a leachate collection sump located at the south end of Area D-South. A proposed pump station then transports the leachate to the existing leachate storage ponds via a 4-inch force main connection to the existing 12-inch pipeline, which services Landfill 6C; refer to Drawings C-104 and C-304 in Appendix A. The leachate collection system is designed to drain leachate from the landfill without any penetrations through the liner system.

The leachate collection pipes at the base of the landfill will be extended to the rim elevation of the landfill. The purpose of the pipe extensions is to provide access to the header for cleaning and maintenance and to provide collection of leachate for above-rim landfilling. The location of the leachate collection piping system is presented in Drawing C-104 in Appendix A.

2.5 Erosion Control

The site soils consist of micaceous silty-sands and/or sandy-silts which are susceptible to erosion. The construction of Area D-South will require a staged schedule or the use of a protective material (jute-mat, temporary geotextile, etc.) to minimize exposure of site soils prior to geomembrane installation. An erosion control plan for construction of Area D-South is attached. The primary erosion control feature necessary for completing Area D-South is a sedimentation

pond which is currently in-place and functioning. An outlet control structure will be provided in order to attenuate runoff from large infrequent storm events while providing stormwater retention time for settlement of soil particles. The sedimentation pond is located at the northern boundary of Area D-South. Additional erosion control during construction will follow Best Management Practices[3].

Above rim (landfill perimeter road elevation) erosion control is provided through proper grading of the perimeter access road. The road is graded to drain away from the landfill and will drain to existing drainage channels located adjacent to the landfill area. In addition, a silt fence will be installed around the perimeter of the containment dike and will be inspected and maintained to assure proper function.

2.6 Access Roadways

Access for Area D-South will utilize existing roadways north of the Work Area along with the construction of a 24 foot wide gravel access road also located north of the Work Area

The location of the roadways is presented on Drawing C-103, along with detailed cross-section on Drawing C-302 in Appendix A.

2.7 Containment Berm

Area D-South is situated downgradient of future landfilling Areas D-North and E. In order to minimize leachate generated by Area D-South, upgradient runoff is prevented from entering the landfilling area by the construction of an earthen containment berm along the northerly boundary of Area D-South. The containment berm acts to divert upgradient runoff into a sedimentation basin therefore bypassing the expansion area entirely.

Runoff can be discharged as clean water via a proposed stormwater piping system described below in Section 2.8. The containment berm will be constructed upon the geomembrane liner system and will consist of suitable site soils (silty sand or sandy silt). The top of the berm will consist of a geotextile overlain with 12 inches of ABC road gravel. The berm sideslopes will also be covered with a geotextile and overlain with granular drainage material, #78M. A cross-section of the cell division berm is shown on Drawing C-301 in Appendix A.

2.8 Stormwater Piping System

The proposed stormwater piping system associated with Area D-South has two purposes. Runoff collected in the existing sedimentation pond will be transported south to a second pond via a 12-inch outlet pipe installed as the primary outlet device of the outlet control structure. Secondly, the 12-inch pipe is perforated and acts as an underdrain pipe. This is necessary as groundwater seepage occurs within the footprint of Area D-South. The seep is located in the existing drainage channel which flows north to south. As the channel is proposed to be filled to achieve base grades for the landfill expansion, it is necessary to intercept and convey any existing seepage. The 12-inch underdrain pipe will act to transport any groundwater seep and convey this, combined with runoff discharged from the sediment pond, into the existing downgradient pond located just south of Area D-South. The 12-inch pipe will be installed beneath the geomembrane liner system to avoid liner penetrations. Groundwater springs located within previous areas of the landfill were managed in a similar manner. The location and typical cross section of the strip drain collection pipe is shown on Drawings C-103 and C-300 in Appendix A.

3.0 DESIGN CONSIDERATIONS

3.1 Stability

3.1.1 Landfill Containment Berm and Waste Stability. SME completed a stability evaluation as part of the landfill expansion into Areas D and E. Components of the evaluation included a stability analysis addressing the geotechnical performance of the subsurface (foundation) soils, the proposed wastes, perimeter containment dikes and the landfill liner system. The evaluation considered both static and seismic loading criteria. The analyses were completed using site-specific data collected during the Fall 2007 site investigation (See Volume 1 of this application), laboratory testing of representative materials, along with data from previous SME investigations and those conducted by others.

Based on interpretations of field and laboratory testing, review of available data, and results of the slope stability evaluation, the final grading plan for Areas D and E meet or exceed generally accepted safety factor requirements for both static and seismic loading for each condition evaluated. The Stability Evaluation Report with associated data and calculations is presented in Appendix B.

3.1.2 Geomembrane Anchor Trench. The geomembrane liner will be anchored along the inside edge of the perimeter access road. The anchor trench is designed to provide enough pull-out resistance to hold the geomembrane in place under normal operating conditions. The anchor trench is also designed to allow the geomembrane to pull out of the trench under extreme loading conditions before the limits of the geomembrane are exceeded.

Based on these criteria, the anchor trench will be 2 feet in depth and will have a run-out of 3 feet. The design calculations and a list of design parameters are provided within Appendix C-1.

3.2 Leachate Collection System

3.2.1 Maximum Leachate Head on Liner. An important design constraint of the leachate collection system is the depth at which the leachate will mound on top of the liner system. The depth of the leachate over the liner or head on the liner is directly related to the leakage rate through the liner system. Therefore, the goal in designing the leachate collection system is to minimize the head on the liner and likewise the leakage rate. A typical design standard for the landfill leachate collection system is to maintain head levels on the liner to less than 12 inches.

The maximum head on the base liner system is calculated by using Giroud's method[4]. The equation to solve the head on the liner utilizes the slope of the base liner system, the leachate collection stone's hydraulic conductivity, the leachate impingement rate, the thickness of the leachate collection stone, and the drainage length between pipes. The head on the liner for the collection system design is 0.24 feet, which is less than the typical maximum allowable head of 1 foot. The leachate collection/liner head calculations are shown in Appendix B-2.

3.2.2 Geotextile Cushion. The geotextile located between the geomembrane liner and the leachate collection stone is required to provide adequate cushion to protect the geomembrane from puncture. The method used to determine the cushion requirements of the geotextile, utilized the geotextile weight, the maximum stone diameter, and the confining stresses to calculate a cushion pressure capacity (Boschuk[5]). The proposed geotextile will provide adequate cushion for protection of the liner. Design calculations presented in Appendix B-3 provide a factor of safety of 20.8, which exceeds the recommended minimum of 2.0. The proposed 16 oz/sy cushion geotextile is considered industry standard.

3.2.3 Leachate Collection and Strip Drain Pipe Strength. The leachate collection piping must be able to withstand the anticipated loads produced by the depth of waste placed over the pipes. The pipe material selected for the landfill is high density polyethylene pipe which is manufactured in a variety of thicknesses, or Standard Diameter Ratios (SDR). The design

strength to resist buckling and critical pressure (crushing) was calculated using pipe thickness, perforations, and confining stresses under a positive projecting condition, i.e. no trench. The proposed pipe and thickness, SDR 11.0 for the perforated leachate collection piping and strip drain piping meets the minimum factor of safety of 2.3 recommended by the manufacturer. Calculations are provided in Appendix B-4.

3.2.4 Leachate Pump Station. A leachate pump station is provided to transport Area D-South leachate to the existing 12-inch gravity leachate transport line. The leachate pump station consists of two separate 275-gpm pumps housed in individual 24" HDPE conduits. The conduits run from the leachate sump area, up the perimeter road dike 2H:1V side slope, to the pump station building which is located along the perimeter road on the southern boundary of Area D-South. The pumps were designed to remove leachate generated by the 24-hour/25-year storm event in an acceptable period of time. The pump station and associated details can be seen on Drawings C-104, C-300 and C-304 in Appendix A. Calculations are provided in Appendix B-5.

3.3 Stormwater and Erosion Control

3.3.1 Perimeter Access Roadway Runoff. The access roadway surrounding Area D-South will be graded to drain away from the landfill, refer to drawings C-103 in Appendix A. Calculations of peak surface water flow generated from a 25-year/24-hour duration storm were made using the Soil Conservation Service Technical Release Manual TR-55 methodology. The calculations indicate that the capacity of the existing stormwater control system will not be exceeded, refer to Attachment 4 in Volume 1 of this application.

3.3.2 Sedimentation Control During Base Grading. Sedimentation control will be provided from the installation of silt fence along the entire perimeter of excavations during construction of the perimeter road. Additionally, a sedimentation pond is located along the northern boundary of Area D-South and will provide sedimentation control for all upgradient areas which includes the construction of the temporary access route to the landfill perimeter road.

Sedimentation control within the contained lined landfill area will is not be required as all runoff is collected in the leachate collection system and conveyed to the leachate collection ponds.

3.3.3 Stormwater Retention Prior to Landfilling. The available capacity for stormwater retention within the lined Area D-South is greater than the required volume of the 25-year/24-hour duration storm.

3.3.4 Erosion Control During Base Grading. Base grading of the landfill area consists of excavating soil and bedrock. The on-site soils are micaceous and are susceptible to erosion. To minimize erosion, the general contractor will be required to perform the work in conformance with the Best Management Practices Manual[3] prepared by the State of North Carolina, and to take any additional measures required to protect the base soil prior to installation of the geomembrane. Additional measures will include staged construction, i.e. grade a 2-acre area, compact, install the geomembrane, and move to the next 2-acre area; or installation of a temporary erosion control material such as a geotextile or jute mat.

4.0 LANDFILL CONSTRUCTION

Blue Ridge plans to initiate construction of Area D-South in the fall of 2009 and anticipates that the facility will be operational by the fall of 2010. A proposed construction schedule is presented on Figure 4-1. The landfill will be constructed by a general contractor who will be responsible for supplying the materials, labor, and equipment necessary to complete the landfill. Services of a general contractor will be procured through a competitive bid process. Bid packages for the solicitation of construction services will require the contractor to identify and demonstrate familiarity and experience with the various aspects of landfill construction. These will include:

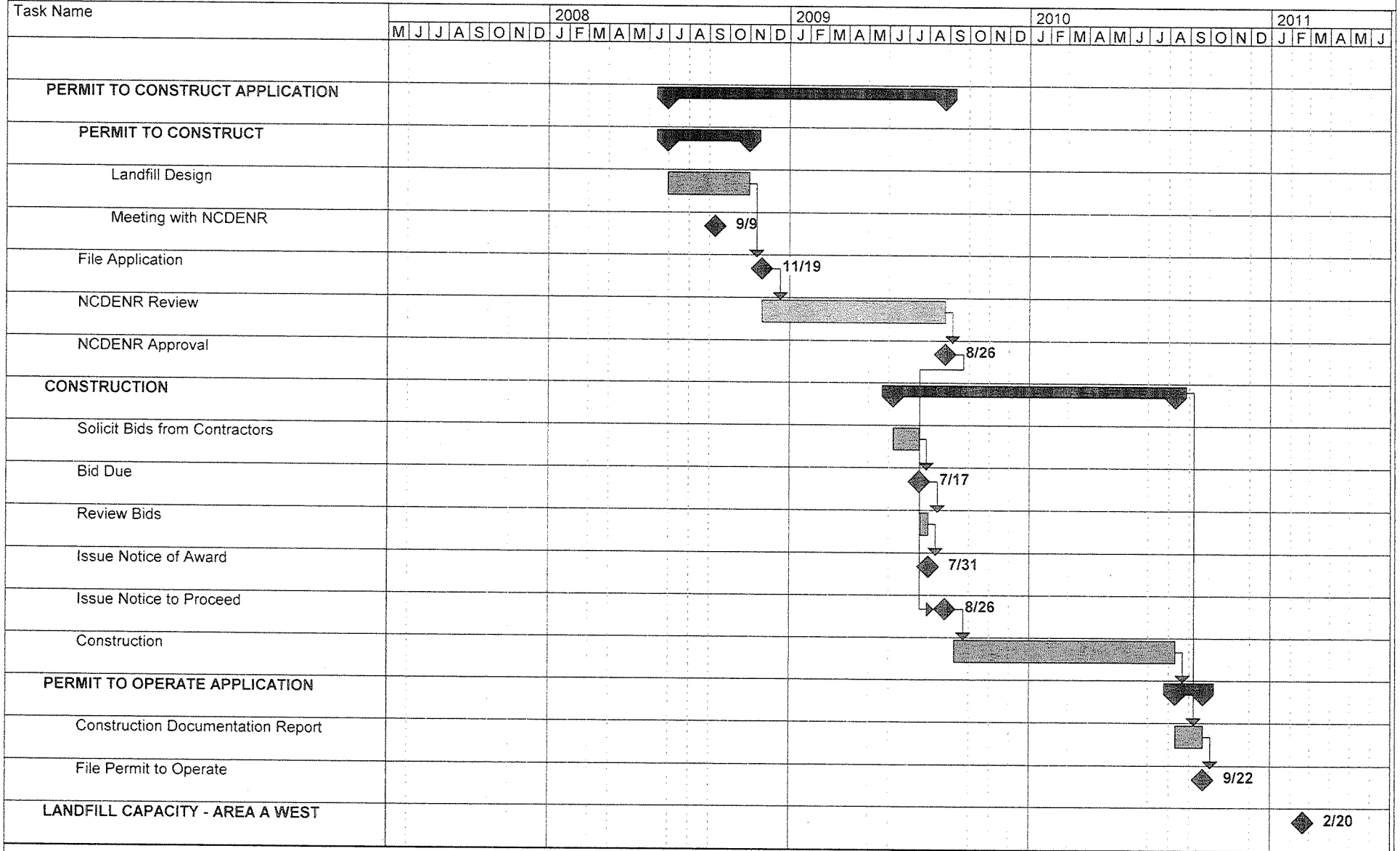
- Earthmoving;
- Pipe installation;
- HDPE and GCL liner installation; and
- Pump station installation.

The specific levels of experience required for the various components of the landfill are included in the technical specifications prepared for the project. These technical specifications are attached in Appendix C.

4.1 Quality Assurance/Quality Control

To control the quality of the soil materials used in the landfill construction, a quality assurance/quality control (QA/QC) program will be implemented. The program will include source testing to demonstrate compliance with material specifications and construction testing to demonstrate that the materials have been properly installed. In addition to source testing of soil materials, the contractor will be responsible for submitting to the engineer for review the manufacturer's specifications and warranties for the following items:

TABLE 4-1
BLUE RIDGE PAPER PRODUCTS
AMENDMENT TO PERMIT
LANDFILL NO. 6
AREA D AND E SCHEDULE



- Leachate collection pipes and fittings;
- Liner geomembrane material; and
- Geotextile.

The specific items which must be submitted for each of these items is discussed in the specifications included in Appendix C.

4.1.1 Source Testing. An excess of excavation material occurs as a result of the proposed Area D-South project. The material may be used for a source of borrow material however testing will be required prior to use to demonstrate compliance with the materials specifications. Additional materials to be used at the landfill construction will be required to be tested at their source prior to being delivered on-site. The soil materials that will require source testing include: granular drainage material and graded drainage stone for leachate collection, and material for the access road. Samples will be collected at each borrow source in accordance with the methods specified by ASTM D 420 and C 702, and tested by the contractor prior to the Owner's acceptance of the materials. The contractor will be required to have the test performed by a State of North Carolina qualified testing laboratory.

4.1.2 Construction Testing. As the soil materials are used in the landfill construction, in-place testing will be performed by Blue Ridge to monitor material placement and conformance with the criteria specified in the construction specifications. In-place material testing will be performed by a qualified materials testing laboratory and will be observed by the owner's representative.

4.1.3 Liner QA/QC. The quality assurance and quality control of the facility's synthetic liner will be as described in the construction specifications contained in Appendix C of this report.

4.2 Weekly Inspection Reports

Weekly inspection reports will be prepared by the owner's representative during the landfill construction period. The report will include material test results, summary of contractor submittals, actions taken, summary of progress made to date, and anticipated work items.

4.3 Photographic Documentation

To provide photographic documentation of the landfill construction, photographs will be taken periodically. Copies of the photographs will be provided in the construction certification report.

4.4 Record Drawings

Upon completion of the landfill construction, record drawings will be prepared for the facility. The drawings will be sealed by a State of North Carolina Professional Engineer and will be submitted to the NCDENR.

4.5 Final Construction Certification and Report

A final construction report will be submitted by Blue Ridge to the NCDENR following the construction completion at Area D-South. The report will include written certification signed and stamped by the engineer supervising project inspection that the site has been constructed in accordance with the approved plans and specifications.

5.0 CONCLUSIONS

The Landfill No. 6 Area D-South proposed design is a state-of-the-art design which provides Blue Ridge with an optimal operational area which maximizes the waste volume for the project area. Area D-South is estimated to require approximately 16 months to complete construction.

Based on the proposed landfill base grades and final grades, Area D-South will have an approximate volume of 1 million cubic yards, and according to current waste disposal rates, a service life of approximately five years.

Proposed specifications are attached to this report in Appendix C for use in procuring bids and detailing construction activities.

REFERENCES

1. Champion International Corporation, 1983. Solid Waste Permit Application – Sanitary Landfill Site Six. March 1983.

2. Law Engineering and Testing Company, 1982. Revised Report of Geotechnical Exploration and Evaluation and Conceptual Site Development Recommendations, Landfill No. 6. February 1982.

3. North Carolina Department of Natural Resources and Community Development, Division of Land Resources Land Quality Section, 1995. Best Management Practices for Erosion Control.

4. Giroud, J.P., et al, 1993. Flow in Leachate Collection Layers.

5. Boschuk, J., 1994. Designing with Geosynthetic Cushions, October 1994.

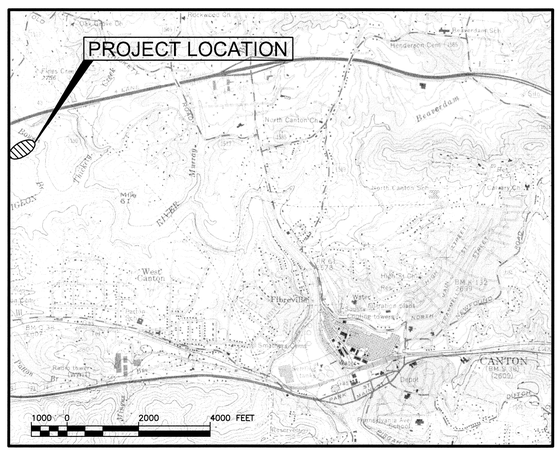
APPENDIX A

ENGINEERING DRAWINGS

BLUE RIDGE PAPER PRODUCTS INC. - CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

TITLE	DWG. NO.
COVER SHEET	
SYMBOLS & ABBREVIATIONS	C-100
EXISTING CONDITIONS PLAN	C-101
OVERALL SITE LOCATION PLAN	C-102
BASE GRADING PLAN	C-103A
BASE GRADING PLAN	C-103B
PIPELINE LOCATION & ELECTRICAL PLAN	C-104
FINAL GRADING PLAN	C-105
PHASE 1 ACCESS/LANDFILL PERIMETER ROAD PROFILE	C-106
CROSS SECTIONS	C-200
SECTIONS & DETAILS	C-300
SECTIONS & DETAILS	C-301
SECTIONS & DETAILS	C-302
UNDERDRAIN AND FORCEMAIN PROFILES	C-303
PUMP STATION DETAILS	C-304
EROSION CONTROL DETAILS	C-305

LOCATION MAP



SME

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NORTH CAROLINA PROFESSIONAL SEAL 20589 ENGINEER JOHN E. SEVEE

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SYMBOLS

EXISTING	PROPOSED	
		NORTH ARROW (MAGNETIC)
N		NORTH ARROW (PLAN NORTH)
25	25	CONTOUR LINES
25 x 63	25.56	SPOT ELEVATION (GRADE)
		EXISTING GROUND
S B		SURVEY BASELINE WITH TRIANGULATION OR INTERSECTION PT.
		PROPERTY LINE OR R.O.W.
N35'–10'–10"W 251.17'	N35'–10'–10"W 251.17'	PROPERTY LINE W/ BEARING AND DISTANCE
	0+00 1+00	CONSTRUCTION BASELINE
		BOUNDARY LINE (State, County, Municipality)
		SURVEY MONUMENT
IF	IF	SURVEY IRON
		DRILL HOLE, PK, OR STAKE
		WOODS OR BRUSH LINE
		INDIVIDUAL TREE (Deciduous)
		INDIVIDUAL TREE (Coniferous)
		TREE, TO BE REMOVED
		MARSH AREA
		BENCHMARK

EXISTING	PROPOSED	
		STONE WALL
		DRAINAGE COURSE (WITH DIRECTION)
SHORE SIDE		EDGE OF WATER
		WATER ELEVATION (GROUND OR SURFACE)
		FENCE LINE (WOOD)
		FENCE LINE (WIRE)
		RETAINING WALL
		GUARD RAIL
		BUILDING AND STRUCTURES
	2 / 1 OR 2:1	SLOPE RATIO (HORIZONTAL TO VERTICAL)
	TOP OF SLOPE 2:1	SLOPES (WITH SLOPE RATIO)
		EDGE OF TRAVELED WAY
		CUT OR FILL LINE
	CLL	CLEARING LIMIT LINE
		BITUMINOUS PAVEMENT
		CONCRETE
B–12 MW–12 P–12	B–12 MW–12 P–12	TEST BORING, MONITORING WELL, OR PIEZOMETER AND NUMBER
TP–12	TP–12	TEST PIT AND NUMBER

EXISTING	PROPOSED	
		MANHOLE
		CATCH BASIN
		WATER VALVE
		HYDRANT
		UTILITY POLE
		CLEAN OUT STRUCTURE
G	G	UNDERGROUND GAS MAIN
T	T	UNDERGROUND TELEPHONE LINE
E	E	UNDERGROUND ELECTRICAL LINE
OE	OE	OVERHEAD ELECTRICAL LINE
	12" ACP	SANITARY SEWER, SIZE & TYPE
FM	8" PVC	FORCE MAIN, SIZE & TYPE
W	8" D.I.	WATER MAIN, SIZE & TYPE
	12" RCP	STORM DRAIN, SIZE & TYPE
UD	8" UD	UNDERDRAIN, SIZE & TYPE
		CULVERT
	LT	LEACHATE TRANSPORT LINE
	LC	LEACHATE COLLECTION LINE
		RAILROAD
	S	SILTATION FENCE
	D	DIVERSION BERM
		STONE CHECK DAM

A.C.C.M.P	ASPHALT COATED C.M.P.
A.C.P.	ASBESTOS CEMENT PIPE
AC	ACRE
AGG	AGGREGATE
ALUM	ALUMINUM
APPD	APPROVED
APPROX	APPROXIMATE
ASB	ASBESTOS
ASPH	ASPHALT
AUTO	AUTOMATIC
AUX	AUXILIARY
AVE	AVENUE
AZ	AZIMUTH
B.C.C.M.P.	BITUMINOUS COATED C.M.P.
B.M.	BENCH MARK
BIT	BITUMINOUS
BLDG	BUILDING
BOT	BOTTOM
BRG	BEARING
C.B.	CATCH BASIN
CEN	CENTER
CEM. LIN.	CEMENT LINED
C.M.P.	CORRUGATED METAL PIPE
C.O.	CLEAN OUT
CF	CUBIC FEET
CFS	CUBIC FEET PER SECOND
CI	CAST IRON
CL	CLASS
CONC	CONCRETE
CONST	CONSTRUCTION
CONTR	CONTRACTOR
CTR	CENTER
CY	CUBIC YARD
D	DEGREE OF CURVE (ARC DEF.)
DBL	DOUBLE
DEG OR °	DEGREE
DEPT	DEPARTMENT
DI	DUCTILE IRON
DIA OR ø	DIAMETER
DIM	DIMENSION
DIST	DISTANCE
DN	DOWN
DR	DRAIN
DWG	DRAWING
EA	EACH
EG	EXISTING GROUND OR GRADE
ELEC	ELECTRIC
EL	ELEVATION
ELB	ELBOW
EQUIP	EQUIPMENT
EST	ESTIMATED
EXC	EXCAVATE
EXIST	EXISTING
F.G.	FINISH GRADE
FBRGL	FIBERGLASS
FDN	FOUNDATION
FLEX	FLEXIBLE
FLG	FLANGE
FLR	FLOOR
FPS	FEET PER SECOND
FT OR '	FEET
FTG	FOOTING
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GPD	GALLONS PER DAY
GPM	GALLONS PER MINUTE
HDPE	HIGH DENSITY POLYETHYLENE
HP	HORSEPOWER
HYD	HYDRANT
I.D.	INSIDE DIAMETER
IN OR "	INCHES
INV	INVERT
INV. EL	INVERT ELEVATION
LB	POUND
LC	LEACHATE COLLECTION
LD	LEAK DETECTION
LIN FT.	LINEAR FEET
LOC	LOCATION
LT	LEFT
M.H.	MANHOLE
M.J.	MECHANICAL JOINT
MATL	MATERIAL
MAX	MAXIMUM
MFR	MANUFACTURE
MIN	MINIMUM
MISC	MISCELLANEOUS
MON	MONUMENT
N.I.T.C.	NOT IN THIS CONTRACT
N.T.S.	NOT TO SCALE
N/F	NOW OR FORMERLY
NO. OR #	NUMBER
O.C.	ON CENTER
O.D.	OUTSIDE DIAMETER
P.C.	POINT ON CURVE
P.I.	POINT OF INTERSECTION
P.T.	POINT OF TANGENT
PERF	PERFORATED
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
PVMT	PAVEMENT
QTY	QUANTITY
R.O.W.	RIGHT OF WAY
RAD	RADIUS
REQD	REQUIRED
RT	RIGHT
RTE	ROUTE
S	SLOPE
SCH	SCHEDULE
SF	SQUARE FEET
SD	STORM DRAIN
SDR	STANDARD DIMENSION RATIO
SHT	SHEET
STA	STATION
SY	SQUARE YARD
TAN	TANGENT
TDH	TOTAL DYNAMIC HEAD
TEMP	TEMPORARY
TYP	TYPICAL
V	VOLTS
W/	WITH
W/O	WITHOUT
YD	YARD

GENERAL NOTES:

THE CONTRACTOR MUST COMPLY WITH ALL APPLICABLE SAFETY PROCEDURES WITH RESPECT TO THE EMPLOYEES OF THE CONTRACTOR AND HIS SUBCONTRACTOR UNDER THE OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA) AND REGULATIONS ISSUED THEREUNDER AND STATE LABOR (SAFETY) DEPARTMENT AND MILL RULES, PROCEDURES, AND REGULATIONS REGARDING SAFETY.

CONTOURS SHOWN ON PLANS MAY NOT REPRESENT EXISTING CONDITIONS OF THE SITE.

PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL PRESENT AND ACQUIRE APPROVAL OF A TEMPORARY EROSION AND SEDIMENT CONTROL PLAN AND DEWATERING PLAN BASED ON THE CONTRACTORS PROPOSED PHASING SEQUENCING.

MATERIAL SPECIFICATIONS:

COMMON BORROW – SECTION 02200 SPECIFICATION
ROADWAY SUBBASE – NCDOT SA AGGREGATE
ROADWAY SURFACE – NCDOT ABC AGGREGATE

#57 STONE – NCDOT #57 AGGREGATE
#78M STONE – NCDOT #78M AGGREGATE
#5 STONE – NCDOT #5 AGGREGATE

COMPACTION – ALL FILL SOIL SHALL BE COMPACTED TO A DENSITY OF 90 PERCENT OF ITS MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 1557 (MODIFIED PROCTOR)

6" HDPE PIPE – SDR 11.0 SOLID
6" HDPE PIPE – SDR 11.0 PERFORATED
12" HDPE PIPE – SDR 11.0 SOLID
12" HDPE PIPE – SDR 11.0 PERFORATED
24" HDPE PIPE – SDR 11.0 SOLID
36" HDPE PIPE – SDR 11.0 PERFORATED

CUSHION GEOTEXTILE – 16 OZ/SY NON–WOVEN GEOTEXTILE, NOCOLON S1600, OR EQUAL
FILTER GEOTEXTILE – MIRAFI 600X, OR EQUAL

GRUBBING:

ALL VEGETATION AND TOPSOIL SHALL BE STRIPPED FROM THE AREA D SOUTH AREA PRIOR TO PLACING ADDITIONAL MATERIAL. ANY TOPSOIL CLAIMED DURING THE GRUBBING OPERATION WILL BE STOCKPILED FOR THE OWNER'S USE. ALL OTHER GRUBBINGS WILL BE DISPOSED OF IN THE EXISTING SPOIL PILE OR AS OUTLINED ON THE PLANS. ALL WORK WILL ABIDE BY NCDOT SPECIFICATION SECTION 200.

SEED AND FERTILIZER:

AREAS DISTURBED BY CONSTRUCTION AND THE OUTBOARD SLOPES OF THE DIKE SHALL BE FERTILIZED AND SEEDED.

MATERIAL:

AGRICULTURAL GROUND LIMESTONE: 100 LBS PER 1,000 SF OR AS NEEDED BASED ON TESTING

FERTILIZER: GRANULAR FERTILIZER 10,10,10 (N.P,K) 25 LB/1000 SF OR AS NEEDED BASED ON TESTING

SEED:		
	TALL FESCUE (KY 31)	80 lb/acre
	SERICEA LESPEDEZA	20 lb/acre
	KOBE LESPEDEZA	10 lb/acre
		110 lb/acre

SEEDING WILL OCCUR BETWEEN MAY 1 AND AUG 15; IF NOT, ADD 40 LB/ACRE RYE GRAIN

MULCH – THE MULCH APPLICATION RATE SHALL BE 2 TONS PER ACRE

VIEW MARKERS & IDENTIFICATION

SECTION TITLE & NO.
ACCESS ROAD 3
C–100
DRAWING WHERE SECTION APPEARS

DETAIL TITLE & LETTER
MANHOLE A
C–100
DRAWING WHERE DETAIL APPEARS

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20583 ENGINEER JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

SYMBOLS AND ABBREVIATIONS

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY: HME
DRAWN BY: SJM
DATE: 8/29/08
CHECKED BY:
LMN:
CTB:

JOB NO. 07089.00 DWG FILE 6E–SYMSHT

C–100

NOTES:

MAPPING FOR LANDFILL AREA COMPILED USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MARCH 5, 2008

LOCATIONS OF OBJECTS SHOWN AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS HAVE CHANGED SINCE THE COMPILATION OF THIS MAP AND STANDARD PRACTICE DICTATES THAT PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED, AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.

GRID IS BASED ON NORTH CAROLINA STATE PLANE COORDINATE SYSTEM BASED ON NAGS (1983).

VERTICAL DATUM BASED ON NGVD (1929).

PROPERTY LINE DIGITIZED FROM LAW ENGINEERING DRAWING DATED JANUARY 14, 1984.

EXISTING GRADE CONTOUR INTERVAL IS 5 FT.

REV.	BY	DATE	STATUS
	[illegible]	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20589 ENGINEER JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

EXISTING CONDITIONS PLAN

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	[illegible]
LMN:	EXCON
CTB:	SME-STD

JOB NO. 07089.00 DWG FILE 6E-SITEPLAN

C-101

NOTES:

MAPPING FOR LANDFILL AREA COMPILED USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MARCH 5, 2008

LOCATIONS OF OBJECTS SHOWN AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS HAVE CHANGED SINCE THE COMPILATION OF THIS MAP AND STANDARD PRACTICE DICTATES THAT PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED, AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.

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PROPERTY LINE DIGITIZED FROM LAW ENGINEERING DRAWING DATED JANUARY 14, 1984.

EXISTING GRADE CONTOUR INTERVAL IS 10 FT.

N

GRID CONTROL POINT #703 ELEV. 2609.75

GRID CONTROL POINT #707 ELEV. 2652.67

GRID CONTROL POINT #701 ELEV. 2680.35

GRID CONTROL POINT #706 ELEV. 2559.59

INCINERATOR ROAD (SR 1550)

I-40

AREA F (CLOSED)

ACM AREA

AREA A EAST (CLOSED)

AREA A WEST (ACTIVE)

AREA H (CLOSED)

AREA E (FUTURE)

AREA B UPPER (CLOSED)

BOWEN BRANCH

AREA C UPPER (CLOSED)

AREA D NORTH (FUTURE)

AREA B LOWER (CLOSED)

AREA G (CLOSED)

AREA C LOWER (CLOSED)

AREA D SOUTH (FUTURE)

PROPOSED LANDFILL PERIMETER ROAD

LEACHATE COLLECTION POND

PIGEON RIVER

APPROXIMATE PROPERTY LINE

100 0 200 400 FEET

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20588 ENGINEER JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

OVERALL SITE LOCATION PLAN

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY: HME
DRAWN BY: SJM
DATE: 8/29/08
CHECKED BY: JEM
LMN:OVERALL SITE LOC
CTB:

JOB NO. 07089.00 DWG FILE 6E-SITEPLAN

C-102

I:\Projects\Canton\Landfill\Overall Site\Site.dwg, 11/14/2008 11:07:14 AM, sjm

NOTES:

MAPPING FOR LANDFILL AREA COMPILED USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MARCH 5, 2008

LOCATIONS OF OBJECTS SHOWN AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS HAVE CHANGED SINCE THE COMPILATION OF THIS MAP AND STANDARD PRACTICE DICTATES THAT PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED, AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.

GRID IS BASED ON NORTH CAROLINA STATE PLANE COORDINATE SYSTEM BASED ON NAGS (1983).

VERTICAL DATUM BASED ON NGVD (1929).

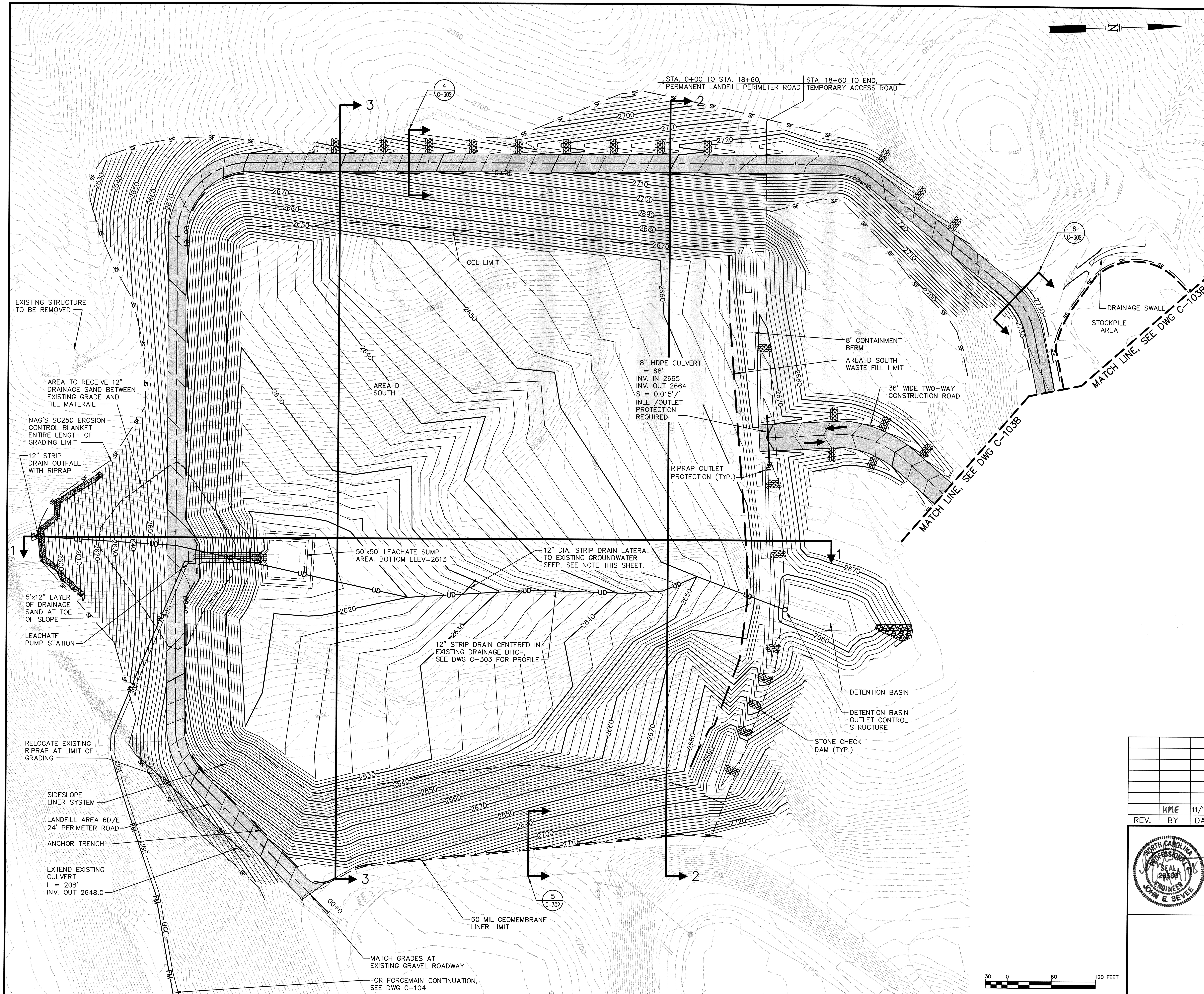
PROPERTY LINE DIGITIZED FROM LAW ENGINEERING DRAWING DATED JANUARY 14, 1984.

EXISTING GRADE CONTOUR INTERVAL IS 2 FT.

BASE GRADE CONTOUR INTERVAL IS 2 FT.

BASE GRADE CONTOURS REPRESENT GRADE PRIOR TO GEOMEMBRANE INSTALLATION.

IN THE EVENT GROUNDWATER SEEPS ARE ENCOUNTERED DURING EXCAVATION ACTIVITIES, THE CONTRACTOR SHALL INSTALL A 12" DIA. STRIP DRAIN LATERAL AT EACH SEEP LOCATION AND CONNECT TO STRIP DRAIN HEADER PIPE.



REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

BASE GRADING PLAN

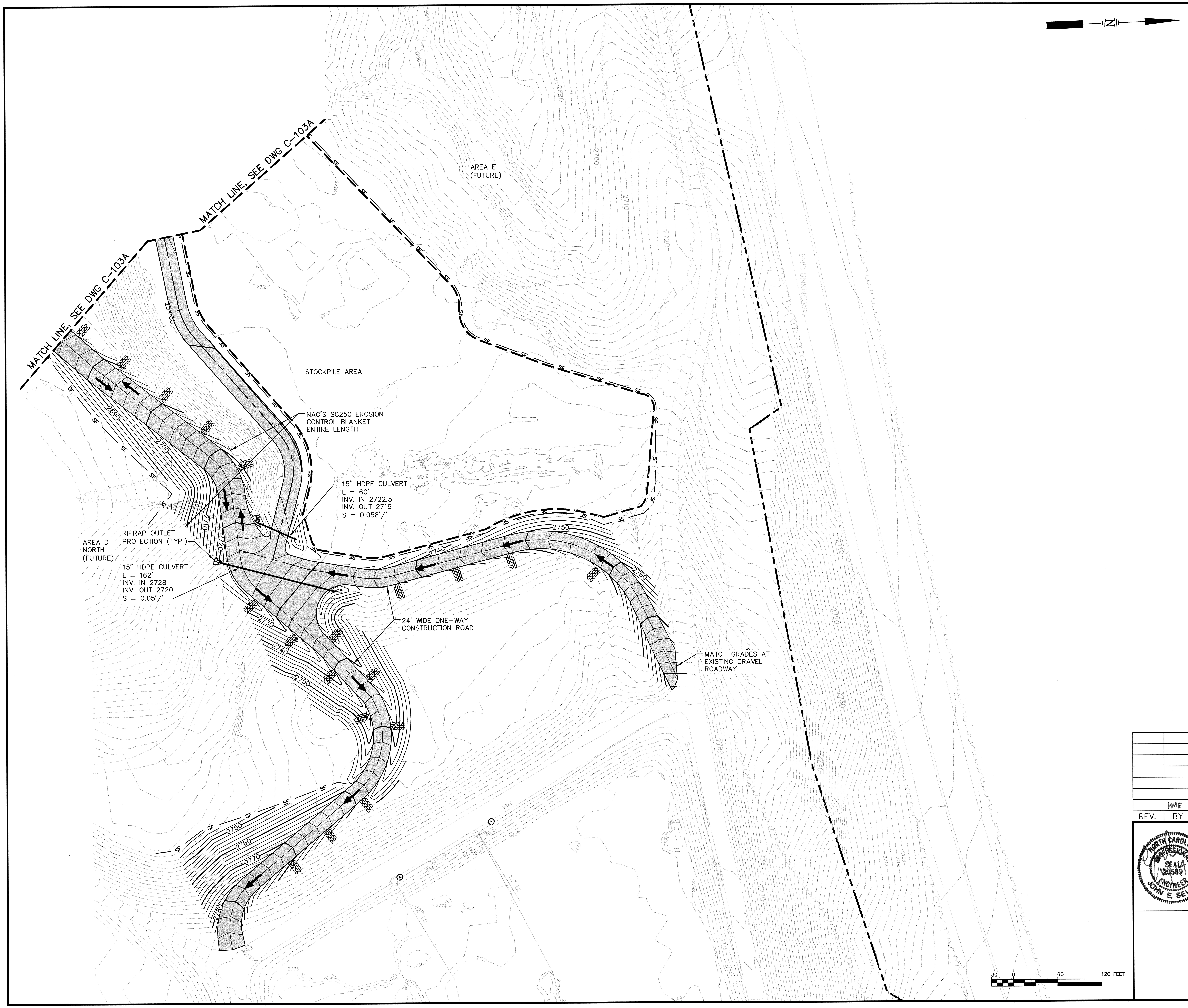
NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 20580 JOHN E. SEVEE

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	
LMN:	BASE GRADING
CTB:	

JOB NO. 07089.00 DWG FILE 6E-SITEPLAN

C-103A



NOTES:

MAPPING FOR LANDFILL AREA COMPILED USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MARCH 5, 2008

LOCATIONS OF OBJECTS SHOWN AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS HAVE CHANGED SINCE THE COMPILATION OF THIS MAP AND STANDARD PRACTICE DICTATES THAT PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED, AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.

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REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 20589 JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

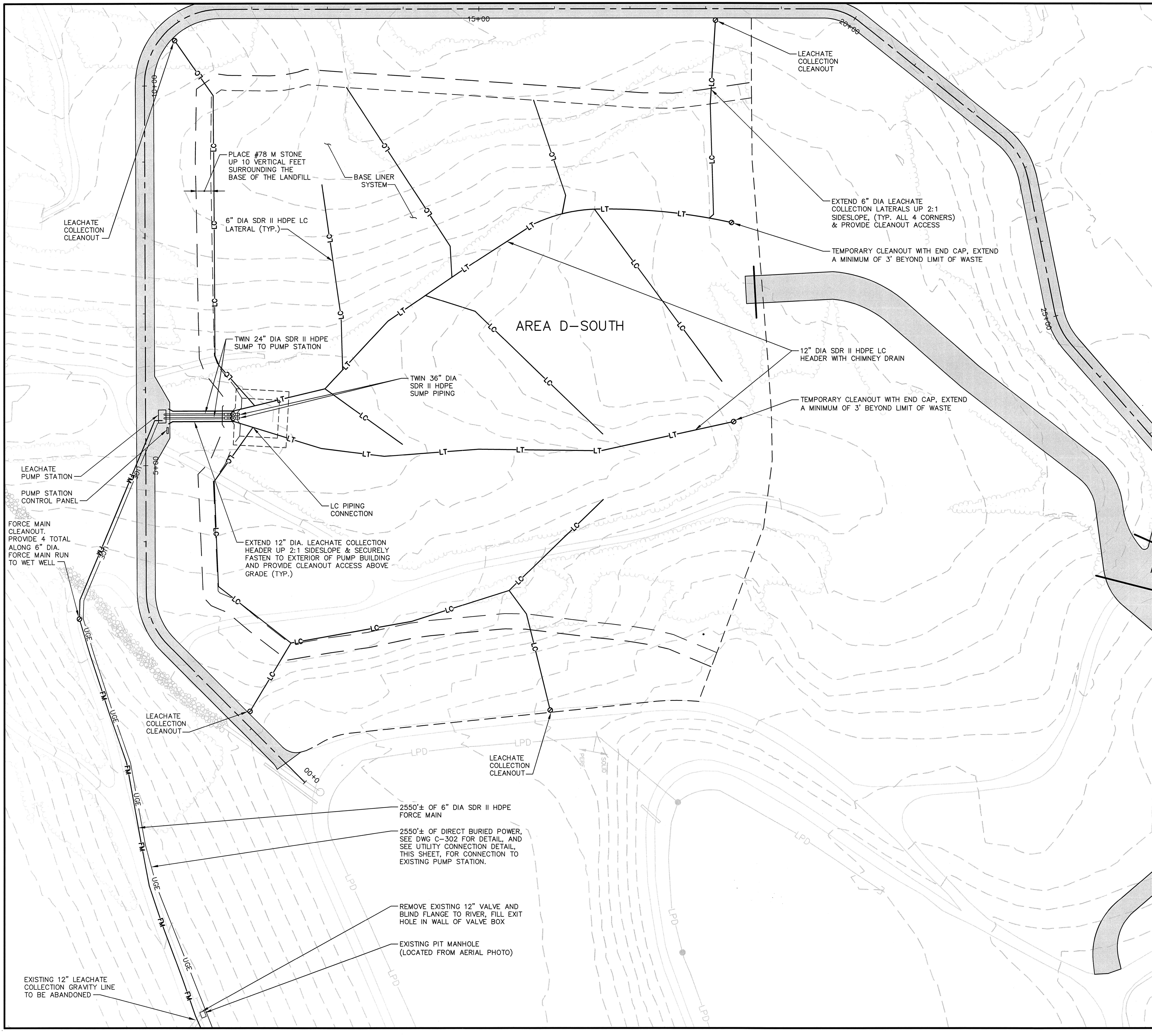
BASE GRADING PLAN

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

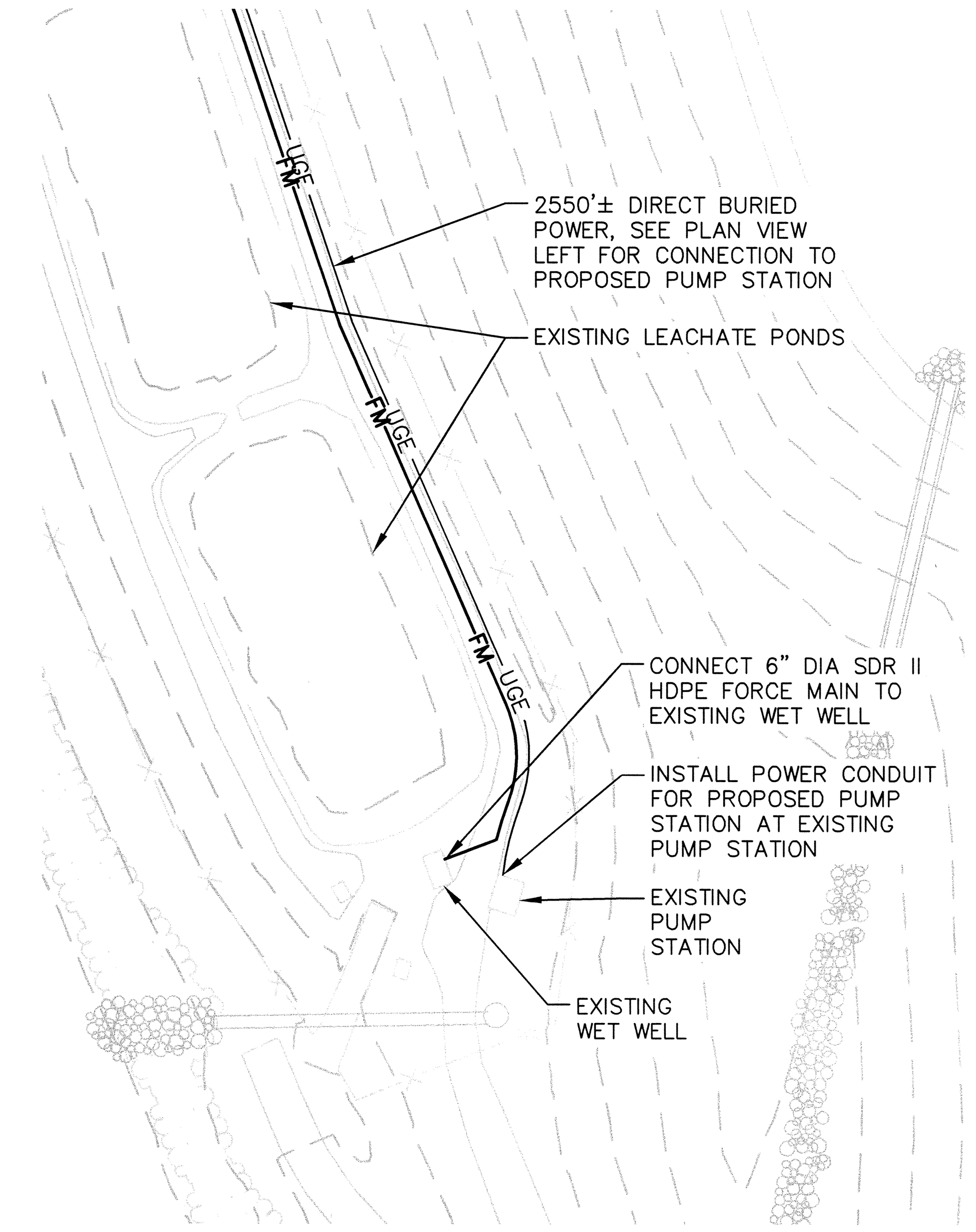
DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	
LMN:	BASE GRADING
CTB:	

JOB NO. 07089.00 DWG FILE 6E-SITEPLAN

C-103B



15+00
20+00
25+00
10+00
5+00
00+0
LEACHATE COLLECTION CLEANOUT
PLACE #78 M STONE UP 10 VERTICAL FEET SURROUNDING THE BASE OF THE LANDFILL
BASE LINER SYSTEM
6" DIA SDR II HDPE LC LATERAL (TYP.)
LEACHATE COLLECTION CLEANOUT
EXTEND 6" DIA LEACHATE COLLECTION LATERALS UP 2:1 SIDESLOPE, (TYP. ALL 4 CORNERS) & PROVIDE CLEANOUT ACCESS
TEMPORARY CLEANOUT WITH END CAP, EXTEND A MINIMUM OF 3' BEYOND LIMIT OF WASTE
AREA D-SOUTH
TWIN 24" DIA SDR II HDPE SUMP TO PUMP STATION
TWIN 36" DIA SDR II HDPE SUMP PIPING
12" DIA SDR II HDPE LC HEADER WITH CHIMNEY DRAIN
TEMPORARY CLEANOUT WITH END CAP, EXTEND A MINIMUM OF 3' BEYOND LIMIT OF WASTE
LEACHATE PUMP STATION
PUMP STATION CONTROL PANEL
FORCE MAIN CLEANOUT. PROVIDE 4 TOTAL ALONG 6" DIA. FORCE MAIN RUN TO WET WELL
LC PIPING CONNECTION
EXTEND 12" DIA. LEACHATE COLLECTION HEADER UP 2:1 SIDESLOPE & SECURELY FASTEN TO EXTERIOR OF PUMP BUILDING AND PROVIDE CLEANOUT ACCESS ABOVE GRADE (TYP.)
LEACHATE COLLECTION CLEANOUT
LEACHATE COLLECTION CLEANOUT
2550'± OF 6" DIA SDR II HDPE FORCE MAIN
2550'± OF DIRECT BURIED POWER, SEE DWG C-302 FOR DETAIL, AND SEE UTILITY CONNECTION DETAIL, THIS SHEET, FOR CONNECTION TO EXISTING PUMP STATION.
REMOVE EXISTING 12" VALVE AND BLIND FLANGE TO RIVER, FILL EXIT HOLE IN WALL OF VALVE BOX
EXISTING PIT MANHOLE (LOCATED FROM AERIAL PHOTO)
EXISTING 12" LEACHATE COLLECTION GRAVITY LINE TO BE ABANDONED
N
30 0 60 120 FEET



2550'± DIRECT BURIED POWER, SEE PLAN VIEW LEFT FOR CONNECTION TO PROPOSED PUMP STATION
EXISTING LEACHATE PONDS
CONNECT 6" DIA SDR II HDPE FORCE MAIN TO EXISTING WET WELL
INSTALL POWER CONDUIT FOR PROPOSED PUMP STATION AT EXISTING PUMP STATION
EXISTING PUMP STATION
EXISTING WET WELL

PUMP STATION POWER AND FORCE MAIN CONNECTION DETAIL

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20589 ENGINEER JOHN E SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

PIPELINE LOCATION & ELECTRICAL PLAN

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY: HME
DRAWN BY: SJM
DATE: 8/29/08
CHECKED BY:
LMN: PIPELINE PLAN
CTB:

JOB NO. 07089.00 DWG FILE 6E-SITEPLAN

C-104

NOTES:

MAPPING FOR LANDFILL AREA COMPILED USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MARCH 5, 2008

LOCATIONS OF OBJECTS SHOWN AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS HAVE CHANGED SINCE THE COMPILATION OF THIS MAP AND STANDARD PRACTICE DICTATES THAT PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED, AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.

GRID IS BASED ON NORTH CAROLINA STATE PLANE COORDINATE SYSTEM BASED ON NAGS (1983).

VERTICAL DATUM BASED ON NGVD (1929).

PROPERTY LINE DIGITIZED FROM LAW ENGINEERING DRAWING DATED JANUARY 14, 1984.

EXISTING GRADE CONTOUR INTERVAL IS 10 FT.

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 20588 JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

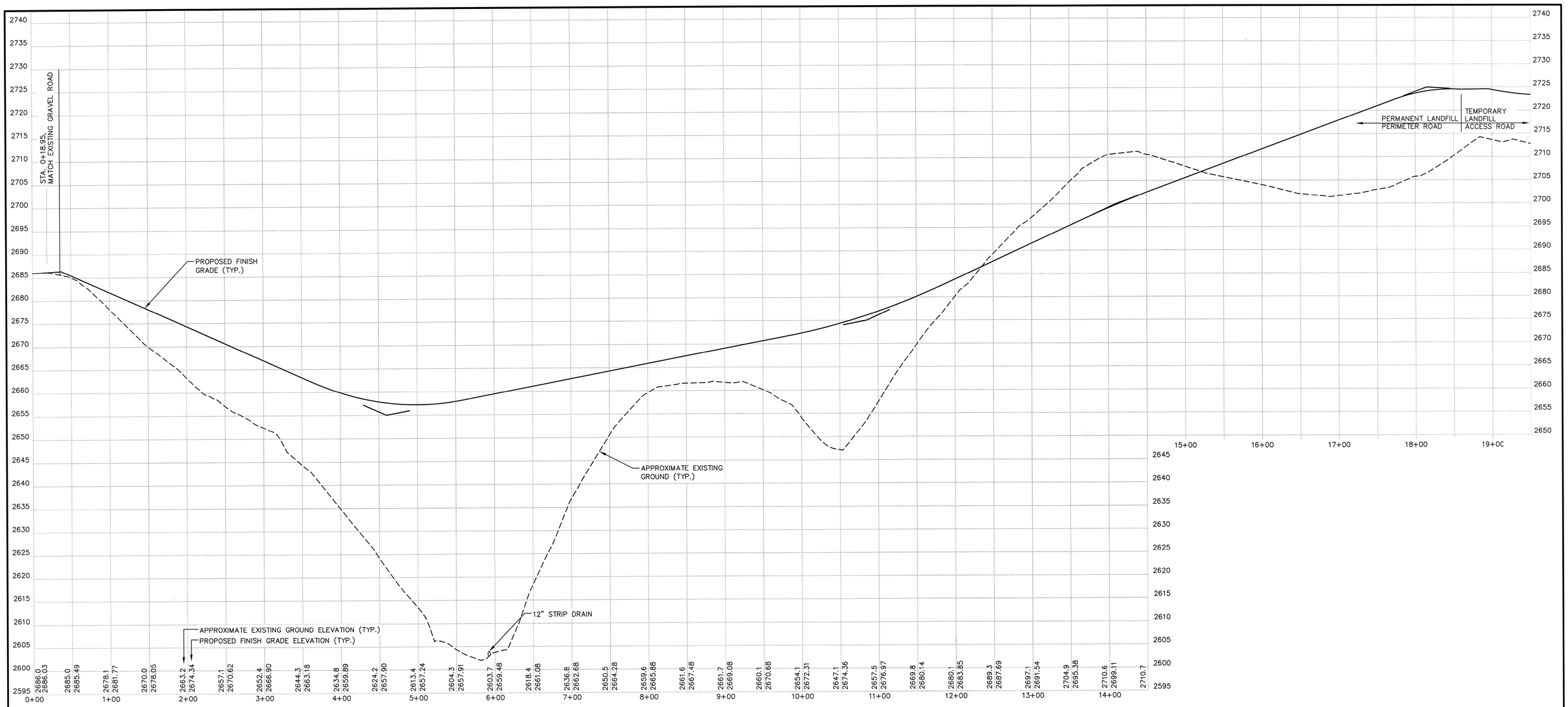
FINAL GRADING PLAN

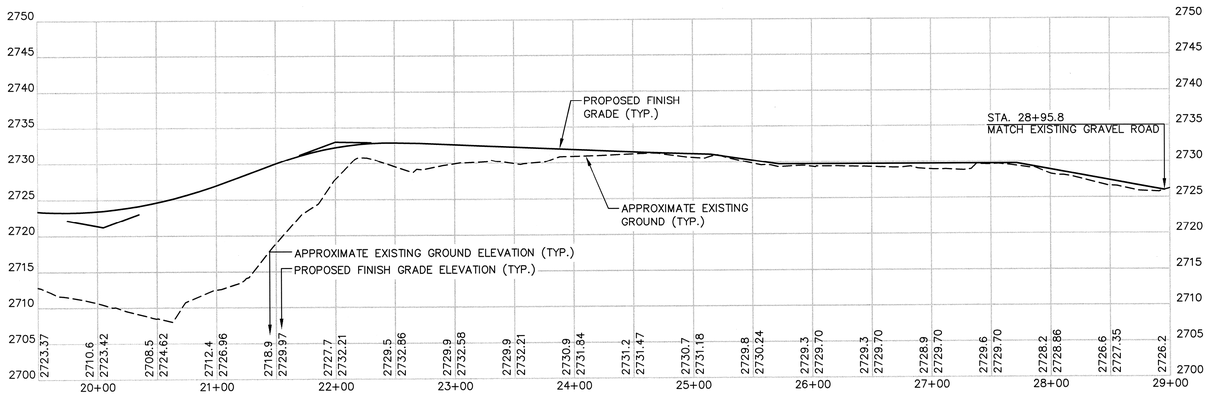
SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	[signature]
LMN:	FINAL GRADING
CTB:	

JOB NO. 07089.00 DWG FILE 6E–SITEPLAN

C–105





30 0 60 120 FEET HORZ.
5 0 10 20 FEET VERT.

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 10089 ENGINEER JOHN E. SEVIER

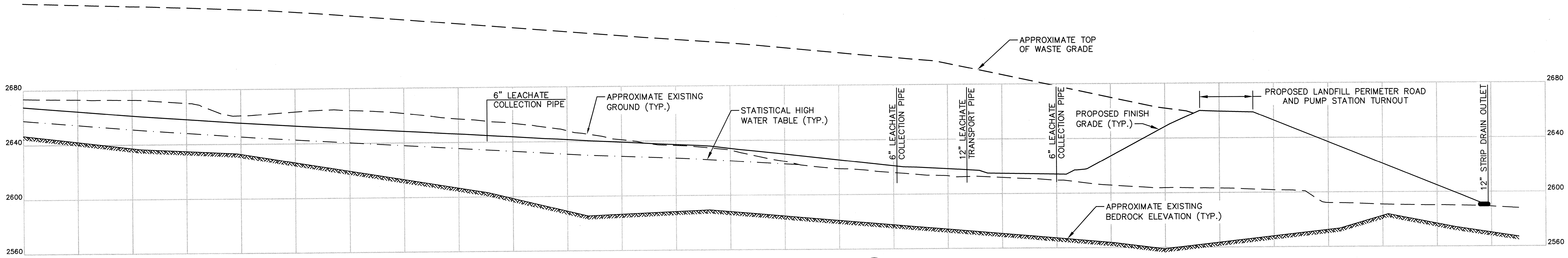
BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT
PHASE 1 ACCESS/LANDFILL PERIMETER ROAD PROFILE

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

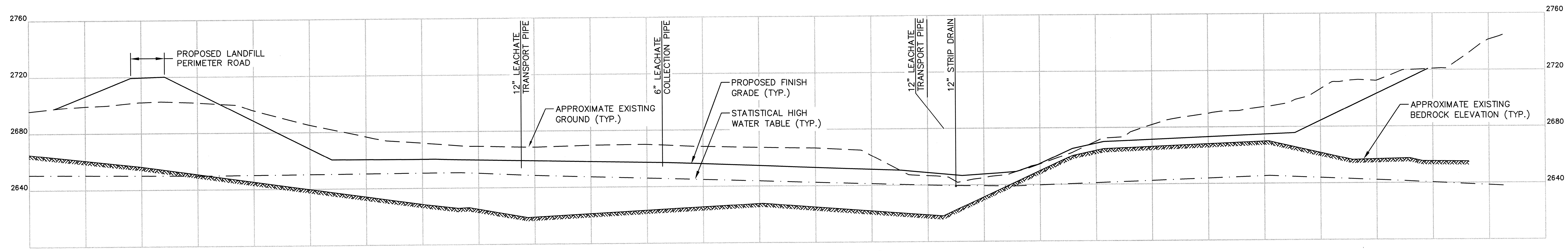
DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	JEM
LMN:	PROFILE
CTB:	

JOB NO. 07089.00 DWG FILE 6E-SITEPLAN

C-106



CROSS SECTION 1



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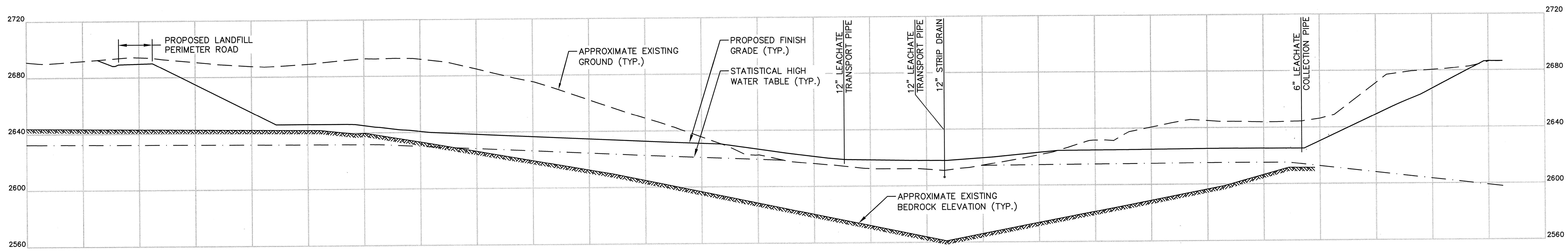


CROSS SECTION 3

20 0 40 80 FEET

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20586 ENGINEER JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

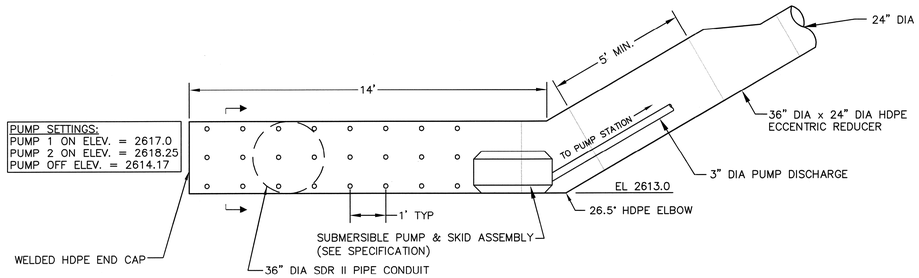
CROSS SECTIONS

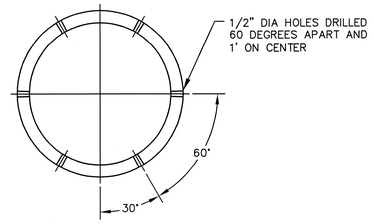
SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY: HME
DRAWN BY: SJM
DATE: 8/29/08
CHECKED BY:
LMN: CROSS SECTIONS
CTB: SME-STD

JOB NO. 07089.00 DWG FILE 6E-SITEPLAN

C-200

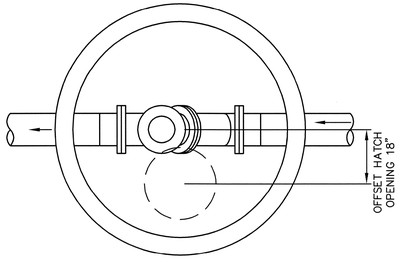




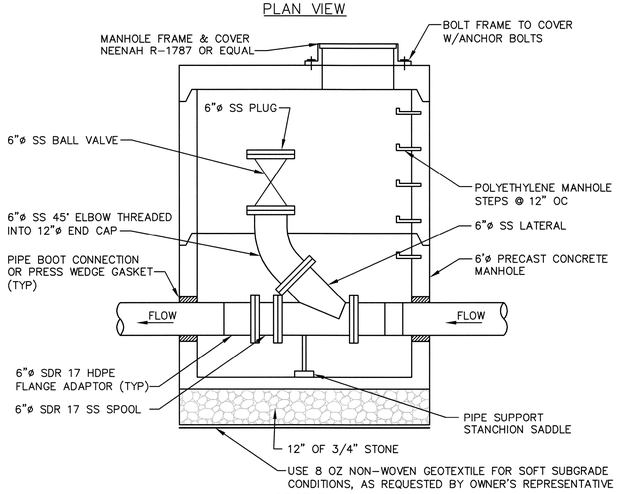
SECTION

HDPE PUMP CONDUIT AND SCREEN

NTS



PLAN VIEW



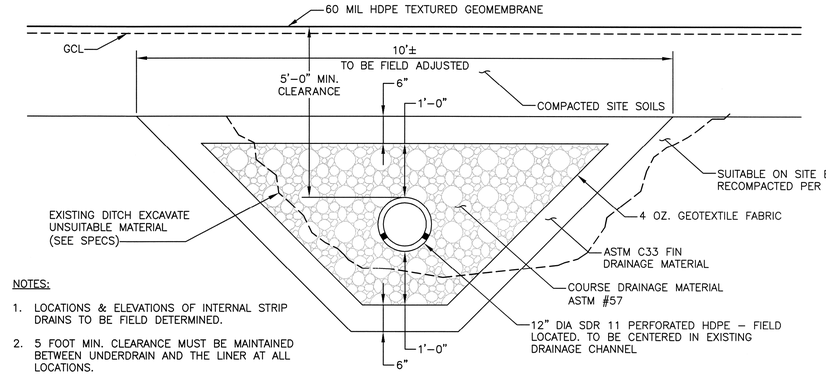
SECTION

NOTES:

1. MANHOLE COVER AND BARREL SECTIONS H-20 LOAD RATED.
2. PRECAST CONCRETE MANHOLE MANUFACTURER TO PROVIDE ANTI-FLOATATION EXTENDED BASE SLAB AS NECESSARY. ANTI-FLOATATION DESIGN AND SHOP DRAWINGS SHALL BE PREPARED BY THE MANUFACTURER AND SUBMITTED TO THE ENGINEER FOR APPROVAL.

FORCE MAIN CLEANOUT DETAIL

NTS

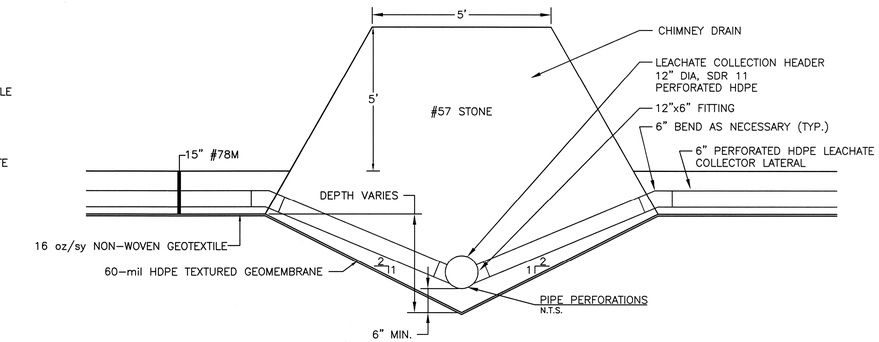


NOTES:

1. LOCATIONS & ELEVATIONS OF INTERNAL STRIP DRAINS TO BE FIELD DETERMINED.
2. 5 FOOT MIN. CLEARANCE MUST BE MAINTAINED BETWEEN UNDERDRAIN AND THE LINER AT ALL LOCATIONS.

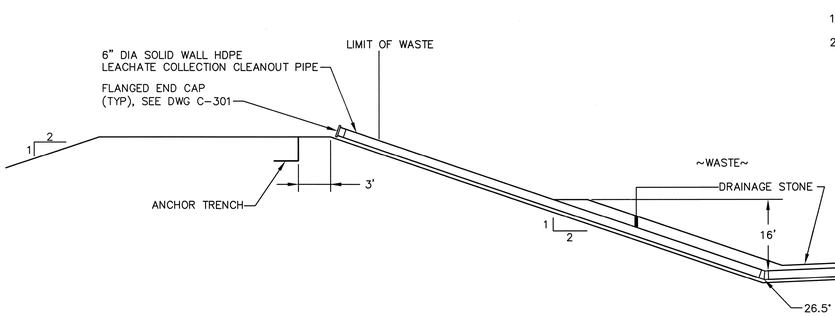
STRIP DRAIN COLLECTION PIPE

N.T.S.



LEACHATE COLLECTION HEADER PIPING SYSTEM WITH CHIMNEY DRAIN

N.T.S.

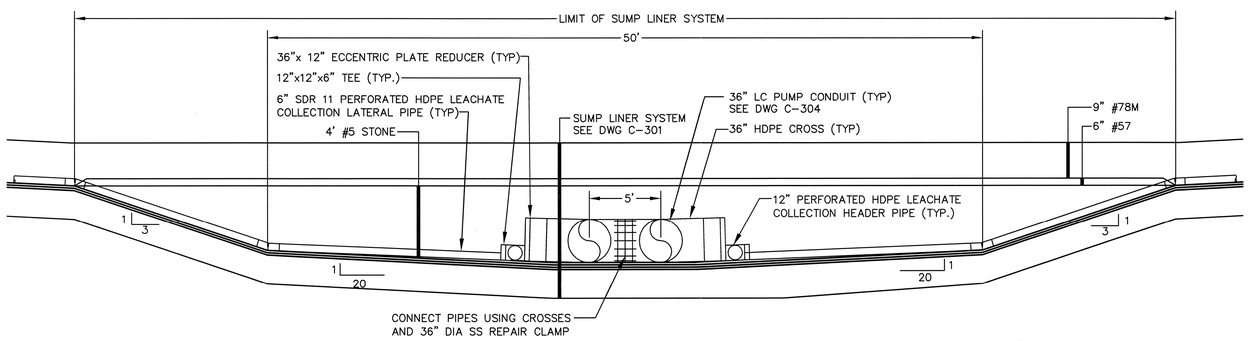


PUMP STATION TO SUMP-PIPE LAYOUT

NTS

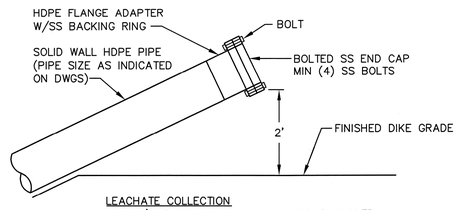
6" LEACHATE COLLECTION CLEANOUT

NTS



LEACHATE SUMP (TYP)

NTS

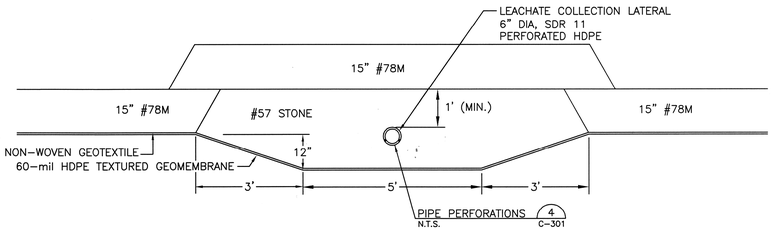


LEACHATE COLLECTION
LAST 6' OF PIPE ON CAP END - SOLID WALLED. PERFORATED PIPE TO LEACHATE COLLECTION HEADER.

LEAK DETECTION
CLEANOUT SOLID WALLED ENTIRE LENGTH TO HEADER.

FLANGED END CAP

NTS



LEACHATE COLLECTION LATERAL PIPING SYSTEM

N.T.S.

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20968 ENGINEER JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. - CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

SECTIONS AND DETAILS

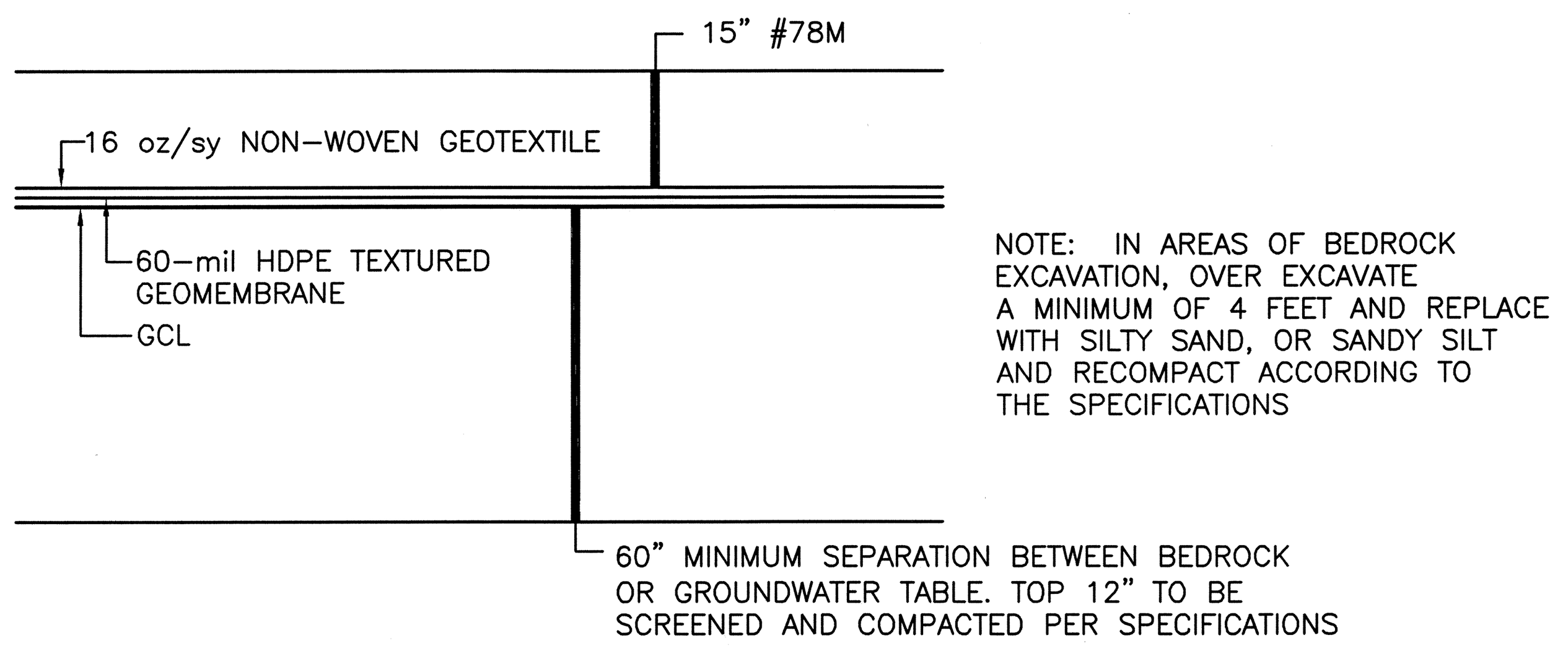
SME

Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

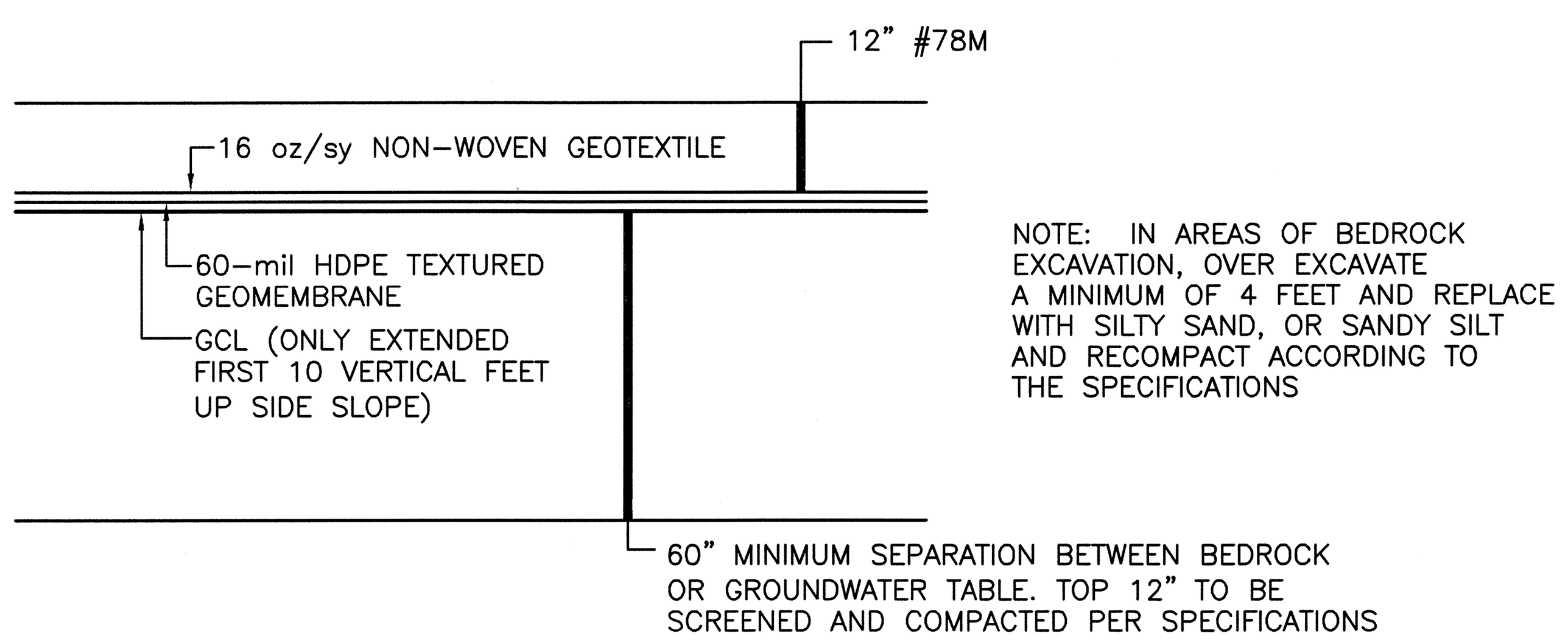
DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	
LMN:	
CTB:	

JOB NO. 07089.00 DWG FILE 6E-DETAILS

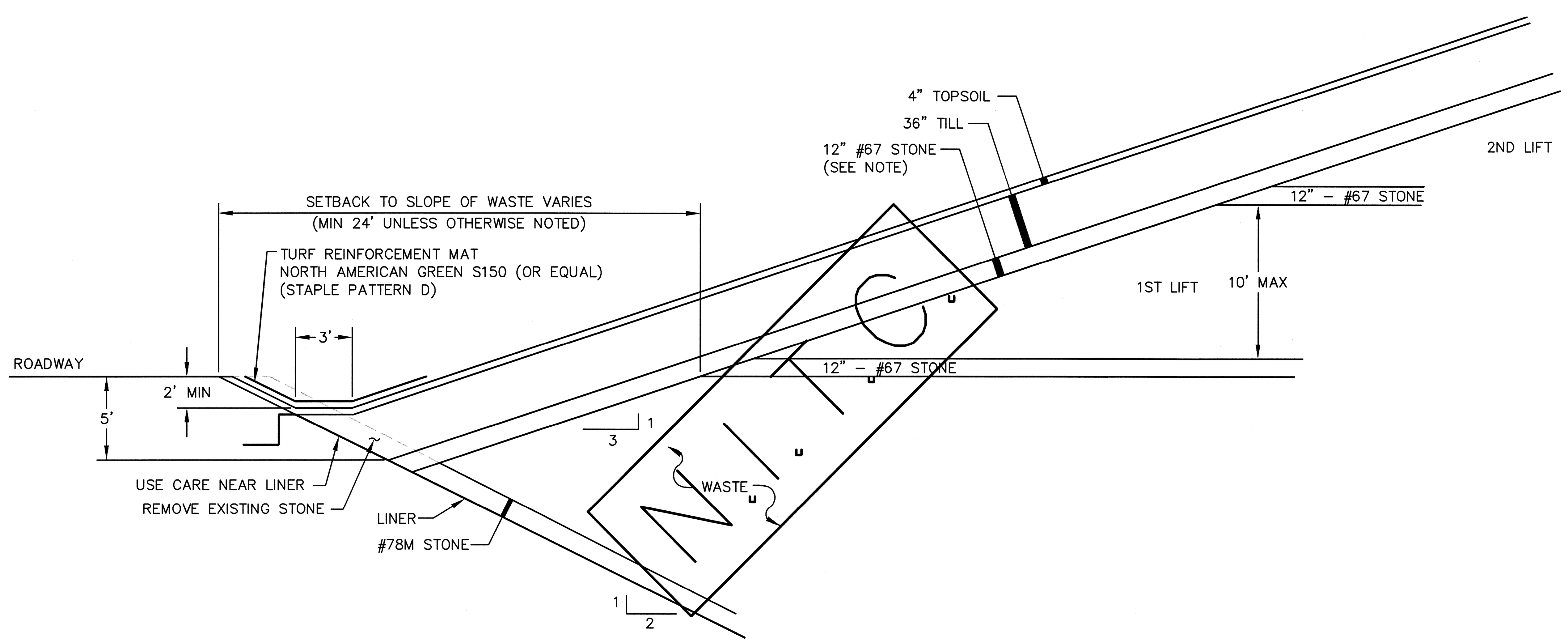
C-300



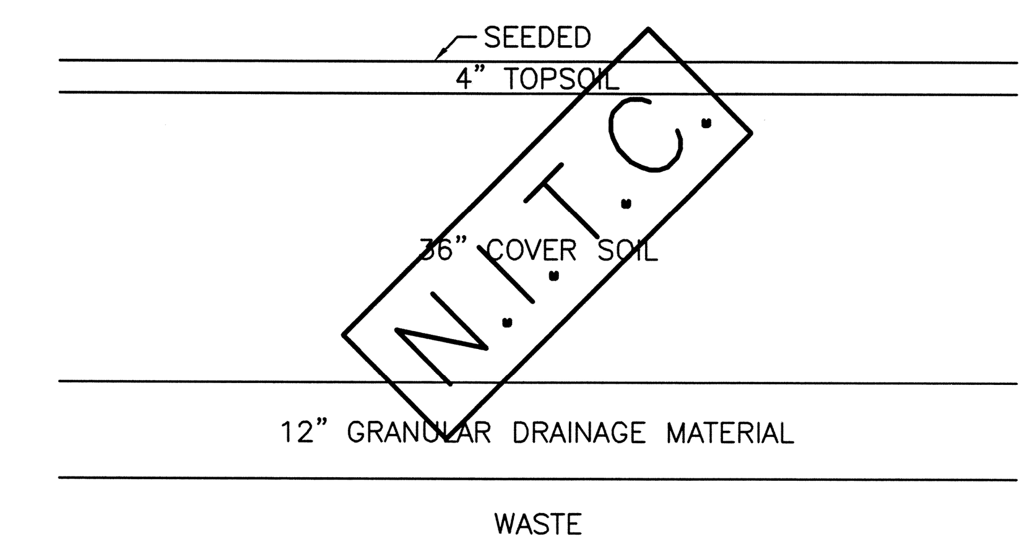
BASE LINER AND LEACHATE COLLECTION SECTION
N.T.S.



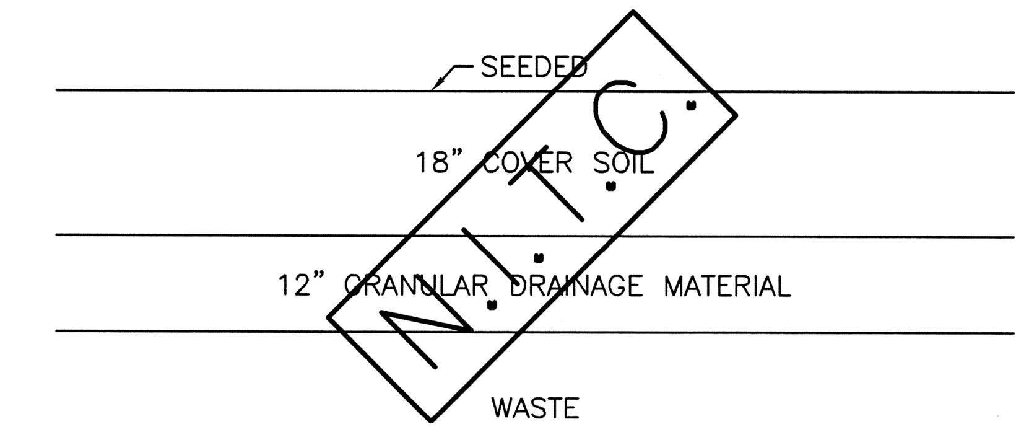
SIDESLOPE LINER AND LEACHATE COLLECTION SECTION
N.T.S.



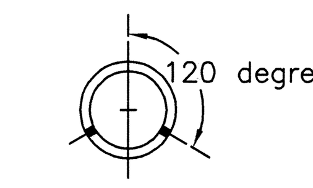
FINAL COVER SYSTEM
NTS



FINAL CLOSURE
N.T.S.

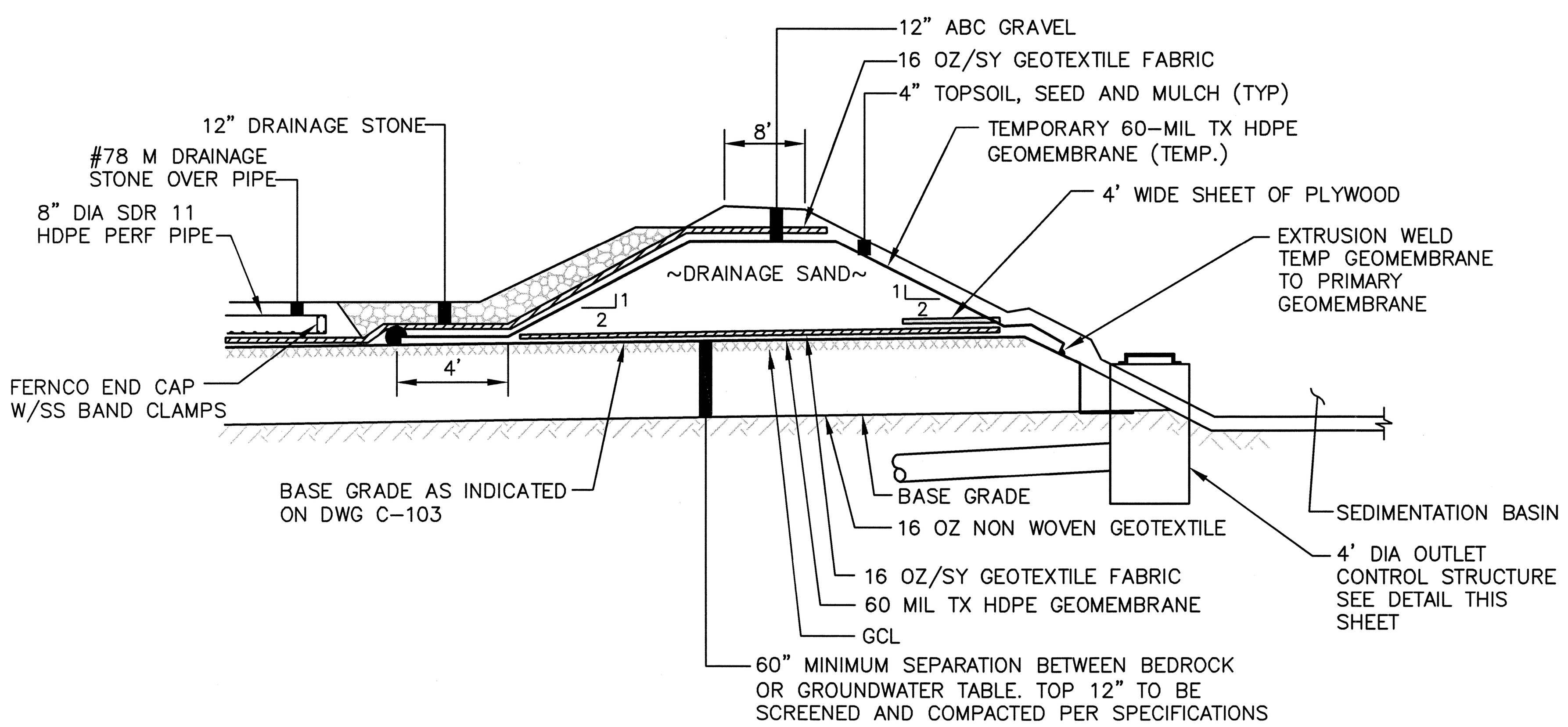


INTERMEDIATE CLOSURE
N.T.S.

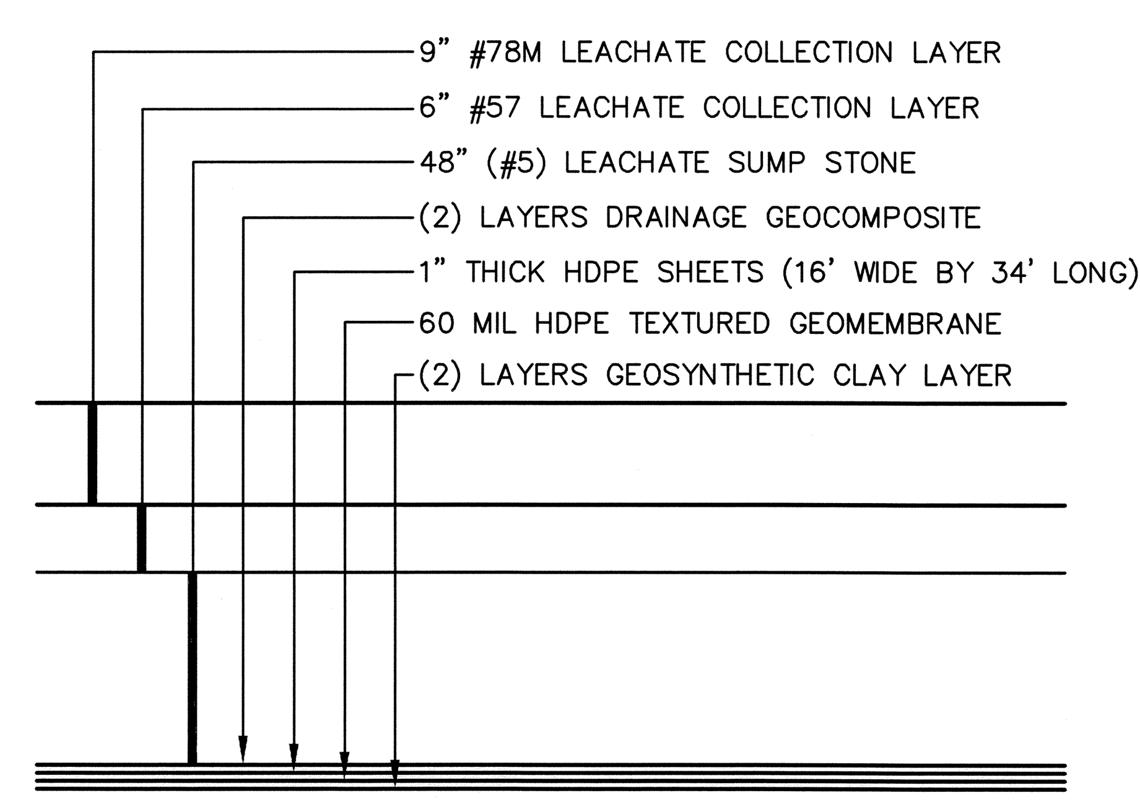


NOTE: PIPE PERFORATIONS SHALL BE 3/8" DIAMETER, 2 ROWS, 6" O.C. MAX., HOLES FACE DOWN

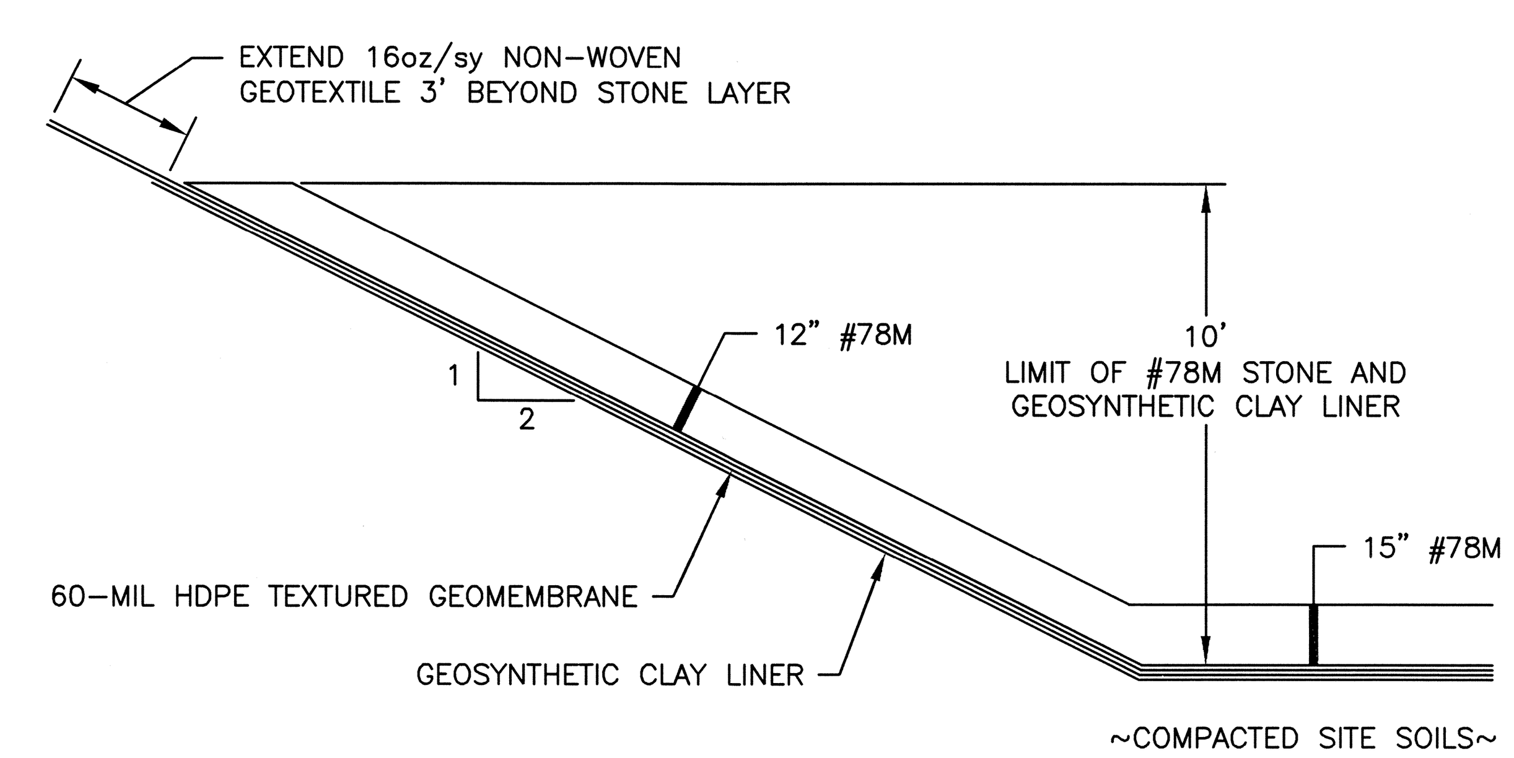
PIPE PERFORATIONS
N.T.S.



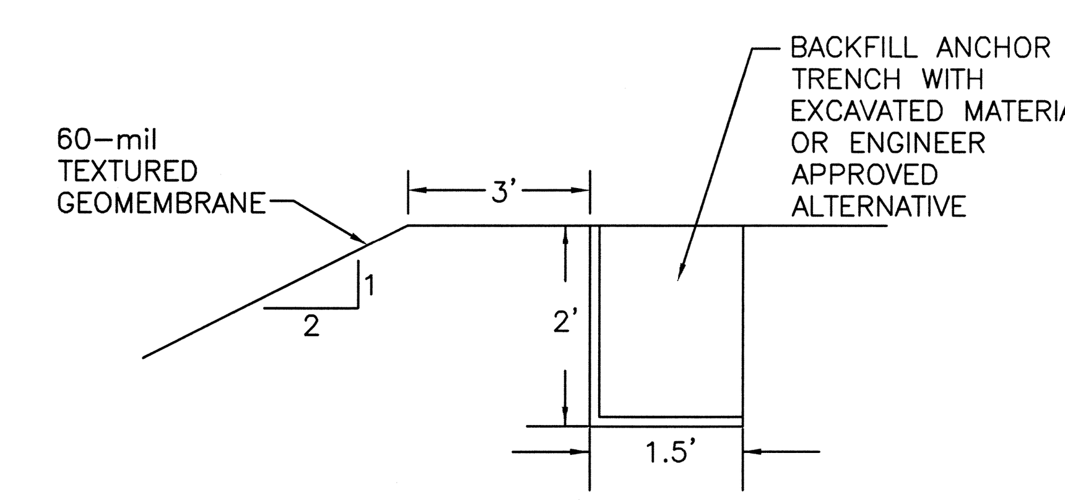
CONTAINMENT BERM
N.T.S.



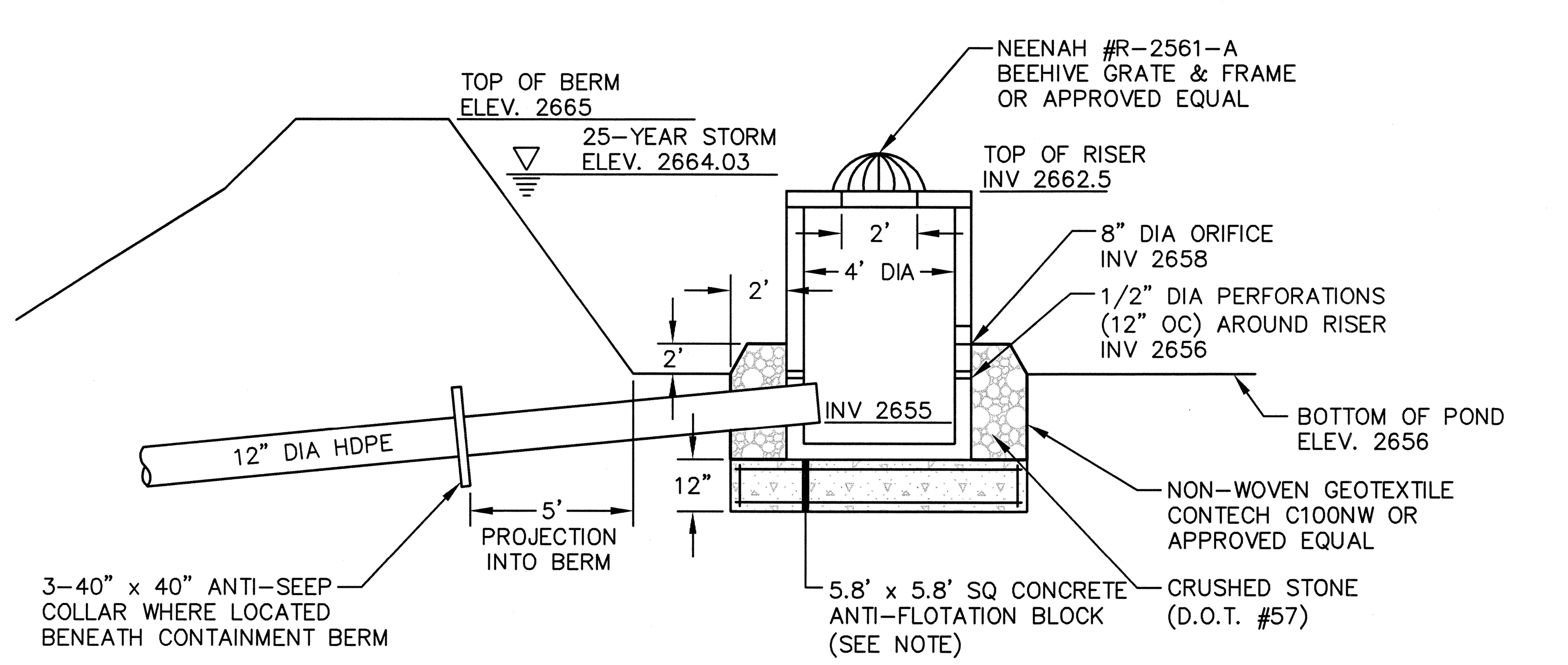
SUMP LINER SYSTEM
NTS



GCL AND LEACHATE COLLECTION SECTION
N.T.S.

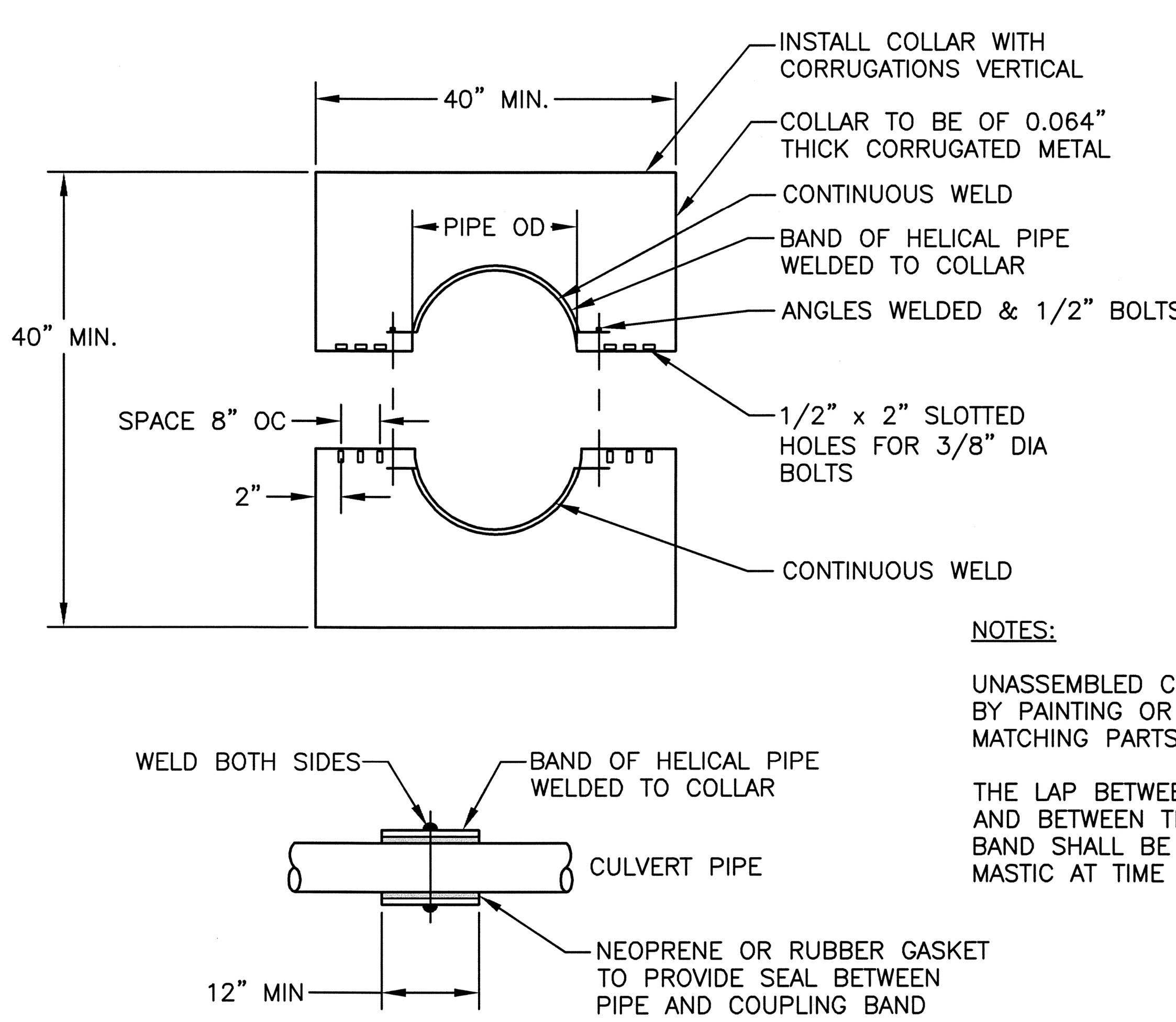


ANCHOR TRENCH
N.T.S.



NOTE:
RISER MUST BE EMBEDDED SIX-INCHES TO CONCRETE DECK.

OUTLET CONTROL STRUCTURE
NTS



NOTES:

UNASSEMBLED COLLAR SHALL BE MARKED BY PAINTING OR TAGGING TO IDENTIFY MATCHING PARTS.

THE LAP BETWEEN THE TWO HALF SECTIONS AND BETWEEN THE PIPE AND CONNECTING BAND SHALL BE CAULKED WITH ASPHALT MASTIC AT TIME OF INSTALLATION.

ANTI-SEEP COLLAR
NTS

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20869 ENGINEER JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

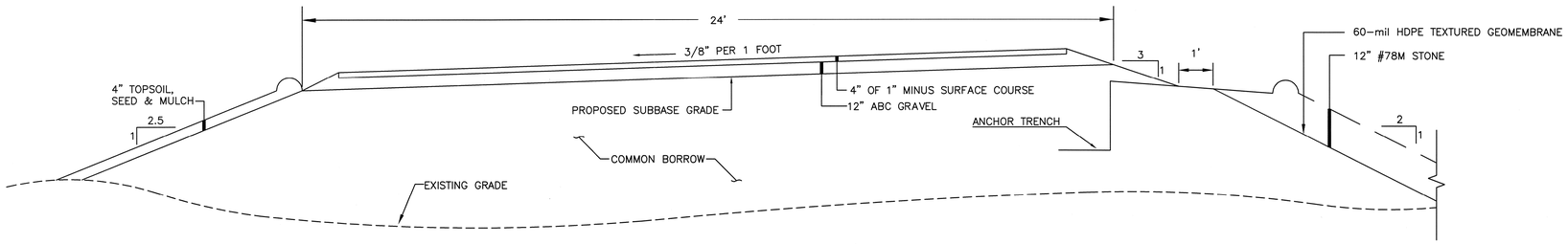
SECTIONS AND DETAILS

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

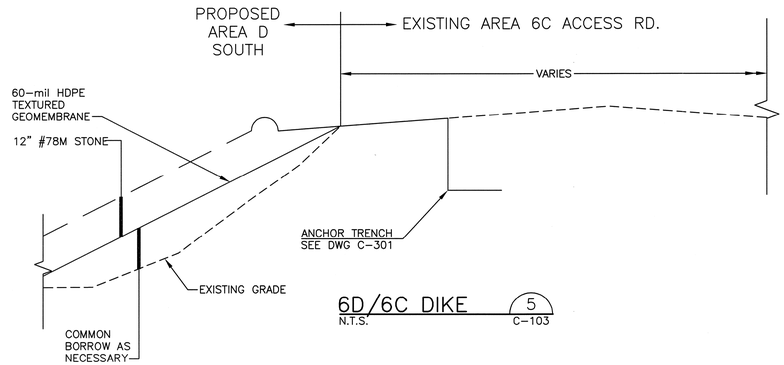
DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	
LMN:	
CTB:	

JOB NO. 07089.00 DWG FILE 6E-DETAILS

C-301

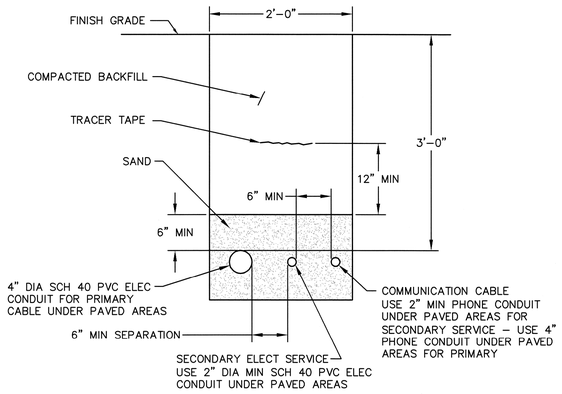


LANDFILL PERIMETER ROAD
N.T.S.

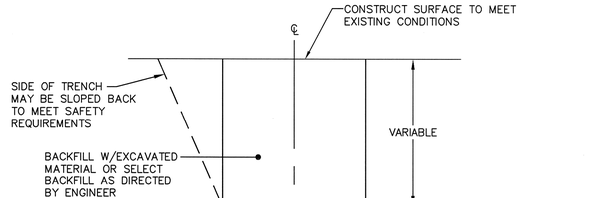


6D/6C DIKE (5, C-103)
N.T.S.

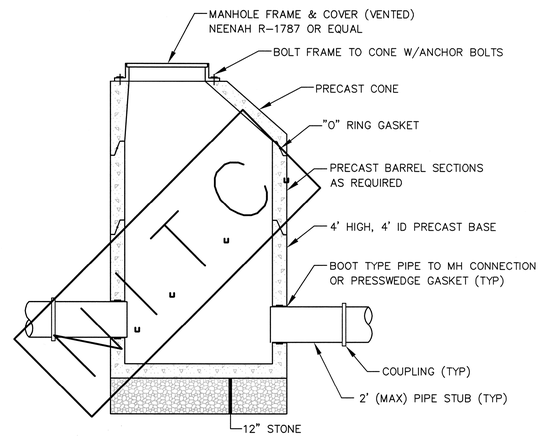
TEMPORARY ACCESS ROAD (6, C-103)
NTS



UNDERGROUND ELECTRICAL TRENCH DETAIL
NTS



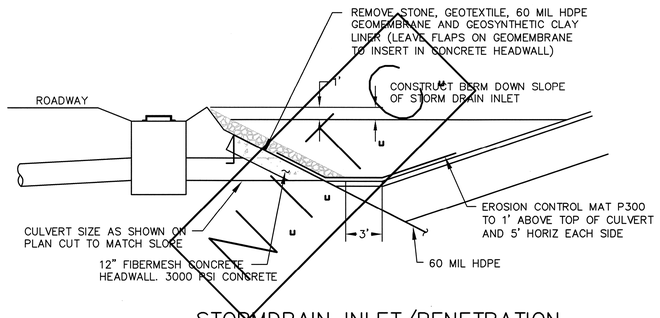
PIPE TRENCH DETAIL
NTS



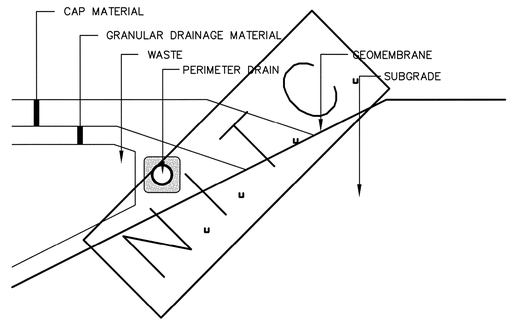
TYPICAL MANHOLE
NTS

MANHOLE NOTES:

1. ALL CONCRETE SHALL HAVE A MINIMUM 4000 PSI COMPRESSIVE STRENGTH AFTER 28 DAYS.
2. DESIGN FOR H-20 WHEEL LOADING.
3. CONFORM TO ASTM-C478 SPECIFICATIONS.
4. FIELD VERIFY EXISTING PIPE INVERTS PRIOR TO CONSTRUCTION.
5. PENETRATIONS INTO EXISTING MANHOLES FOR NEW PIPES SHALL USE EITHER A PRESS BOOT CONNECTION OR COMPRESSION TYPE GASKET.



STORMDRAIN INLET/PENETRATION
NTS



PERIMETER DRAIN
N.T.S.

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20589 ENGINEER JOHN E. SEVEE

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

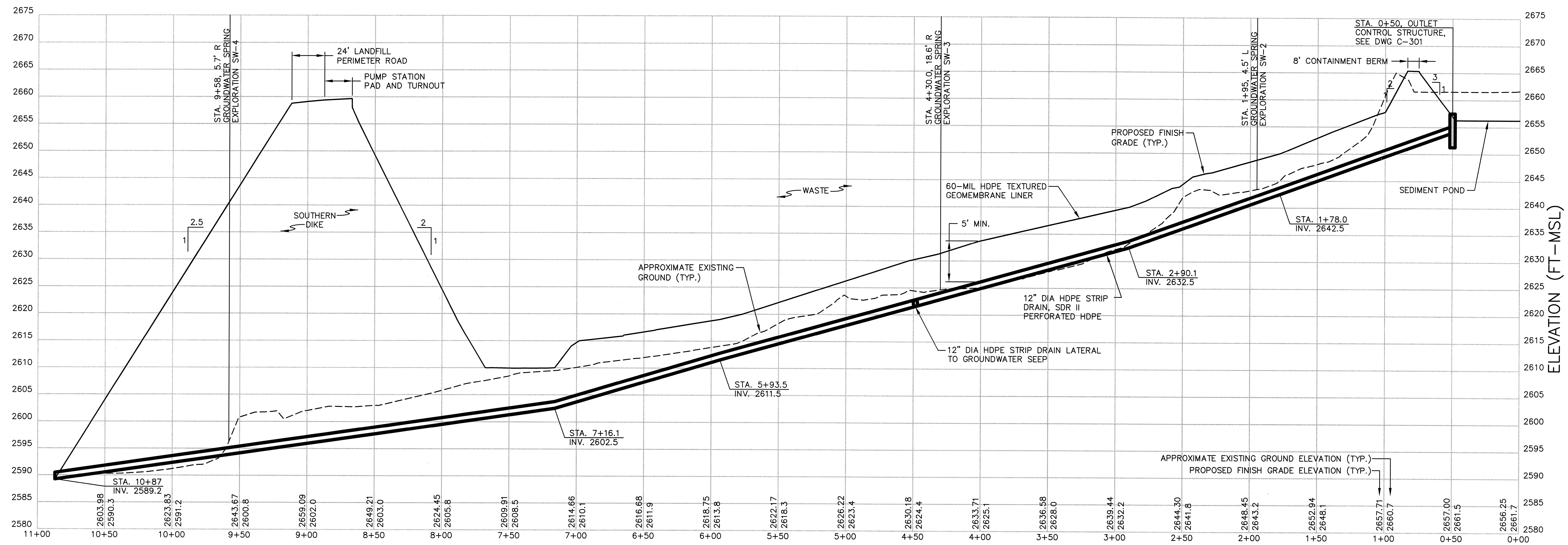
SECTIONS AND DETAILS

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	
LMN:	
CTB:	

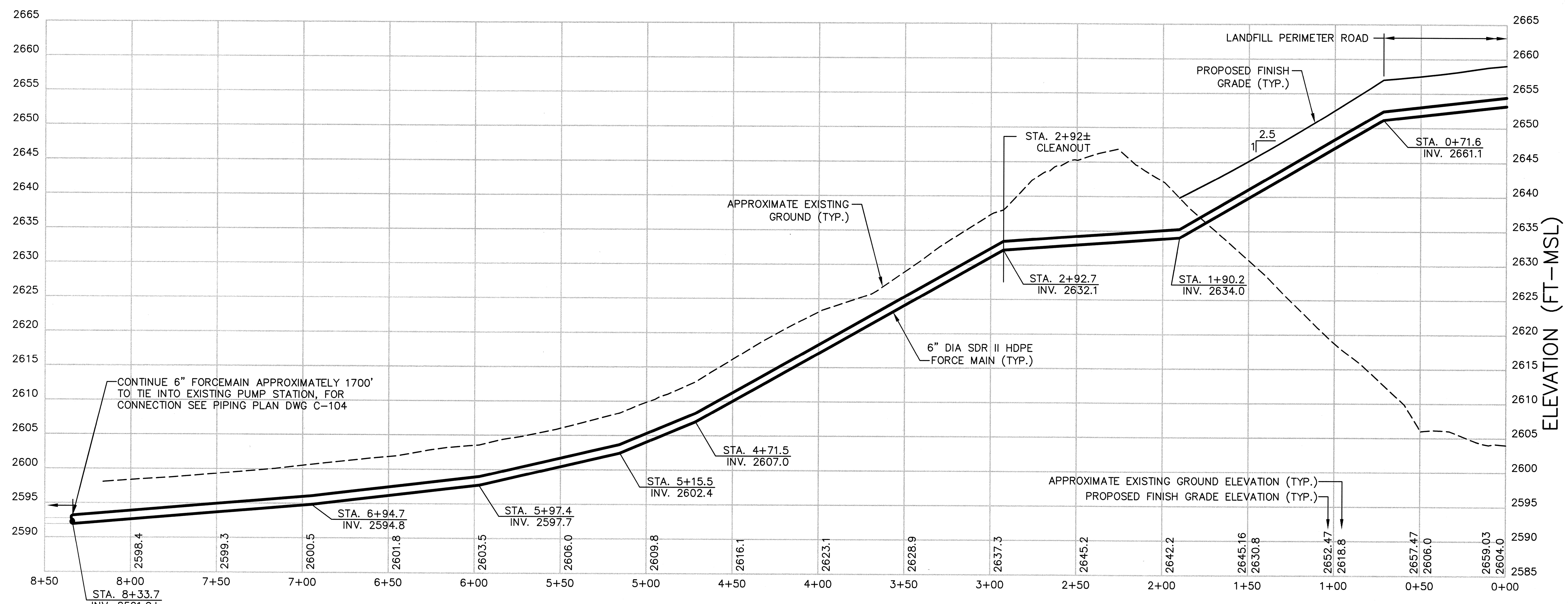
JOB NO. 07089.00 DWG FILE 6E-DETAILS

C-302



PROFILE ALONG UNDERDRAIN

SCALE: 1"=40' H
1"=10' V



PROFILE ALONG FORCEMAIN

SCALE: 1"=40' H
1"=10' V

20 0 40 80 FEET HORZ.
5 0 10 20 FEET VERT.

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BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT
UNDERDRAIN AND FORCEMAIN PROFILES

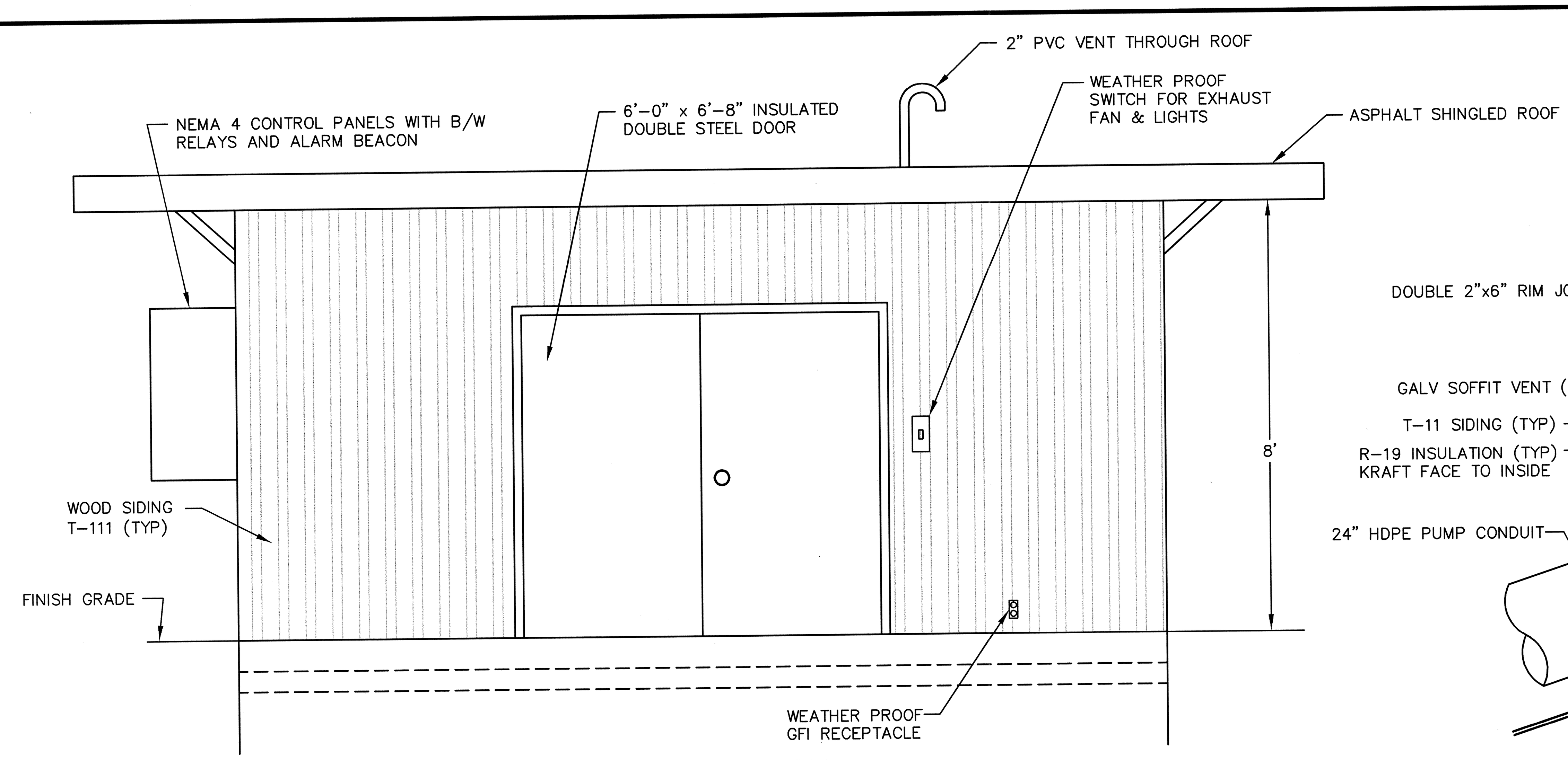
NORTH CAROLINA PROFESSIONAL SEAL 20668 ENGINEER JOHN E. SEVEE

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

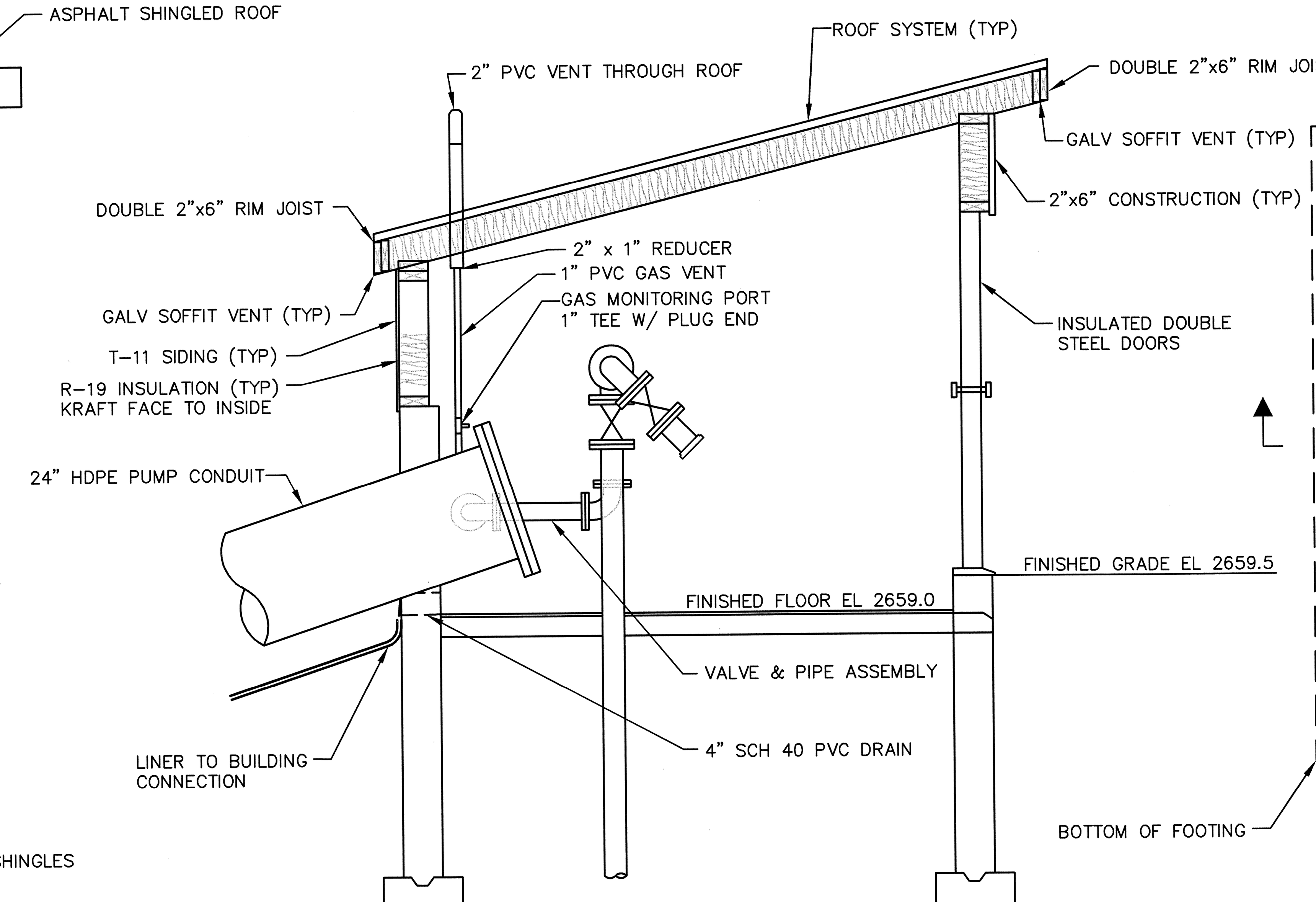
DESIGN BY: HME
DRAWN BY: SJM
DATE: 8/29/08
CHECKED BY:
LMN:
CTB:

JOB NO. 07089.00 DWG FILE 6E-DETAILS

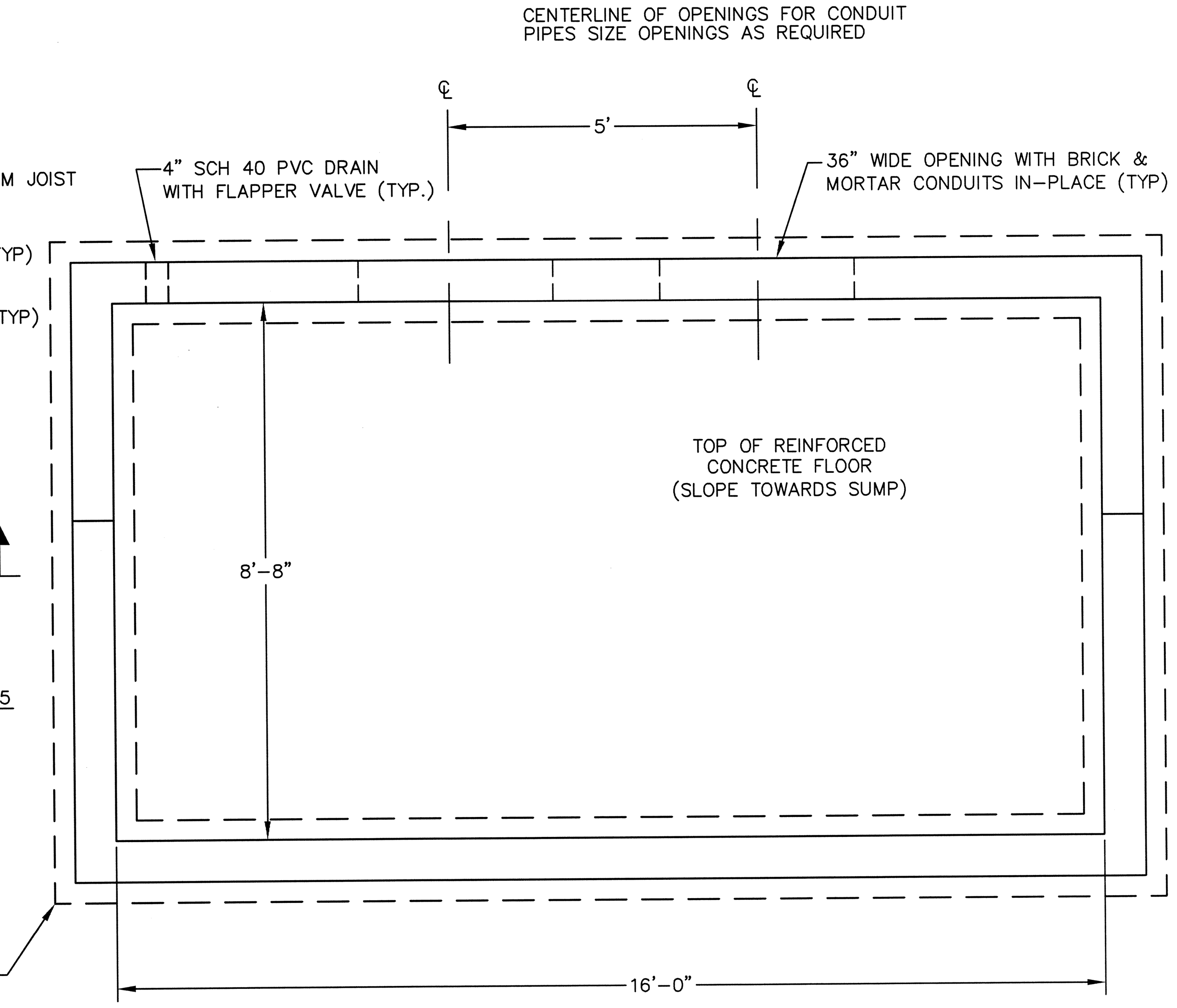
C-303



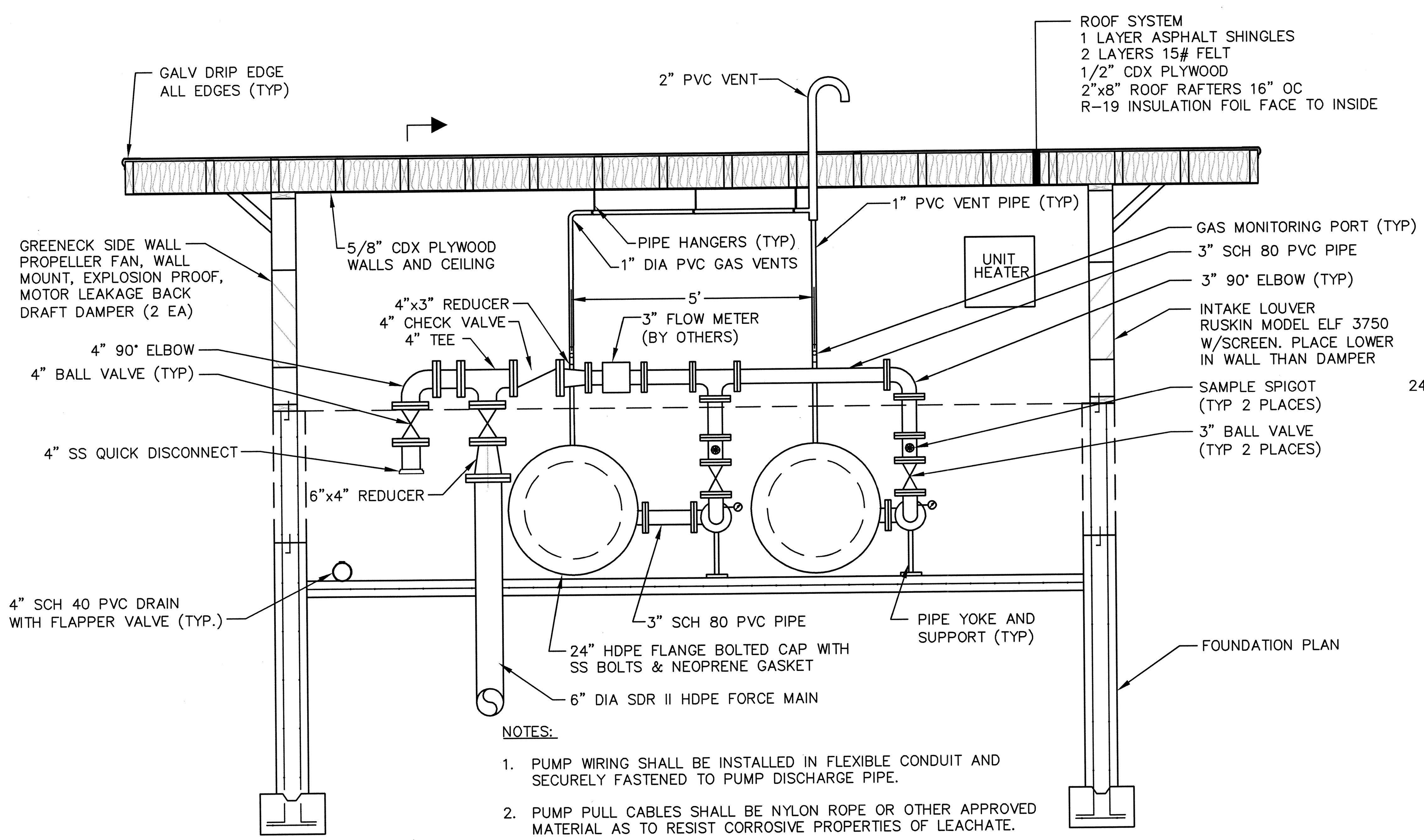
SOUTH ELEVATION
NTS



SECTION
NTS



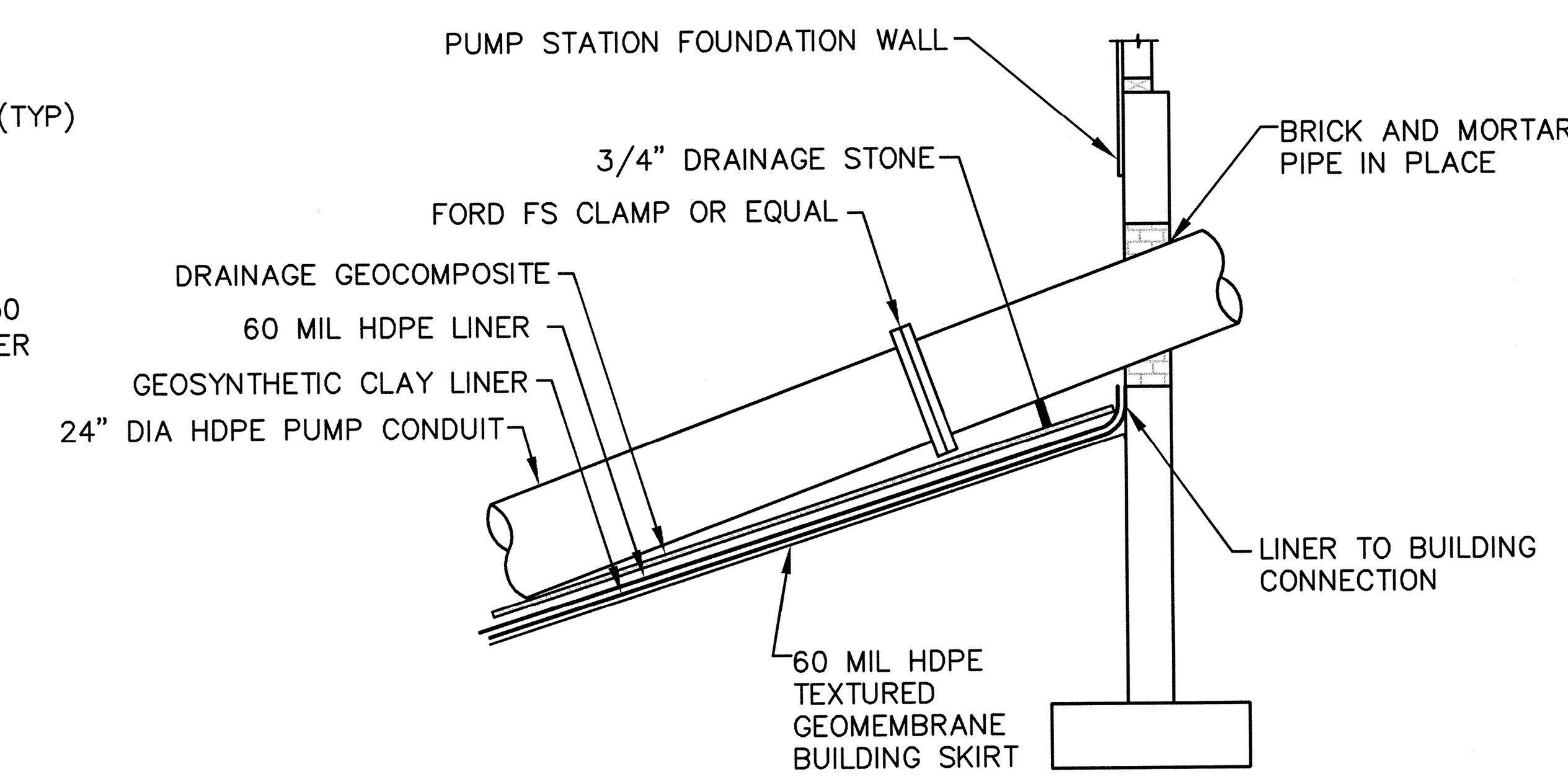
PLAN



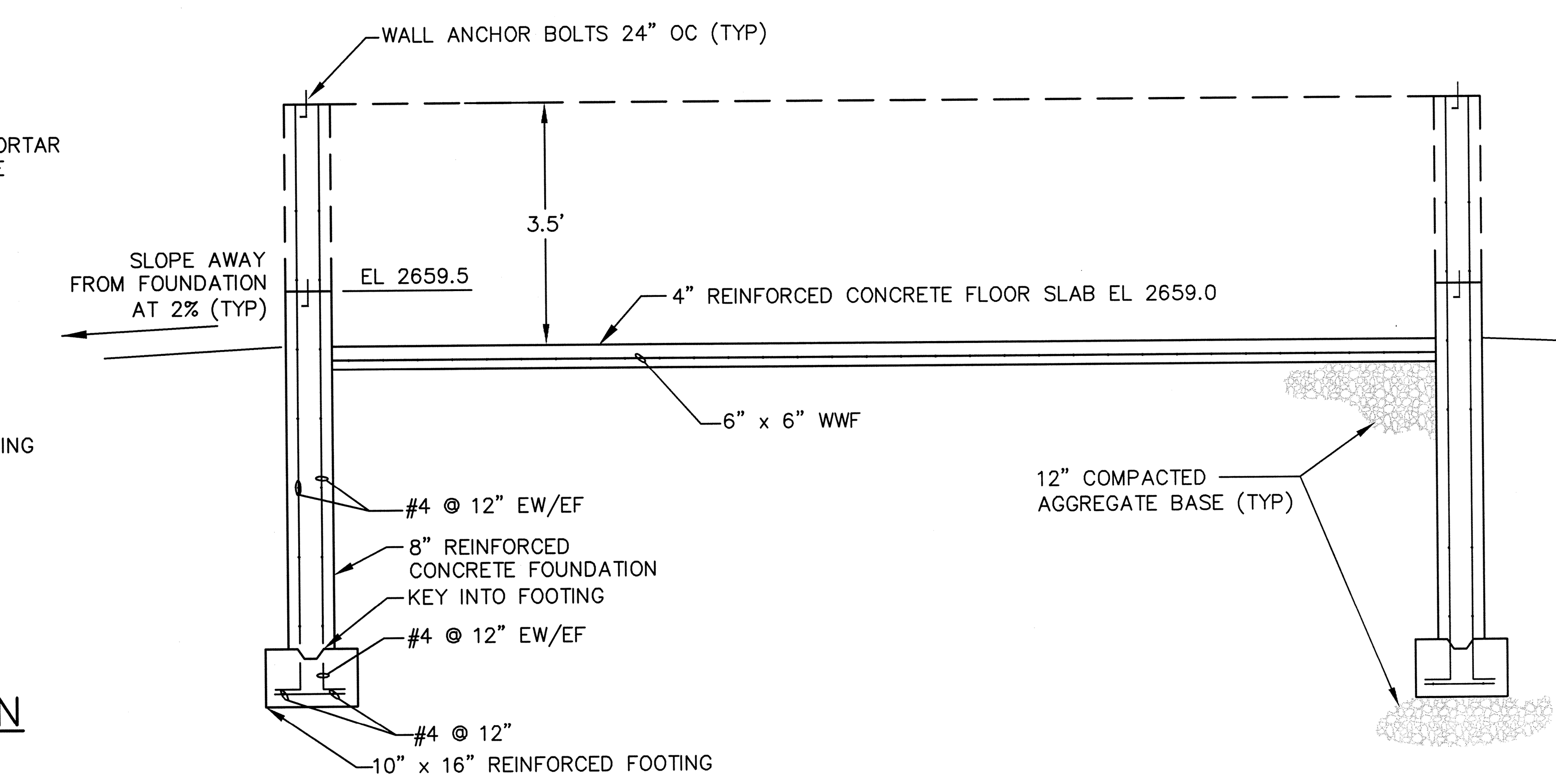
NOTES:

1. PUMP WIRING SHALL BE INSTALLED IN FLEXIBLE CONDUIT AND SECURELY FASTENED TO PUMP DISCHARGE PIPE.
2. PUMP PULL CABLES SHALL BE NYLON ROPE OR OTHER APPROVED MATERIAL AS TO RESIST CORROSIVE PROPERTIES OF LEACHATE.
3. SEAL ALL PUMP ELECTRICAL CONDUIT PENETRATIONS THROUGH PUMP BUILDING.

LEACHATE PUMP STATION
NTS

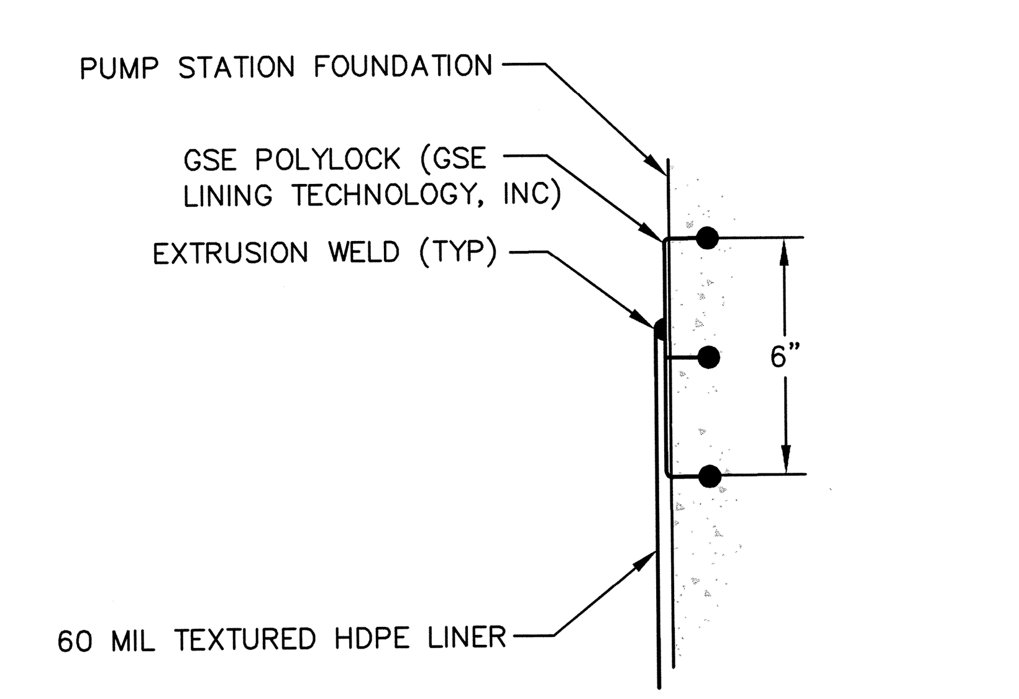


LINER TO PUMP STATION CONNECTION
NTS

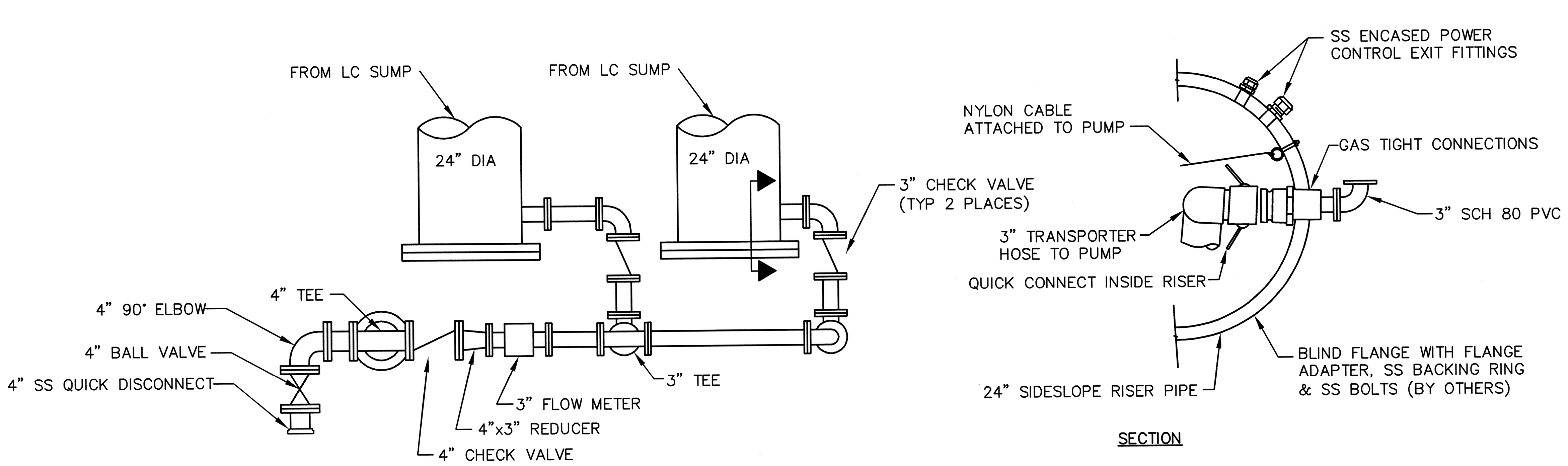


SECTION

FOUNDATION DETAIL
NTS



LINER TO BUILDING CONNECTION
NTS



VALVE & PIPE ASSEMBLY
NTS

REV.	BY	DATE	STATUS
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BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

PUMP STATION DETAILS

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 28589 JOHN E. SEVEE

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

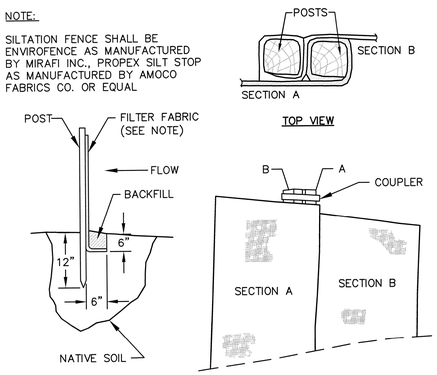
DESIGN BY: HME
DRAWN BY: SJM
DATE: 8/29/08
CHECKED BY:
LMN:
CTB:

JOB NO. 07089.00 DWG FILE 6E-DETAILS

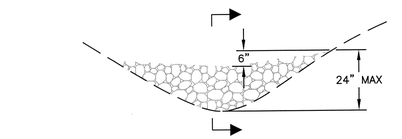
C-304

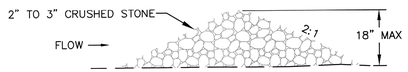
NOTE:

SILTATION FENCE SHALL BE ENVIROFENCE AS MANUFACTURED BY MIRAFI INC., PROPEX SILT STOP AS MANUFACTURED BY AMOCO FABRICS CO. OR EQUAL



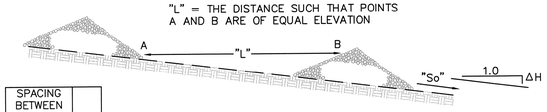
SILT FENCE
NTS





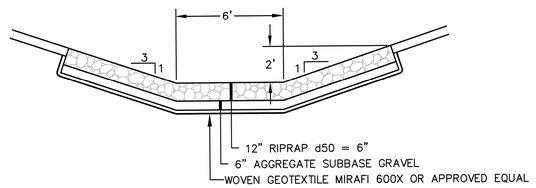
SECTION

"L" = THE DISTANCE SUCH THAT POINTS A AND B ARE OF EQUAL ELEVATION

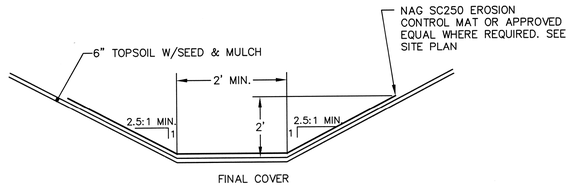


SPACING BETWEEN CHECK DAMS	
"So" FT/FT	"L" FT
0.020	75
0.030	50
0.040	40
0.050	30
0.080	20
0.100	10

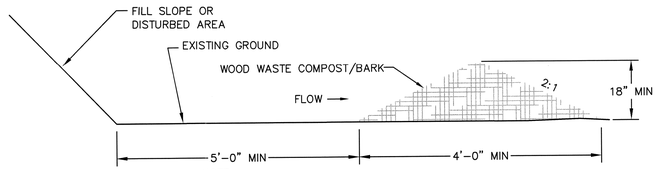
STONE CHECK DAM
NTS



RIPRAP DITCH
NTS



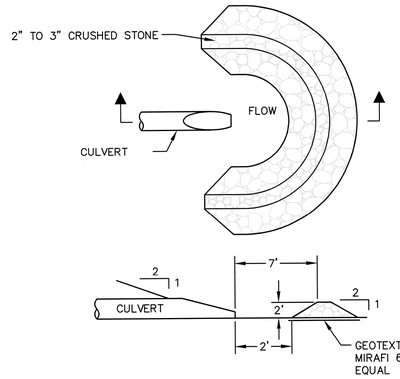
GRASS DITCH
NTS



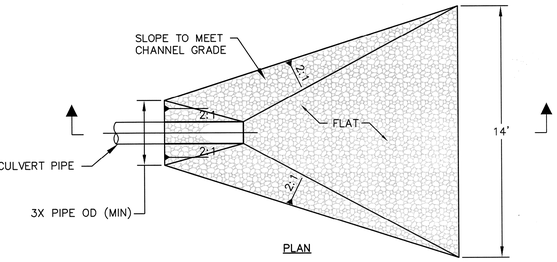
NOTE:

BARK MULCH SEDIMENT BARRIERS MAY BE USED AS AN ALTERNATE TO SILT FENCE WHEN APPROVED BY THE ENGINEER.

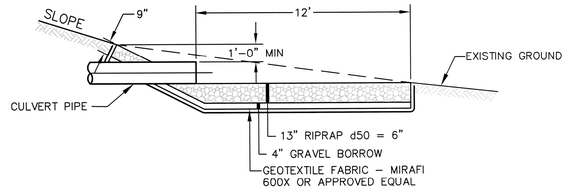
BARK MULCH SEDIMENT BARRIER
NTS



RIPRAP CULVERT INLET PROTECTION (TEMPORARY)
NTS

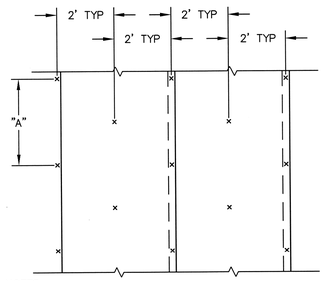


PLAN



SECTION

RIPRAP APRON
NTS



NOTES:

1. SEE TABLE FOR DIMENSION "A".
2. SIMILAR PATTERN FOR 8'W ROLLS.
3. MIDDLE ROW OF STAPLES OFFSET BY 1/2 X "A".

	DIMENSION "A"	
	SLOPE	CHANNEL
CURLEX-I	<3:1 6' >3:1 3'	3'
CURLEX-II	<3:1 6' >3:1 3'	2'-6"
CURLEX-III	<2:1 3' >2:1 2'	2'

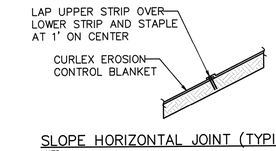
NOTE:

1. SEE PLAN VIEW FOR DIMENSION "A".

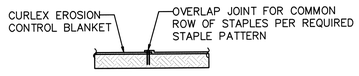
STAPLES:

1. COHESIVE SOIL: 6"L X 1"W.
2. NON-COHESIVE SOIL: 8"L X 2"W.
3. INSTALL 1' OC AT TOP OF STRIP.

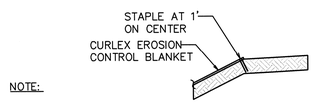
CURLEX STAPLE PATTERN
NTS



SLOPE HORIZONTAL JOINT (TYPICAL)
NTS



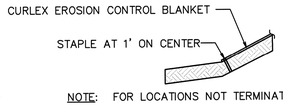
SLOPE VERTICAL JOINT (TYPICAL)
NTS



NOTE:

FOR LOCATIONS EXPOSED TO LITTLE/NO OVERLAND FLOW FROM ABOVE.

SLOPE UPHILL TERMINATION - TYPE I (TYPICAL)
NTS



NOTE: FOR LOCATIONS NOT TERMINATING IN CHANNEL.

SLOPE DOWNHILL TERMINATION - TYPE I (TYPICAL)
NTS

EROSION CONTROL BLANKET (TYP)
NTS

REV.	BY	DATE	STATUS
	HME	11/14/08	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 20899 ENGINEER JOHN E SEVEE

BLUE RIDGE PAPER PRODUCTS INC. - CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

EROSION CONTROL DETAILS

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	8/29/08
CHECKED BY:	
LMN:	
CTB:	

JOB NO. 07089.00 DWG FILE 6E-DETAILS

C-305

APPENDIX B

STABILITY EVALUATION

STABILITY EVALUATION

LANDFILL NO. 6
SITE INVESTIGATION – AREAS D AND E

BLUE RIDGE PAPER PRODUCTS INC. –
CANTON MILL
DIVISION OF EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

NOVEMBER 2008

SME

Sevee & Maher Engineers, Inc.
Waste Management and Hydrogeologic Consultants
Cumberland Center, Maine

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

1.0 STABILITY EVALUATION

SME has completed a stability evaluation as part of the landfill expansion into Areas D and E. Components of the evaluation included a stability analysis addressing the geotechnical performance of the subsurface (foundation) soils, the proposed wastes, perimeter containment dikes and the landfill liner system. The evaluation considered both static and seismic loading conditions. The stability evaluation for Areas D and E of Blue Ridge Paper Products Inc. – Canton Mill (Blue Ridge) Landfill No. 6 used site data collected in the Fall of 2007 as part of the site investigation (as described in Volume I of the Application). In addition, SME's evaluation made use of several previous geotechnical investigations that have been conducted at the Blue Ridge landfill facility. Testing has been performed by SME and others on the site wastes, foundation and dike soils. Data from previous investigations were used to augment the 2007 investigation and testing, namely:

- Landfill Stability Evaluation for Vertical Expansions, Area 6A-West (SME, 2006)
- Landfill Stability Evaluation for Vertical Expansions, Area 6A-East (SME, 1999)
- Operations Manual, Champion International Corporation Landfill No. 6 East, Canton, North Carolina, (SME, 1995a)
- Landfill No. 6 Closure Report, Field and Laboratory Investigation Report (SME, 1995b)
- Geotechnical Report for Landfill No. 6 Expansion Area A (Sirrine, 1989)
- Revised Report of Geotechnical Exploration and Evaluation and Conceptual Site Development Recommendations, Landfill No. 6 (Law, 1982)

1.1 Selection of Input Parameters

1.1.1 Landfill Wastes. The relevant geotechnical properties for the proposed Areas D and E waste were selected based primarily on the laboratory testing performed as part of SME's, May 2006 Landfill Stability Evaluation for Vertical Expansion, Area 6A-West (SME, 2006). The total unit weight and effective strength data are tabularized on Table A-1 in Appendix A. The

selected effective shear strength of the waste is graphically presented relative to the rest of the available test data in Figure A-1 in Appendix A. The properties selected for the waste were: an average total unit weight of 90 pcf and an average effective friction angle of 36 degrees with no cohesion. Both of these values are conservative estimates based on SME's laboratory testing and on the historical values presented by others. Selective laboratory test results are presented in Appendix A.

1.1.2 Perimeter Dikes. The geotechnical properties for the proposed Areas D and E dikes were selected based on data and testing performed and collected from dike soils as part of the Area 6A-East Vertical Expansion. This data along with data from previous investigations is tabularized on Table A-2 in Appendix A. The direct shear data is plotted in Figure A-2 of Appendix A, along with available data from previous investigations of borrow source material for the perimeter dike. The geotechnical properties selected for the perimeter dikes were a total unit weight of 120 pcf and an effective friction angle of 32 degrees with an effective cohesion of zero psf.

1.1.3 Foundation Materials. The geotechnical properties of the foundation soils were also based on testing performed as part of the Area 6A-West Vertical Expansion and confirmed with field testing performed as part of the Areas D and E site investigation. The foundation soils were assumed to have a slightly lower friction angle than the dike soils since they were not manually compacted. The total unit weight and effective friction angles were selected based on undisturbed tube samples of foundation soils tested by Sirrine, 1989. A total unit weight of 115 pcf and an effective friction angle of 28.5 degrees with no cohesion was selected for use in the stability analysis. The data is graphically presented in Figure A-3, and is tabularized on Table A-3, both in Appendix A.

1.1.4 Soil Cover. The soil cover was estimated to have an effective friction angle of 30 degrees with no cohesion and was assumed to have a unit weight of 125 pcf. The shear strength is based on a slight reduction of the dike soil strength, since a similar soil is assumed for the cover.

1.1.5 Liner. The proposed Areas D and E liner system will consist of 15-inches of #78 stone, underlain by a 16-ounce geotextile, underlain by a 60 mil HDPE textured geomembrane and, on all but the interior sideslopes, the 60-mil HDPE textured geomembrane is underlain by a geosynthetic clay liner. The liner system was assigned a strength envelop based on interface strength testing that SME has obtained on similar materials. That data is presented in Appendix A-1.

1.1.6 Piezometric Conditions. Based on water level data collected from piezometers placed within and around Areas D and E during the fall of 2007, a groundwater phreatic surface (i.e., water table) in the foundation soils was developed. Based on water level measurements of the Area 6A-West piezometers (SME, 2006), which showed that no phreatic surface existed within the dikes, it was assumed for the stability analysis that the Areas D and E dikes will be unsaturated. For the stability analysis it was assumed that the phreatic surface in the foundation soils was below the base of Areas D and E, sloping from Elevation 2702 feet NGVD in the north to Elevation 2590 feet NGVD at the landfill's southern toe.

The piezometric conditions assumed within the proposed Areas D and E waste mass were based on measurements from piezometers placed within the Area 6A-West waste (SME, 2006). In that evaluation, a relationship between excess pore pressure and waste depth was established, based on the measured liquid levels in the piezometers. As a result, for every foot of waste depth in the landfill, 0.18 feet of pore pressure was applied within the waste. A plot of this relationship is presented in Appendix B.

It should be noted that although the piezometric conditions modeled in Areas D and E were observed in Area 6A-West wastes, the SME evaluation also analyzed the worst-case condition of a fully-saturated waste mass with a phreatic surface at the top of the waste. This conservative condition assumes that the wastes are undrained and the leachate collection system is inoperable.

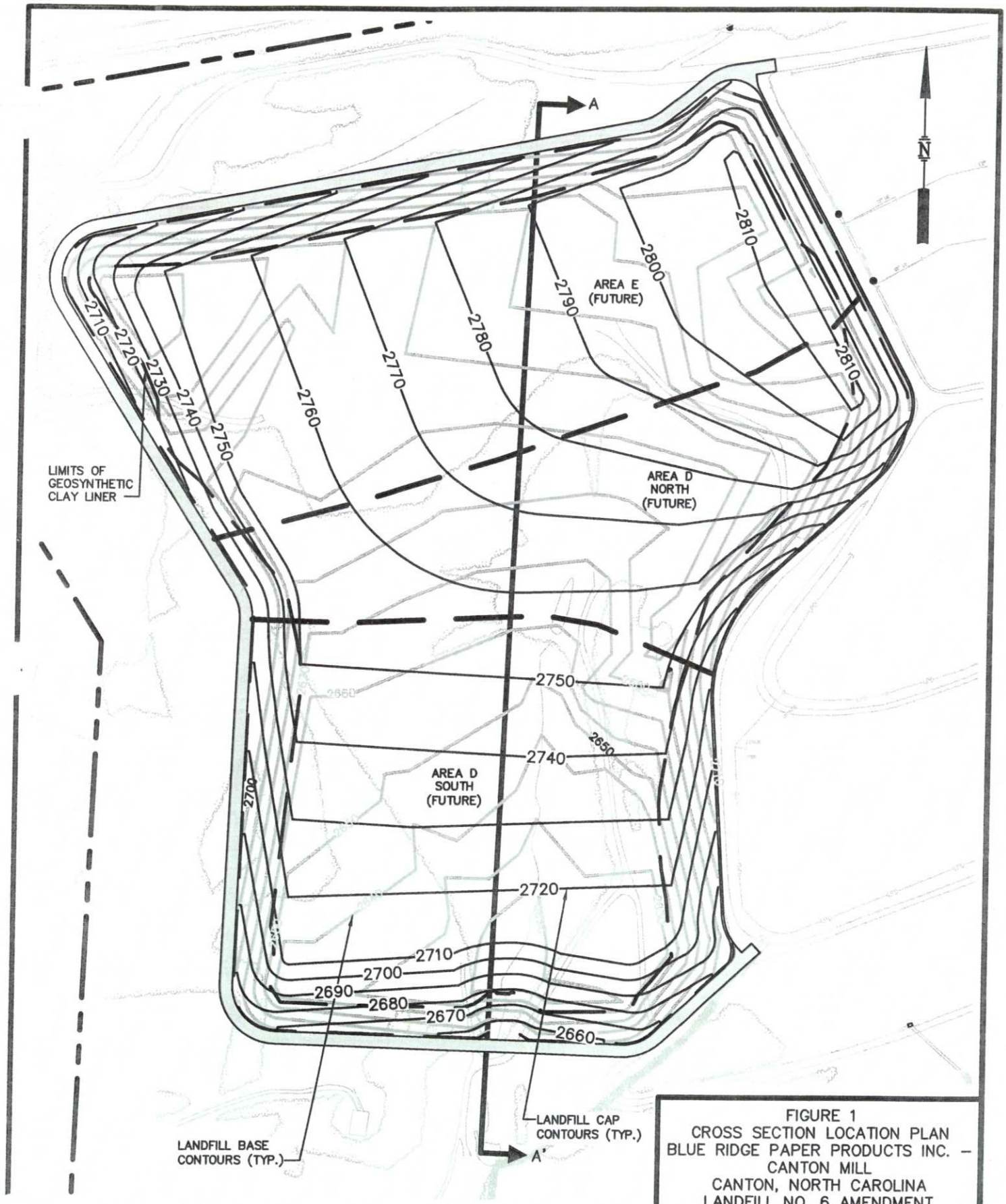


FIGURE 1
CROSS SECTION LOCATION PLAN
BLUE RIDGE PAPER PRODUCTS INC. –
CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

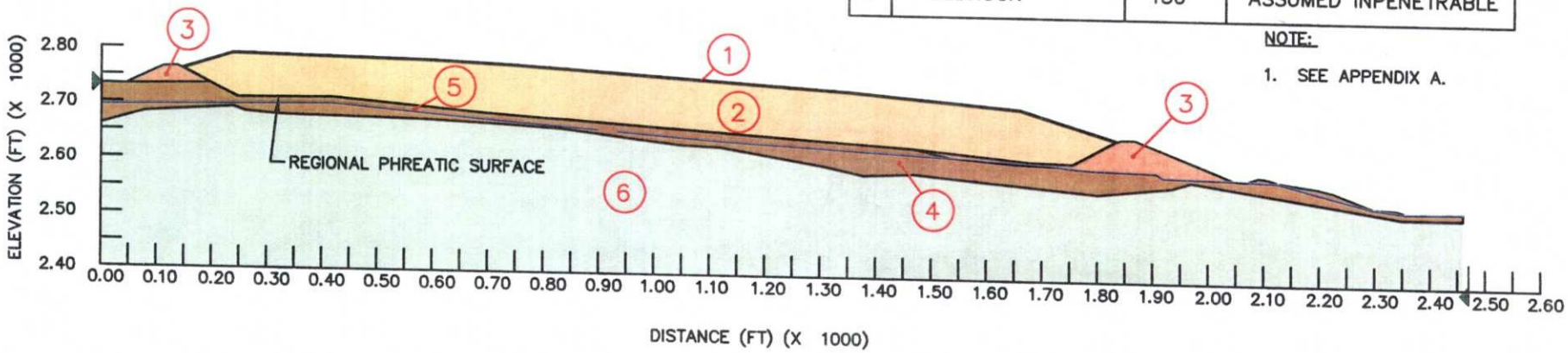
SME
Sevee & Maher Engineers, Inc.

DWG: SITEPLAN LMN: SECT-LOC CTB: SECT-LOCREV: 10/16/08

MATERIAL		UNIT	SHEAR STRENGTH	
NO	TYPE	WEIGHT (PCF)	ø (DEGREES)	c (PSF)
1	SOIL COVER	125	30	--
2	WASTE	90	36	--
3	PERIMETER DIKE	120	32	115
4	FOUNDATION SOIL	115	28.5	--
5	LINER	120	STRENGTH ENVELOPE [1]	
6	BEDROCK	150	ASSUMED INPENETRABLE	

NOTE:

1. SEE APPENDIX A.



NOTE:

PIEZOMETRIC CONDITION IN WASTE MODELED AS A GRID OF PRESSURE HEADS. BASED ON THE RELATIONSHIP OF 0.18 FEET OF PORE PRESSURE PER FOOT OF WASTE.

FIGURE 2
CROSS SECTION A–A'
BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

SME
Sevee & Maher Engineers, Inc.

DWG:SECTION A–A LMN: CTB:HPSTD REV:10/20/08

1.2 Selection of Critical Stability Cross-Section

One cross-section (Cross-Section A-A') was selected as representative of the geometry for Areas D and E, relative to slope stability. This cross-section is presented in Figure 2, and its locations in Figure 1. Cross-Sections A-A' was selected as because it passes through the area with the greatest proposed waste thickness and steepest sloping base grades. The maximum designed waste grade for Cross-Section A-A' is about Elevation 2790 feet NGVD, and the elevation of the toe of the southern dike is about Elevation 2590 feet NGVD.

1.3 Stability Analyses

Effective stress conditions were used in the stability analysis for the post-closure period. This approach is appropriate for free-draining materials such as the wastes expected to be landfilled in Areas D and E. The assumed piezometric conditions in the waste, foundation soils and perimeter dike allowed application of piezometric conditions necessary for the effective stress analysis. SME performed both static (i.e., non-earthquake) and pseudo-static (i.e., earthquake) stability analysis for the proposed final grading after closure of Areas D and E. The pseudo-static analysis consisted of applying a horizontal force to the static model to simulate an earthquake acceleration. The seismic stability analyses followed the approach outlined in U.S.EPA Subtitle D – Seismic Design Guidance. Based on the work of Hynes and Franklin, 1984, for a factor of safety greater than or equal to 1.0, a maximum value of the seismic coefficient used in the pseudo-static analysis was one-half the maximum acceleration estimated at the base of the landfill in order to keep permanent cover and embankment deformations less than 12 inches after an earthquake. Six to 12 inches of seismically induced downslope displacement is generally considered tolerable in the current design of landfill liners (Seed and Bonaparte, 1992). The maximum horizontal seismic acceleration at Areas D and E were obtained from Algermissen, et al, 1990. This map provides a maximum acceleration at the bedrock surface of 0.26g (acceleration, as a percent of gravity) in the western North Carolina region, with a 90 percent probability of not being exceeded in 250 years. Based on Hynes and Franklin, 1984, the seismic coefficient to be used in the pseudo-static stability analysis is one-half of 0.26g or 0.13g.

The results of static and pseudo-static analyses are included in Appendix C and indicate factors of safety greater than 1.5 for the proposed final grading configuration under drained conditions. Factors of safety were calculated for three types of slip surfaces: (1) a slip surface passing through the waste alone; (2) a slip surface passing through the waste, perimeter dike and foundation soil; and (3) a slip surface passing through the dike and foundation soil. Minimum factors of safety for the three types of slip surfaces described above were 2.3, 1.8 and 1.7, respectively. For the seismic case, minimum factors of safety were 1.6, 1.1 and 1.1 for the three failure scenarios, respectively. Factors of safety greater than 1.5 for static loading and 1.0 for seismic loading are considered acceptable for this type of facility, based on SME experience in other states and other projects in North Carolina where no regulatory limits exist.

Moreover, analysis of waste stability for a worst-case condition of a fully-saturated waste mass with a phreatic surface at the top of the waste yielded factors of safety of 1.5 or better for each of the slip surface types described above.

It is expected that the interior of the containment dike will remain unsaturated. However, sensitivity analysis was performed with respect to the phreatic surface within the dike. The results demonstrated that the water surface within the dike could be as high as forty feet above the existing regional groundwater surface before dike stability is potentially compromised, as shown on the output plots in Appendix C.

Stability analysis was performed to evaluate the operational stability of the liner system, relative to the waste placement lift height and the slope of the operating face. The analyses demonstrate that the slope of the waste operating face should not be placed at an angle greater than 2 horizontal (H) to 1 vertical (V). At angles greater than this, stress imbalances on the liner system result in factors of safety less than 1.3, which is considered adequate to maintain operational stability.

The infinite-slope case (Lambe and Whitman, 1969) was used to check the stability of the face of the closed landfill and cover. At this point, it is expected that a compacted soil cover will be

used for Area 6A-West. No specific final cover system stability analysis was performed for this report other than this infinite slope analysis. Based on the selected shear strengths, and assuming no seepage parallel to the landfill slope faces, a minimum factor of safety of 1.7 was calculated. This calculation is provided in Appendix C.

2.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the interpretation of the available site specific field and laboratory test data, and the results of the slope stability evaluation completed for this report, the following conclusions have been reached.

- The results of the static and seismic stability analyses conducted for the proposed final grading plan for the Areas 6D and 6E Landfill exceed generally accepted safety factors for the stability cross-section analyzed. Accordingly, it is concluded that stable slope, foundation, and waste conditions will be maintained with the proposed final grades and waste streams described in this report.

- Future wastes delivered to the landfill are assumed to consist mainly of the same sludge, ash, and lime mud as has historically been placed in Area 6A-East and Area 6A-West. It is recommended that if the future waste stream changes in strength or character, or if the percentage of low-strength material increases from that described within this report, that a reevaluation of the landfill stability be conducted by a qualified geotechnical engineer.

- It is recommended that layering of ash and sludge continue during landfilling operations to maintain landfill stability and otherwise follow the recommendations set forth in the Operations Manual (SME, 2006), including the placement of any lower strength waste within the interior portion of the landfill, not less than 100 feet from the exterior slope faces. Moreover, to avoid stress imbalances and potential compromise of the integrity of the liner system, it is recommended that the slope of the landfill operating face not exceed 2H to 1V.

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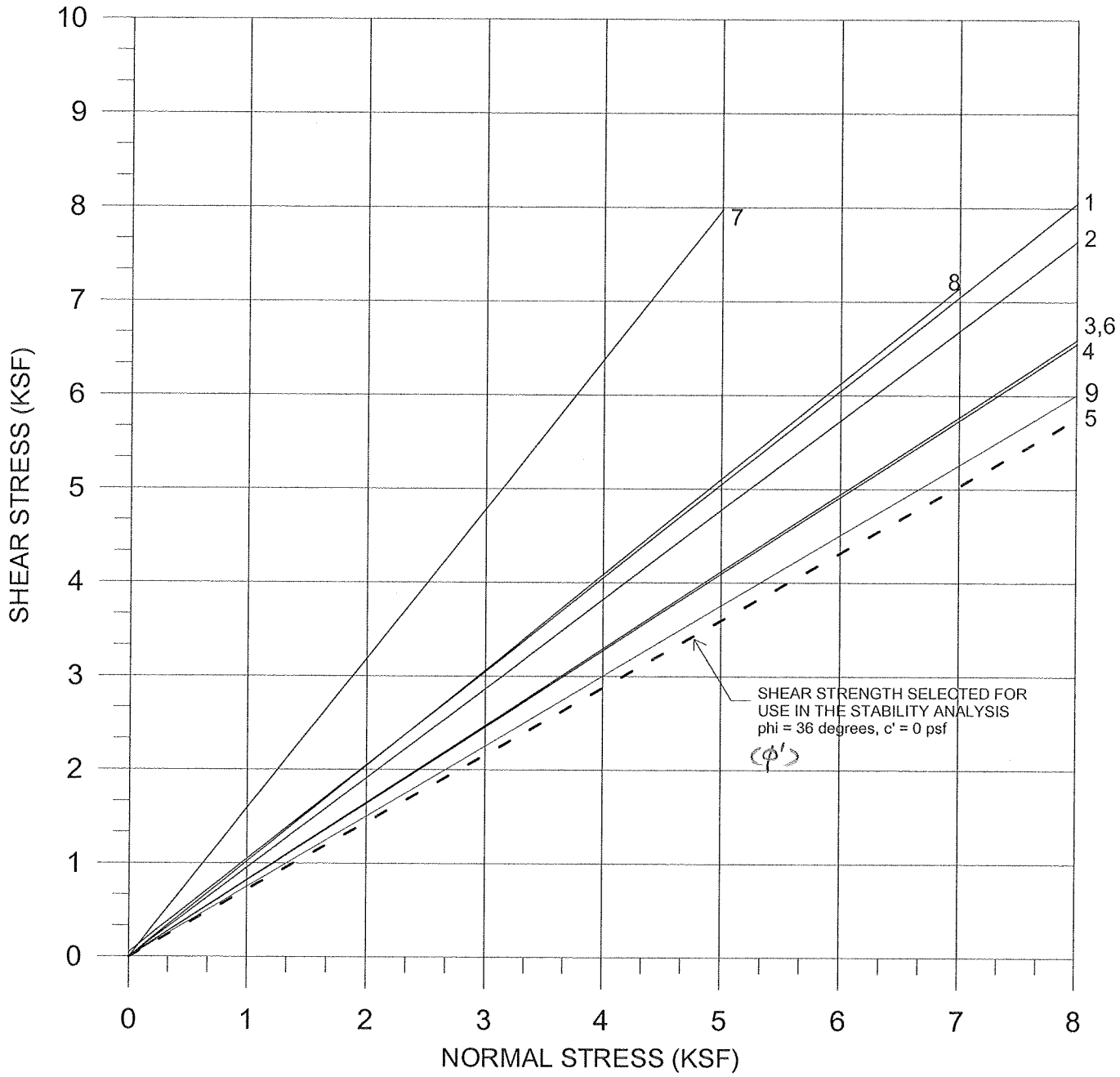
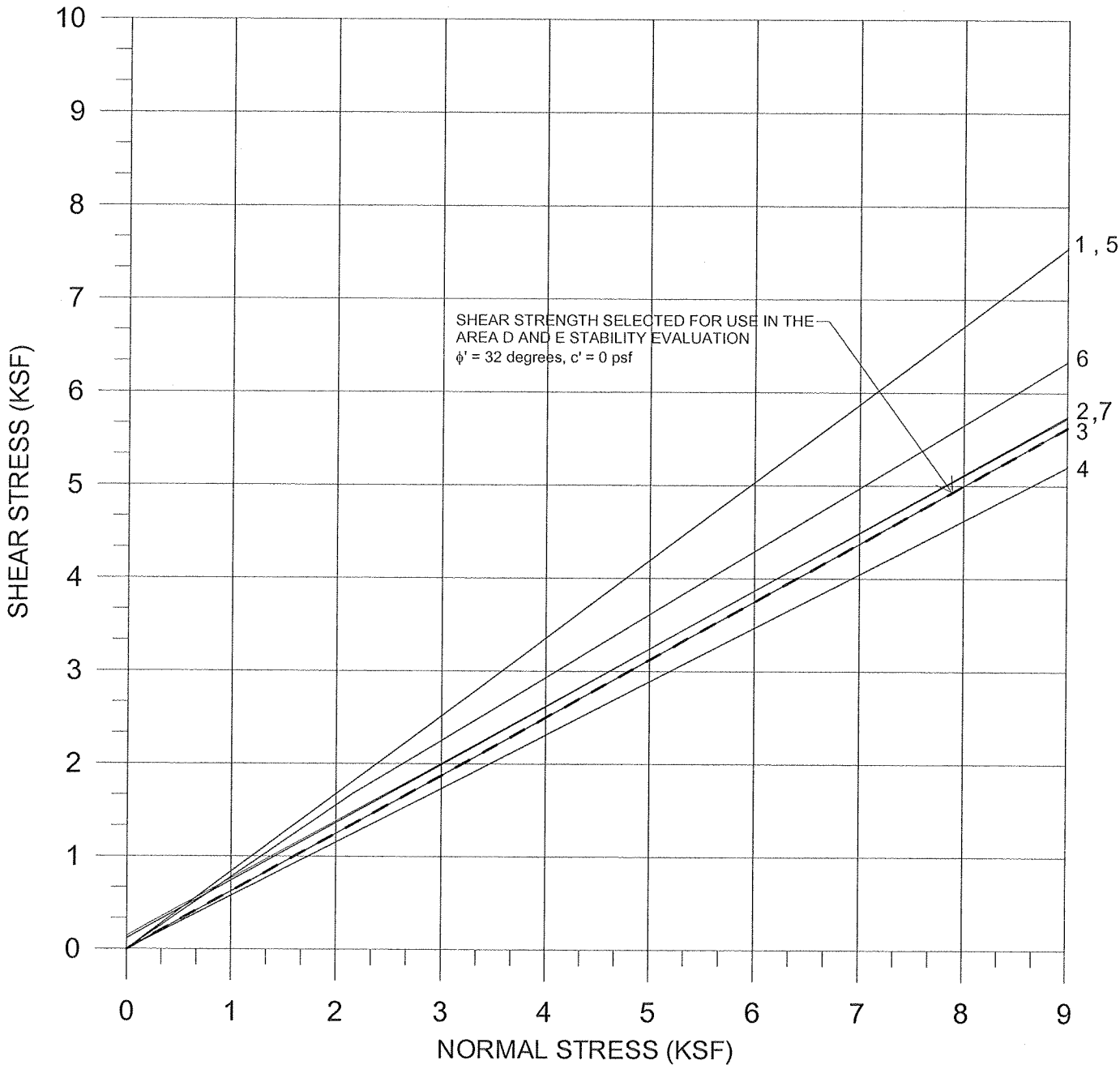
APPENDIX A

SHEAR STRENGTH SELECTED FOR USE IN THE STABILITY ANALYSIS



1) 45°, 0.05 KSF; LAW 1982, ASSUMED WASTE VALUE
2) 43.7°, 0 KSF; SME 1995, SLUDGE/ASH, CIUC TEST
3) 39.5°, 0 KSF; SME 1995, SLUDGE/ASH, CIUC TEST
4) 39.3°, 0 KSF; SME 1995, SLUDGE/ASH, CIUC TEST
5) 35.7°, 0 KSF; SME 1995, SLUDGE/ASH, CIUC TEST
6) 39.5°, 0 KSF; SME 1999, LIME MUD, CIUC TEST
7) 57.9°, 0 KSF; SME 1999, SLUDGE/ASH, CIUC TEST
8) 45.6°, 0 KSF; SME 1999, SLUDGE/ASH, CIUC TEST
9) 36.9°, 0 KSF; SME 2006, SLUDGE/LIME/ASH, CIUC TEST

FIGURE A-1
PLOT OF AVAILABLE EFFECTIVE SHEAR STRENGTHS FOR WASTES
LANDFILL NO. 6, AREA D AND E
BLUE RIDGE PAPER PRODUCTS INC.



1) 40°, 0 KSF; SIRRINE 1989, CIUC TEST

2) 32°, 0.115 KSF; SIRRINE 1989, CIUC TEST

3) 32°, 0 KSF; LAW 1982, CIUC TEST

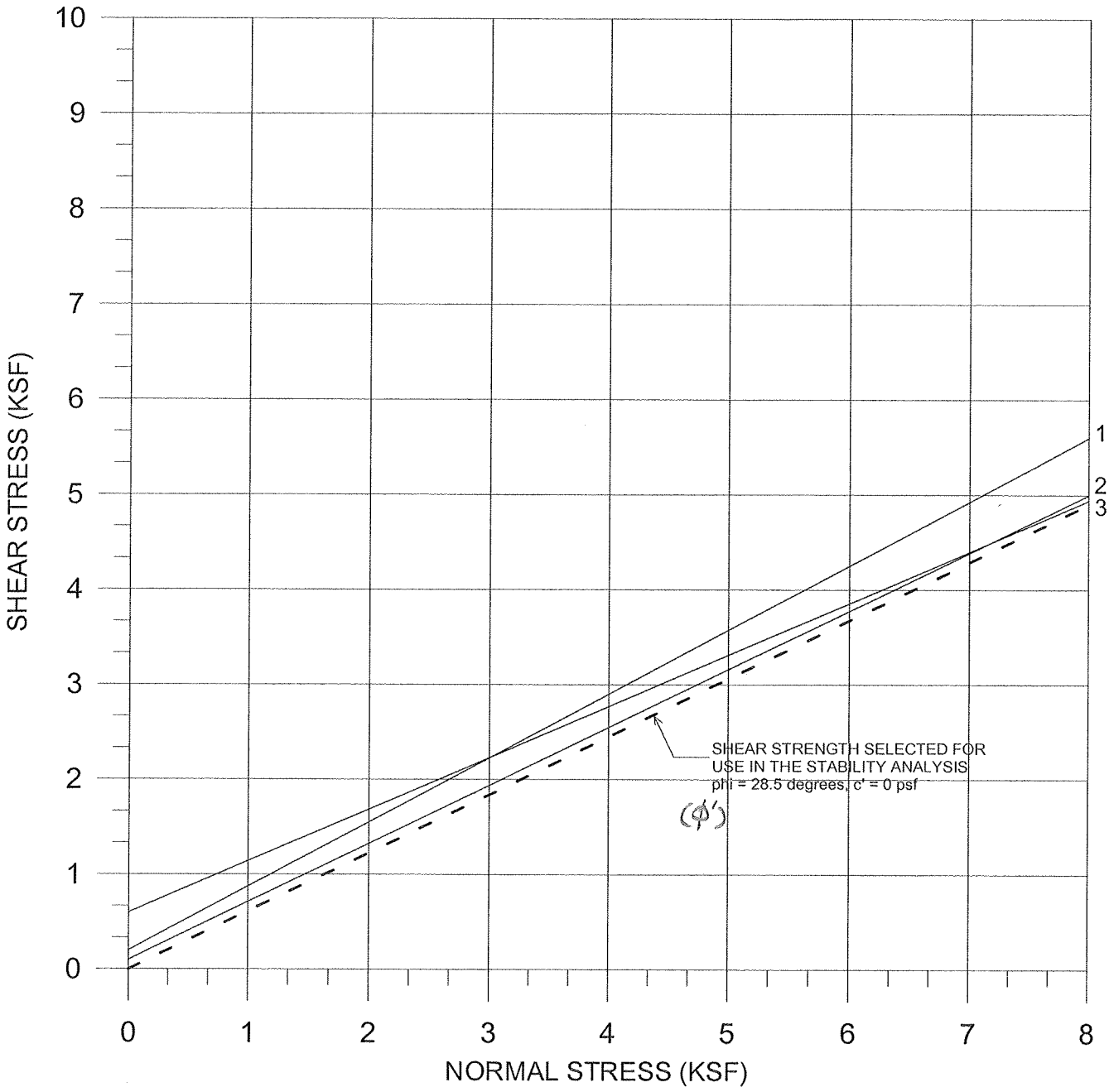
4) 30°, 0 KSF; LAW 1982, CIUC TEST

5) 40°, 0 KSF; SME 1999, DIRECT SHEAR TEST (WET)

6) 38°, 0 KSF FOR NORMAL STRESSES LESS THAN 2.2 KSF
34°, 0.26 KSF FOR NORMAL STRESSES GREATER THAN 2.2 KSF;
SME 1999, DIRECT SHEAR TEST (DRY)

7) 32°, 0.144 KSF; SME 2006

FIGURE A-2
PLOT OF AVAILABLE EFFECTIVE SHEAR STRENGTHS FOR PERIMETER DIKE SOILS
LANDFILL NO. 6, AREA D AND E
BLUE RIDGE PAPER PRODUCTS INC.



1) 34°, 0.2 KSF; LAW 1982, CIUC TEST

2) 31.5°, 0.1 KSF; LAW 1982, CIUC TEST

3) 28.5°, 0.6 KSF; LAW 1982, CIUC TEST

FIGURE A-3
PLOT OF AVAILABLE EFFECTIVE SHEAR STRENGTHS FOR FOUNDATION SOILS
LANDFILL NO. 6, AREA D AND E
BLUE RIDGE PAPER PRODUCTS INC.

Table A-1
Summary of Waste Geotechnical Properties Used in the Stability Analysis
Landfill 6 Area D and E
Blue Ridge Paper Products Inc.

Data Source	Boring ID	Sample ID	Depth (ft.below ground)	Total Unit Weight (pcf)	Water Content (%)	Effective Friction Angle (degrees)	Effective Cohesion (psf)	Total Friction Angle (degrees)	Total Stress Cohesion (psf)	Description
(1)		Bulk #1		64	160				570	Sludge UU Test
(1)		Bulk #2		82	160				550	Sludge/Ash, UU Test
(1)		Bulk #3		68	90				1100	Sludge/Ash, UU Test
(1)		Sample #1		#N\A				40	200	Sludge, Compaction Test
(1)		Sample #2		#N\A						Sludge/Ash, Compaction Test
(2)				55		45	50			Assumed
(3)				76						Used in Report
(3)	B101	3S	32.5	78	79	39.3	0			Sludge/Ash,CIUC
(3)	B101	4S	40.5	80	75	43.7	0			Sludge/Ash,CIUC
(3)	B101	1S	13.5	#N\A	79	35.7	0			Ash
(3)	B102	1S	12.5	#N\A	79	39.5	0			Ash, some Sludge
(3)				96	54					Lime mud Density test
(4)	B99-102	U3	30.6	78	77.6	57.9	0			Sludge/Ash,CIUC
(4)	B99-102	U2	20.5	85	71.1	45.6	0			Sludge/Ash,CIUC
(4)	B99-103	U4	40.5	96		39.5	0			Lime mud, CIUC
(5)	B-06-01	2S	16-18	84	94					Sludge/Ash/Lime, CIUC
(5)	B-06-01	1S	6.5-8.5	81	50	36.9	0			Lime mud, CIUC
(5)	B-06-02	2S	35.5-37.5	94	52					Lime/Sludge/Ash, CIUC

(1) Sirrine, 1989
(2) Law, 1982
(3) SME, 1995
(4) SME, 1999
(5) SME, 2006

Table A-2
Summary of Perimeter Dike Geotechnical Properties Used in the Stability Analysis
Landfill 6 Area D and E
Blue Ridge Paper Products Inc.

Data Source	Boring ID	Depth (ft.below ground)	Total Unit Weight[5] (pcf)	Maximum Dry Density (pcf)	Optimum Water Content (%)	Effective Friction Angle (degrees)	Effective Cohesion (psf)	Total Friction Angle (degrees)	Total Stress Cohesion (psf)	Description
(1)	AP-18	18.5-23.5	126	109	15.9					Compaction Test
(1)	AP-14	28.5-38.5	133	117	14.1					Compaction Test
(1)	AP-5	18.5-23.5	127	112	13.9	40	0	20	216	CIUC/Compaction Test
(1)	AP-3	14-20	128	109	18.6					Compaction Test
(1)	AP-1	20-35	127	110	15.5	32	115	18.5	202	CIUC/Compaction Test
(2)	B-8	3-12	127	107	17.9					Compaction Test
(2)	B-10	1-8	131	113	16.3	32	0	19	600	CIUC/Compaction Test
(2)	B-18	1-8	129	111	16.3	30	0	19	900	CIUC/Compaction Test
(2)	B-18	18-23	127	108	17.3					Compaction Test
(3)	B99-101	10-60	117		14.6[6]	34	260			Direct Shear test, run dry,normal stress>15psi
(3)	B99-101	10-60	117		14.6[6]	38	0			Direct Shear test, run dry,normal stress<15psi
(3)	B99-101	10-60	117		16.4[6]	40	0			Direct Shear test, run wet
(4)	B-06-04	4-14	119-124		17.8[6]	32	144			Direct Shear test, run dry

(1) Sirrine, 1989
(2) Law, 1982
(3) SME, 1999
(4) SME, 2006
(5) With the exception of the direct shear tests, total unit weight is based on max. dry density and optimum water content.
(6) Natural water content.

Table A-3
Summary of Foundation Soil Geotechnical Properties Used in the Stability Analysis
Landfill 6 Area D and E
Blue Ridge Paper Products Inc.

Data Source	Boring ID	Depth (ft.below ground)	Total Unit Weight (pcf)	Saturated Total Unit Weight (pcf)	Water Content (%)	Effective Friction Angle (degrees)	Effective Cohesion (psf)	Total Friction Angle (degrees)	Total Stress Cohesion (psf)	Description
(1)	B-8	9-11	117	130	13.2	34	200	27.5	300	Undisturbed Sample
(1)	B-10	13-15	104	118	19.7	31.5	100	16.5	400	Undisturbed Sample
(1)	B-11	8-11	124	125	28.3	28.5	600	17.5	800	Undisturbed Sample

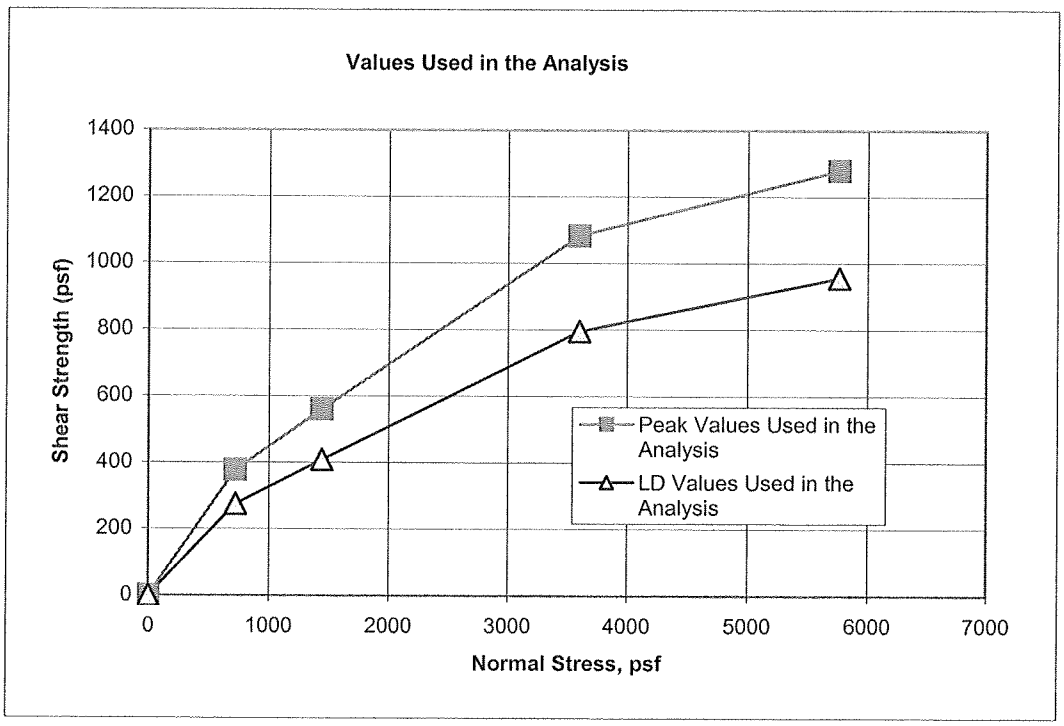
(1) Law, 1982

Summary of Interface Shear Strength Testing on GCL vs. Textured HDPE Interface.
SME Database

	TEST RESULTS (By Interface)					
	GCL vs 60-milHDPE					
	PGL Table		3-1	3-2	3-2RT	3-3
	GCL		820CV ST	820CV-ST	820CV-ST	820CV-ST
	HDPE		60-1-70981	40-1-70967	40-1-70967	40-1-70972
Normal Stress psf	Average Peak, psf	Minimum Peak, psf	Peak Shear Strength (psf)			
720	393	378	398	404		378
1440	651	561	561	724		667
3600	1215	1083	1295	1268		1083
5760	1494	1279	1888	1319	1279	1490
Normal Stress psf	Average LD psf	Minimum LD psf	LD Shear Strength (psf)			
720	302	275	329	275		302
1440	502	408	408	553		546
3600	811	795	795	803		834
5760	1079	956	1320	966	956	1074

LD = Large Displacement, as Reported by Precision Geosynthetic Laboratories

VALUES USED IN ANALYSIS	
Normal psf	Peak psf
0	0
720	378
1440	561
3600	1083
5760	1279
Normal psf	LD psf
0	0
720	275
1440	408
3600	795
5760	956



SELECTIVE LABORATORY TEST RESULTS (SME, 2006)

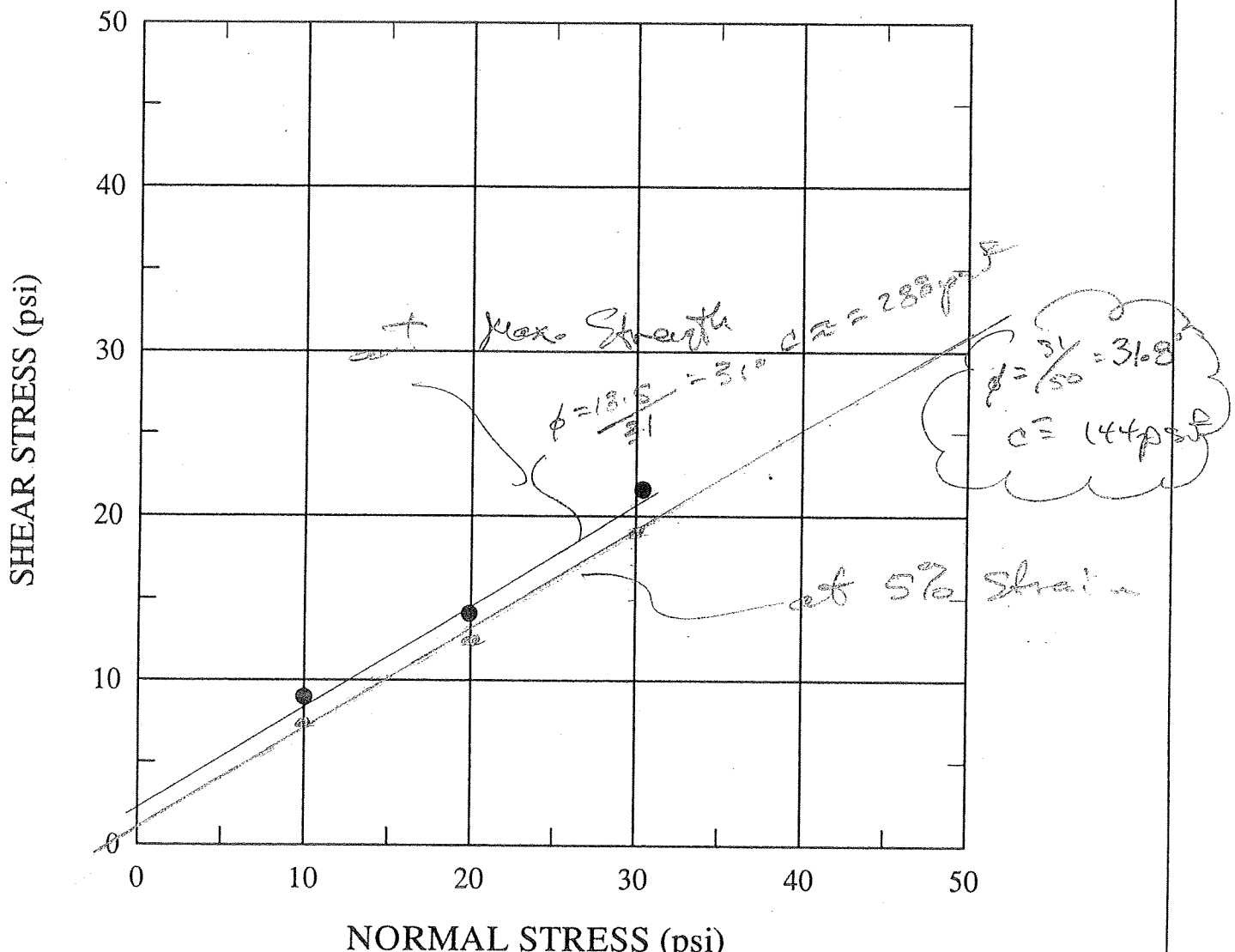
DIRECT SHEAR TEST

PROJECT: BLUE RIDGE PAPER
CANTON, N. CAROLINA

JOB No: 05127
DATE: FEB 06
TEST No: DS 1-3

BORING No: B06-4
SAMPLE No: Composite
DEPTH (ft.): 4-14

DESCRIPTION: Red/ brown sandy SILT (DIKE FILL)



DIAMETER= 2.5 in..
AREA= 4.909 sq. in.
NORMAL STRESS= See Graph psi

LOADING RATE= 0.008 in/min
INIT. W.C.= 17.8 %
PRE-SHEAR DENSITY= 119-124 pcf

Sevee & Maher Engineers

DIRECT SHEAR TEST

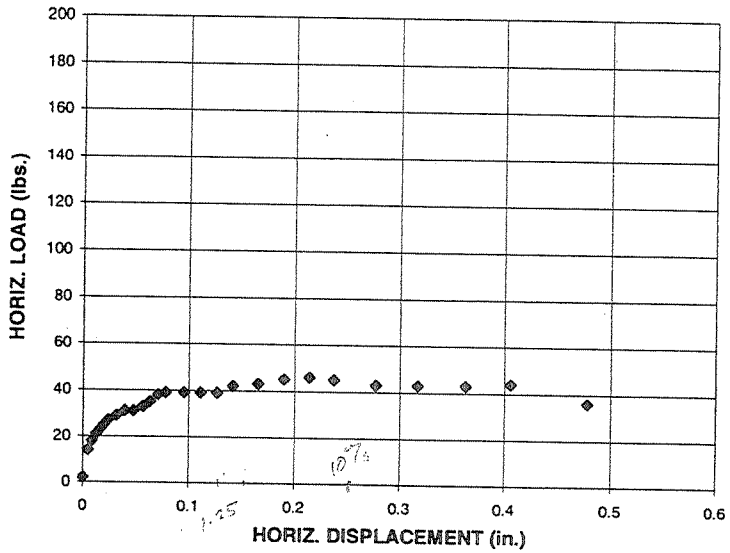
CLIENT: Blue Ridge Paper
PROJECT: Canton, N. Carolina

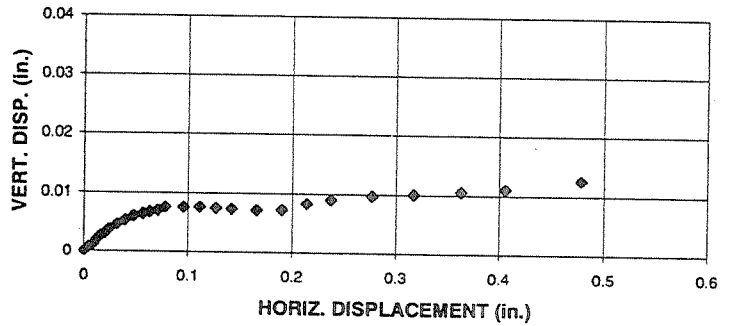
SAMPLE DESCRIPTION: Rd-br sandy SILT to silty SAND

BORING:	B06-4		TEST No.:	DS-1	
SAMPLE:	Composite		WEIGHT:	221.3	(gms)
DEPTH:	4-16	(ft.)	AVE. INITIAL W.C.:	17.8	(%)
INIT. HEIGHT:	1.47	(in.)	FINAL W.C.:	17.8	(%)
DELTA H.:	0.0296	(in.)	INITIAL DENSITY:	116.8	(pcf)
AREA:	4.909	(sq.in.)	BEFORE SHEAR DENSITY;	119.2	(pcf)
STRAIN RATE:	0.008	(in./min.)	NORMAL STRESS:	10	(psi)

ELASPED TIME (min.)	VERICAL DIAL READING (in.)	VERTICAL DISP. (in.)	HORIZ. DIAL READING (in.)	HORIZ. DISP. (in.)	LOAD CELL READING (lbs.)	SHEAR STRESS (psi)
0	0.361	0	0.878	0	2	0.00
0.5	0.3603	0.0007	0.8735	0.0045	14	2.44
1	0.3598	0.0012	0.8695	0.0085	18	3.26
1.5	0.359	0.002	0.8657	0.0123	21	3.87
2	0.3584	0.0026	0.862	0.016	23	4.28
2.5	0.358	0.003	0.858	0.02	25	4.69
3	0.3573	0.0037	0.854	0.024	27	5.09
4	0.3564	0.0046	0.846	0.032	29	5.50
5	0.3557	0.0053	0.8383	0.0397	31	5.91
6	0.355	0.006	0.83	0.048	31	5.91
7	0.3546	0.0064	0.821	0.057	33	6.31
8	0.3543	0.0067	0.8145	0.0635	35	6.72
9	0.354	0.007	0.807	0.071	38	7.33
10	0.3535	0.0075	0.7997	0.0783	39	7.54
12	0.3535	0.0075	0.7823	0.0957	39	7.54
14	0.3534	0.0076	0.767	0.111	39	7.54
16	0.3536	0.0074	0.7515	0.1265	39	7.54
18	0.3537	0.0073	0.7365	0.1415	42	8.15
21	0.3539	0.0071	0.7125	0.1655	43	8.35
24	0.3538	0.0072	0.6882	0.1898	45	8.76
27	0.3527	0.0083	0.664	0.214	46	8.96
30	0.352	0.009	0.641	0.237	45	8.76
35	0.3513	0.0097	0.601	0.277	43	8.35
40	0.351	0.01	0.5608	0.3172	43	8.35
45	0.3505	0.0105	0.515	0.363	43	8.35
51	0.35	0.011	0.4723	0.4057	44	8.56
60	0.3484	0.0126	0.4	0.478	36	6.93

Note: Shear Box Not Flooded





DIRECT SHEAR TEST

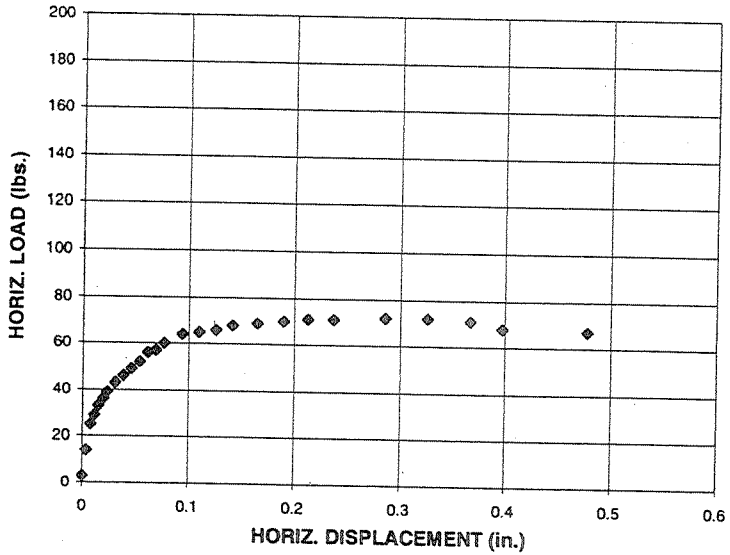
CLIENT: Blue Ridge Paper
PROJECT: Canton, N. Carolina

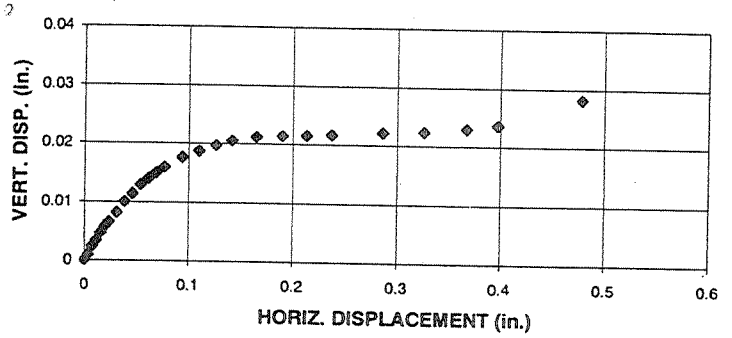
SAMPLE DESCRIPTION: Rd-br sandy SILT to silty SAND

BORING:	B06-4		TEST No.:	DS-2	
SAMPLE:	Composite		WEIGHT:	221.7	(gms)
DEPTH:	4-16	(ft.)	AVE. INITIAL W.C.:	17.8	(%)
INIT. HEIGHT:	1.47	(in.)	FINAL W.C.:	17.8	(%)
DELTA H.:	0.0362	(in.)	INITIAL DENSITY:	117.0	(pcf)
AREA:	4.909	(sq.in.)	BEFORE SHEAR DENSITY:	120.0	(pcf)
STRAIN RATE:	0.008	(in./min.)	NORMAL STRESS:	19.9	(psi)

ELASPED TIME (min.)	VERICAL DIAL READING (in.)	VERTICAL DISP. (in.)	HORIZ. DIAL READING (in.)	HORIZ. DISP. (in.)	LOAD CELL READING (lbs.)	SHEAR STRESS (psi)
0	0.3482	0	0.867	0	3	0.00
0.5	0.3473	0.0009	0.8635	0.0035	14	2.24
1	0.3458	0.0024	0.8595	0.0075	25	4.48
1.5	0.3448	0.0034	0.8558	0.0112	29	5.30
2	0.3435	0.0047	0.852	0.015	33	6.11
2.5	0.3424	0.0058	0.8475	0.0195	36	6.72
3	0.3416	0.0066	0.844	0.023	39	7.33
4	0.34	0.0082	0.8362	0.0308	43	8.15
5	0.3382	0.01	0.8285	0.0385	46	8.76
6	0.3368	0.0114	0.821	0.046	49	9.37
7	0.3353	0.0129	0.813	0.054	52	9.98
8	0.3342	0.014	0.8053	0.0617	56	10.80
9	0.3332	0.015	0.7978	0.0692	57	11.00
10	0.3323	0.0159	0.79	0.077	60	11.61
12	0.3306	0.0176	0.773	0.094	64	12.43
14	0.3295	0.0187	0.757	0.11	65	12.63
16	0.3285	0.0197	0.741	0.126	66	12.83
18	0.3277	0.0205	0.7255	0.1415	68	13.24
21	0.327	0.0212	0.702	0.165	69	13.44
24	0.3268	0.0214	0.677	0.19	70	13.65
27	0.3267	0.0215	0.6542	0.2128	71	13.85
30	0.3265	0.0217	0.63	0.237	71	13.85
36	0.326	0.0222	0.581	0.286	72	14.06
41	0.3258	0.0224	0.541	0.326	72	14.06
46	0.3252	0.023	0.5	0.367	71	13.85
50	0.3246	0.0236	0.4695	0.3975	68	13.24
60	0.32	0.0282	0.389	0.478	67	13.04

Note: Shear Box Not Flooded





DIRECT SHEAR TEST

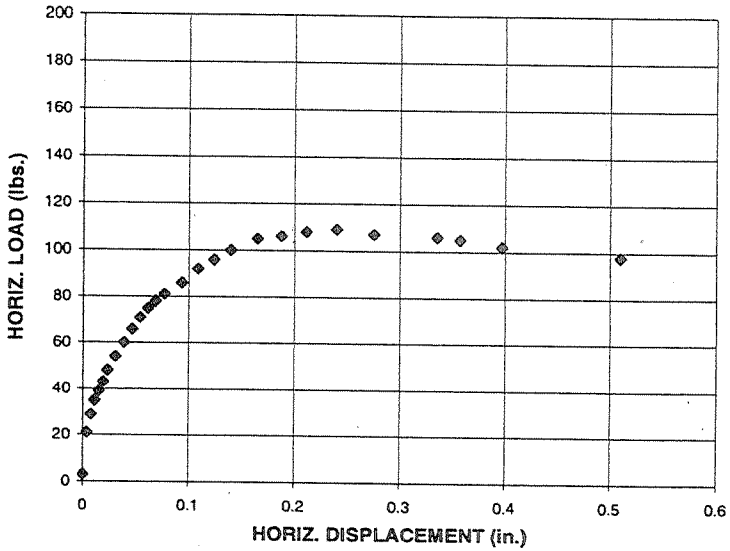
CLIENT: Blue Ridge Paper
PROJECT: Canton, N. Carolina

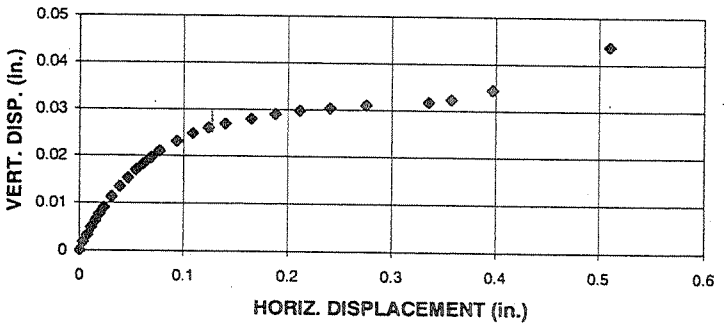
SAMPLE DESCRIPTION: Rd-br sandy SILT to silty SAND

BORING:	B06-4		TEST No.:	DS-3	
SAMPLE:	Composite		WEIGHT:	221.4	(gms)
DEPTH:	4-16	(ft.)	AVE. INITIAL W.C.:	17.8	(%)
INIT. HEIGHT:	1.47	(in.)	FINAL W.C.:	17.8	(%)
DELTA H.:	0.0852	(in.)	INITIAL DENSITY:	116.9	(pcf)
AREA:	4.909	(sq.in.)	BEFORE SHEAR DENSITY;	124.1	(pcf)
STRAIN RATE:	0.008	(in./min.)	NORMAL STRESS:	30.4	(psi)

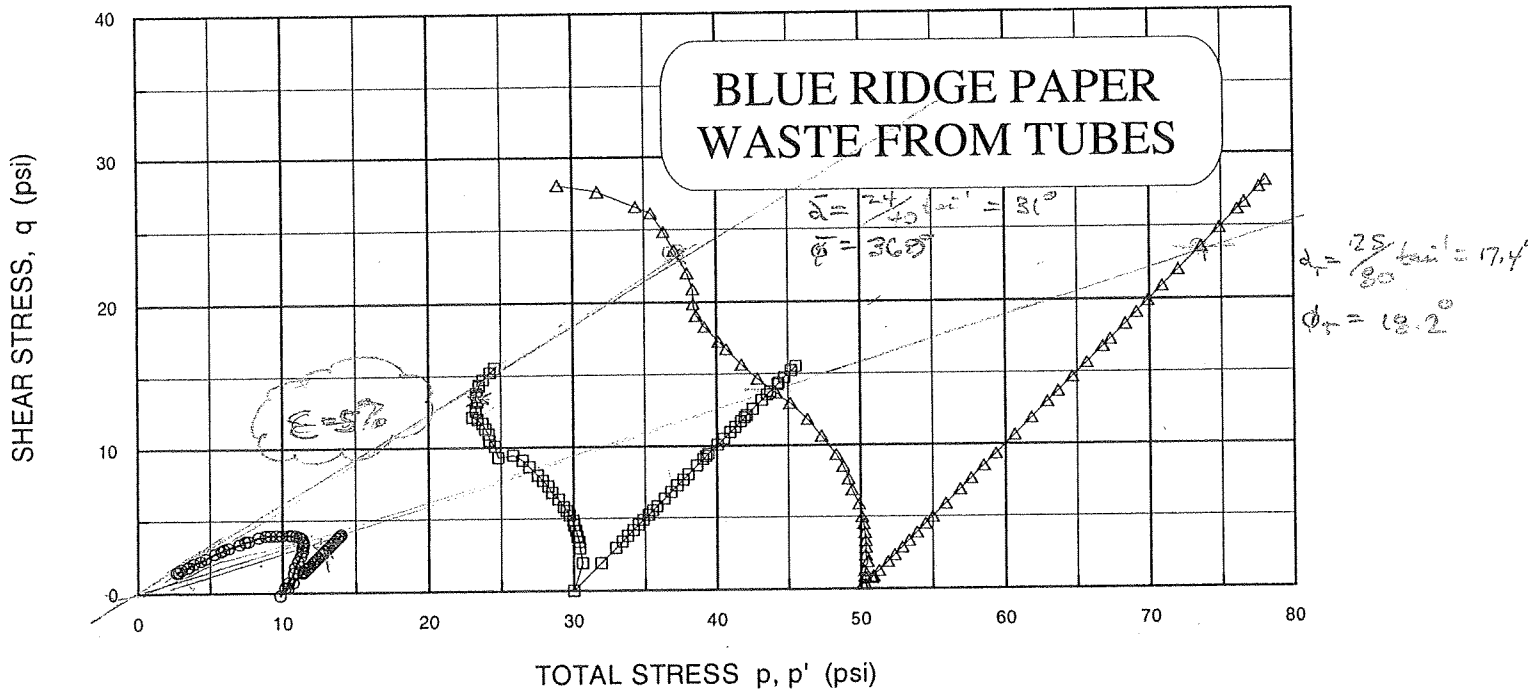
ELASPED TIME (min.)	VERICAL DIAL READING (in.)	VERTICAL DISP. (in.)	HORIZ. DIAL READING (in.)	HORIZ. DISP. (in.)	LOAD CELL READING (lbs.)	SHEAR STRESS (psi)
0	0.3003	0	0.87	0	3	0.00
0.5	0.2985	0.0018	0.8665	0.0035	21	3.67
1	0.297	0.0033	0.8625	0.0075	29	5.30
1.5	0.2954	0.0049	0.859	0.011	35	6.52
2	0.294	0.0063	0.855	0.015	39	7.33
2.5	0.2926	0.0077	0.851	0.019	43	8.15
3	0.2913	0.009	0.847	0.023	48	9.17
4	0.289	0.0113	0.8395	0.0305	54	10.39
5	0.2868	0.0135	0.8315	0.0385	60	11.61
6	0.285	0.0153	0.8235	0.0465	66	12.83
7	0.2833	0.017	0.816	0.054	71	13.85
8	0.282	0.0183	0.8085	0.0615	75	14.67
9	0.2807	0.0196	0.801	0.069	78	15.28
10	0.2793	0.021	0.793	0.077	81	15.89
12	0.2772	0.0231	0.7765	0.0935	86	16.91
14	0.2755	0.0248	0.761	0.109	92	18.13
16	0.2743	0.026	0.746	0.124	96	18.94
18	0.2734	0.0269	0.73	0.14	100	19.76
21	0.2723	0.028	0.705	0.165	105	20.78
24	0.2713	0.029	0.682	0.188	106	20.98
27	0.2705	0.0298	0.6585	0.2115	108	21.39
30	0.27	0.0303	0.6295	0.2405	109	21.59
35	0.2693	0.031	0.5945	0.2755	107	21.19
40	0.2686	0.0317	0.535	0.335	106	20.98
45	0.268	0.0323	0.513	0.357	105	20.78
50	0.266	0.0343	0.473	0.397	102	20.17
64	0.2565	0.0438	0.36	0.51	98	19.35

Note: Shear Box Not Flooded

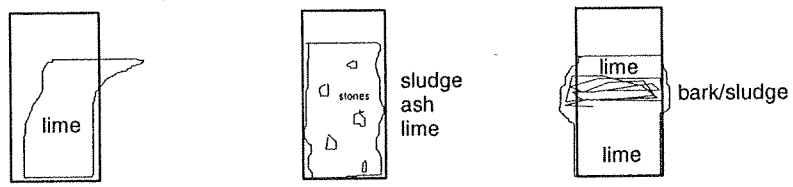




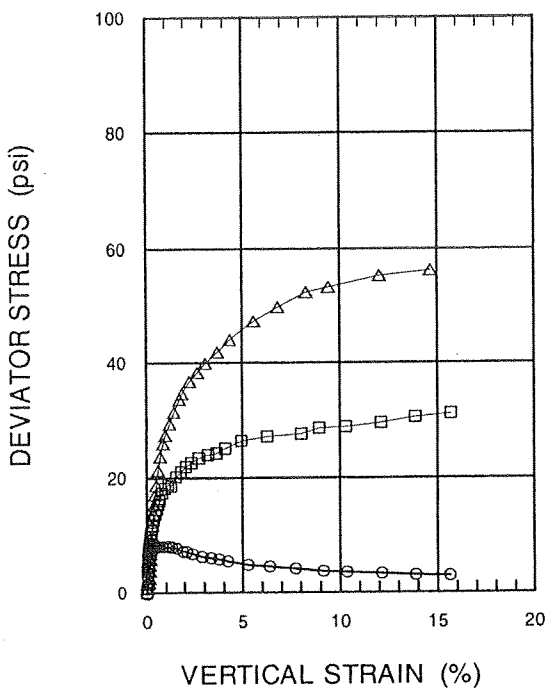
Consolidated Undrained Triaxial Test ASTM D4767



Failure Sketch



CU-1 CU-2 CU-3



TEST CONDITIONS

	SYMBOL:	O	□	△
	TEST No.:	CU-1	CU-2	CU-3
INITIAL	WATER CONTENT (%):	50	89.6	59
	AREA (in^2):	6.350	6.417	6.474
	HEIGHT (in.):	6.000	6.000	6.000
	DRY DENSITY (pcf):	53.9	46.1	55.3
	SATURATION (%):	64.9	92.7	82.5
	VOID RATIO:	1.988	2.495	1.730
	B-VALUE:	1	1	1
PRE-SHEAR	WATER CONTENT (%):	63.7	64.3	57.4
	DRY DENSITY (pcf):	58.7	54.1	66.1
	SATURATION (%):	94.2	84	103
	VOID RATIO:	1.744	1.975	1.437
	MINOR PRIN. STRESS (psi):	10	30	50
	MAX DEVIATOR STRESS (psi):	8	31.1	56.1
	RATE OF STRAIN (in./min.):	0.005	0.005	0.005
	FINAL WATER CONTENT (%):	63.7	64.3	57.4

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

		TEST CONDITIONS			INITIAL	PRE-SHEAR	FINAL			
PROJECT:	Blue Ridge Paper	INITIAL DIAL READING (in.):	0.43	HEIGHT (in.):	6.000	5.663		15.2400	14.384	(cm)
DESCRIPTION:	Lime Mud with sludge	SPECIFIC GRAVITY:	2.58 est.	AREA (in²):	6.474	6.124		41.7664	39.5077	(cm²)
BORING:	B06-2	INITIAL WET WT. (gms):	934.2	TOTAL DENSITY (pcf):	91.6	104.0				
SAMPLE:	2S	INITIAL DRY WT. (gms):	601.5	DRY DENSITY (pcf):	59.0	66.1				
DEPTH (ft.):	35.9	CELL PRESSURE (psi):	105	WATER CONTENT (%):	55.3		57.4			
FILE No.:	05127	BACK PRESSURE (psi):	55	VOLUME TOTAL (cc):	636.52	568.28				
TEST No.:	CIUC-3	EFFECTIVE CONFINING PRESSURE (psi):	50	VOLUME SOLIDS (cc):	233.16					
DATE:	2/15/2005	PORE PRESSURE @ PRESHEAR (psi):	55.1	VOLUME VOIDS (cc):	403.36	335.12				
TESTED BY:	EJL	AXIAL STRAIN RATE (in./min.):	0.005	VOID RATIO:	1.7300	1.4373				
PRC (lb/div):	0.463	MEMBRANE THICKNESS (in.):	0.012	SATURATION (%):	82.5	103.0				

TIME (min)	DIAL (in.)	LOAD (lb)	PWP (psi)	DELTA L (in.)	AREA CF	CORR. AREA (sq. in.)	IND LOAD (lbs.)	IND PWP (psi)	DEV STRESS (psi)	SIGMA 3 (psi)	SIGMA 1 (psi)	SIGMA 3' (psi)	SIGMA 1' (psi)	P (psi)	P' (psi)	Q (psi)	STRAIN (%)	A
0	0.43	53	55.3	0.0000	1.0000	6.12	3.9	0	0.6	50.0	50.6	49.8	50.4	50.3	50.1	0.3	0.00	0.32
0.5	0.4335	65	55.5	0.0035	0.9994	6.13	9.4	0.4	1.5	50.0	51.5	49.6	51.1	50.8	50.4	0.8	0.06	0.26
1	0.436	68	55.7	0.0060	0.9989	6.13	10.8	0.6	1.8	50.0	51.8	49.4	51.2	50.9	50.3	0.9	0.11	0.34
1.5	0.4375	78	56.1	0.0075	0.9987	6.13	15.4	1.0	2.5	50.0	52.5	49.0	51.5	51.3	50.3	1.3	0.13	0.40
2	0.4383	94	56.5	0.0083	0.9985	6.13	22.8	1.4	3.7	50.0	53.7	48.6	52.3	51.9	50.5	1.9	0.15	0.38
2.5	0.4392	107	57.1	0.0092	0.9984	6.13	28.9	2.0	4.7	50.0	54.7	48.0	52.7	52.4	50.4	2.4	0.16	0.43
3	0.44	120.5	57.6	0.0100	0.9982	6.13	35.1	2.5	5.7	50.0	55.7	47.5	53.2	52.9	50.4	2.9	0.18	0.44
3.5	0.441	133.5	58.1	0.0110	0.9981	6.14	41.1	3.0	6.7	50.0	56.7	47.0	53.7	53.4	50.4	3.4	0.19	0.45
4	0.442	148	58.7	0.0120	0.9979	6.14	47.8	3.6	7.8	50.0	57.8	46.4	54.2	53.9	50.3	3.9	0.21	0.46
4.5	0.4433	164	59.4	0.0133	0.9977	6.14	55.2	4.3	9.0	50.0	59.0	45.7	54.7	54.5	50.2	4.5	0.23	0.48
5	0.4444	177	60	0.0144	0.9975	6.14	61.3	4.9	10.0	50.0	60.0	45.1	55.1	55.0	50.1	5.0	0.25	0.49
6	0.4465	201	61.1	0.0165	0.9971	6.14	72.4	6.0	11.8	50.0	61.8	44.0	55.8	55.9	49.9	5.9	0.29	0.51
7	0.4493	228	62.6	0.0193	0.9966	6.14	84.9	7.5	13.8	50.0	63.8	42.5	56.3	56.9	49.4	6.9	0.34	0.54
8	0.4513	248	63.6	0.0213	0.9962	6.15	94.1	8.5	15.3	50.0	65.3	41.5	56.8	57.7	49.2	7.7	0.38	0.56
9	0.454	271	64.8	0.0240	0.9958	6.15	104.8	9.7	17.0	50.0	67.0	40.3	57.3	58.5	48.8	8.5	0.42	0.57
10	0.457	293	66.1	0.0270	0.9952	6.15	115.0	11.0	18.7	50.0	68.7	39.0	57.7	59.3	48.3	9.3	0.48	0.59
12	0.463	328	68.4	0.0330	0.9942	6.16	131.2	13.3	21.3	50.0	71.3	36.7	58.0	60.6	47.3	10.6	0.58	0.62
14	0.47	360	70.6	0.0400	0.9929	6.17	146.0	15.5	23.7	50.0	73.7	34.5	58.2	61.8	46.3	11.8	0.71	0.65
16	0.478	390	72.9	0.0480	0.9915	6.18	159.9	17.8	25.9	50.0	75.9	32.2	58.1	62.9	45.1	12.9	0.85	0.69
18	0.485	409.7	74.6	0.0550	0.9903	6.18	169.0	19.5	27.3	50.0	77.3	30.5	57.8	63.7	44.2	13.7	0.97	0.71
21	0.498	437.5	76.9	0.0680	0.9880	6.20	181.9	21.8	29.3	50.0	79.3	28.2	57.5	64.7	42.9	14.7	1.20	0.74
24	0.5115	465.5	79	0.0815	0.9856	6.21	194.8	23.9	31.4	50.0	81.4	26.1	57.5	65.7	41.8	15.7	1.44	0.76
28	0.5285	496	81.2	0.0985	0.9826	6.23	209.0	26.1	33.5	50.0	83.5	23.9	57.4	66.8	40.7	16.8	1.74	0.78
30	0.5365	510	82.2	0.1065	0.9812	6.24	215.4	27.1	34.5	50.0	84.5	22.9	57.4	67.3	40.2	17.3	1.88	0.79
35	0.559	540.5	84.2	0.1290	0.9772	6.27	229.6	29.1	36.6	50.0	86.6	20.9	57.5	68.3	39.2	18.3	2.28	0.79
40	0.5815	564	85.6	0.1515	0.9732	6.29	240.4	30.5	38.2	50.0	88.2	19.5	57.7	69.1	38.6	19.1	2.68	0.80
45	0.604	588	86.6	0.1740	0.9693	6.32	251.6	31.5	39.8	50.0	89.8	18.5	58.3	69.9	38.4	19.9	3.07	0.79
52	0.6385	618.5	87.6	0.2085	0.9632	6.36	265.7	32.5	41.8	50.0	91.8	17.5	59.3	70.9	38.4	20.9	3.68	0.78
60	0.675	653	89.1	0.2450	0.9567	6.40	281.7	34.0	44.0	50.0	94.0	16.0	60.0	72.0	38.0	22.0	4.33	0.77
75	0.747	706	91.6	0.3170	0.9440	6.49	306.2	36.5	47.2	50.0	97.2	13.5	60.7	73.6	37.1	23.6	5.60	0.77
90	0.8175	751	93.6	0.3875	0.9316	6.57	327.0	38.5	49.7	50.0	99.7	11.5	61.2	74.9	36.4	24.9	6.84	0.77
107	0.9	799	95.8	0.4700	0.9170	6.68	349.3	40.7	52.3	50.0	102.3	9.3	61.6	76.1	35.4	26.1	8.30	0.78
120	0.964	822	97.3	0.5340	0.9057	6.76	359.9	42.2	53.2	50.0	103.2	7.8	61.0	76.6	34.4	26.6	9.43	0.79
150	1.1125	875.5	101	0.6825	0.8795	6.96	384.7	45.9	55.2	50.0	105.2	4.1	59.3	77.6	31.7	27.6	12.05	0.83
180	1.261	915	104.2	0.8310	0.8533	7.18	403.0	49.1	56.1	50.0	106.1	0.9	57.0	78.1	29.0	28.1	14.67	0.87

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

PROJECT:	Blue Ridge Paper	TEST CONDITIONS				INITIAL	PRE-SHEAR	FINAL			
DESCRIPTION:	Green LIME MUD, trace ash pockets	INITIAL DIAL READING (in.):	0.3343		HEIGHT (in.):	6.000	5.861		15.2400	14.887	(cm)
BORING:	B06-1	SPECIFIC GRAVITY:	2.58	est.	AREA (in²):	6.350	5.971		40.9651	38.5219	(cm²)
SAMPLE:	1S	INITIAL WET WT. (gms):	808.7		TOTAL DENSITY (pcf):	80.9	96.1				
DEPTH (ft.):	-	INITIAL DRY WT. (gms):	539.1		DRY DENSITY (pcf):	53.9	58.7				
FILE No.:	05127	CELL PRESSURE (psi):	100		WATER CONTENT (%):	50		63.7			
TEST No.:	CIUC-1	BACK PRESSURE (psi):	90		VOLUME TOTAL (cc):	624.31	573.47				
DATE:	2/6/2006	EFFECTIVE CONFINING PRESSURE (psi):	10		VOLUME SOLIDS (cc):	208.97					
TESTED BY:	EJL	PORE PRESSURE @ PRESHEAR (psi):	90.8		VOLUME VOIDS (cc):	415.34	364.51				
PRC (lb/div):	0.463	AXIAL STRAIN RATE (in./min.):	0.005		VOID RATIO:	1.9876	1.7443				
		MEMBRANE THICKNESS (in.):	0.012		SATURATION (%):	64.9	94.2				

TIME (min)	DIAL (in.)	LOAD (lb)	PWP (psi)	DELTA L (in.)	AREA CF	CORR. AREA (sq. in.)	IND LOAD (lbs.)	IND PWP (psi)	DEV STRESS (psi)	SIGMA 3 (psi)	SIGMA 1 (psi)	SIGMA 3' (psi)	SIGMA 1' (psi)	P (psi)	P' (psi)	Q (psi)	STRAIN (%)	A
0	0.3343	38.5	90.8	0.0000	1.0000	5.97	-1.9	0	-0.3	10.0	9.7	10.0	9.7	9.8	9.8	-0.2	0.00	0.00
0.5	0.335	52	91.0	0.0007	0.9999	5.97	4.4	0.2	0.7	10.0	10.7	9.8	10.5	10.4	10.2	0.4	0.01	0.27
1	0.3358	61	91.1	0.0015	0.9997	5.97	8.5	0.3	1.4	10.0	11.4	9.7	11.1	10.7	10.4	0.7	0.03	0.21
1.5	0.337	77.5	91.4	0.0027	0.9995	5.97	16.2	0.6	2.7	10.0	12.7	9.4	12.1	11.4	10.8	1.4	0.05	0.22
2	0.3382	87.5	91.7	0.0039	0.9993	5.97	20.8	0.9	3.5	10.0	13.5	9.1	12.6	11.7	10.8	1.7	0.07	0.26
2.5	0.3395	98.5	91.9	0.0052	0.9991	5.98	25.9	1.1	4.3	10.0	14.3	8.9	13.2	12.2	11.1	2.2	0.09	0.25
3	0.341	108	92.1	0.0067	0.9989	5.98	30.3	1.3	5.1	10.0	15.1	8.7	13.8	12.5	11.2	2.5	0.11	0.26
3.5	0.3425	116.5	92.3	0.0082	0.9986	5.98	34.2	1.5	5.7	10.0	15.7	8.5	14.2	12.9	11.4	2.9	0.14	0.26
4	0.3443	124	92.6	0.0100	0.9983	5.98	37.7	1.8	6.3	10.0	16.3	8.2	14.5	13.2	11.4	3.2	0.17	0.29
4.5	0.3465	129	92.7	0.0122	0.9979	5.98	40.0	1.9	6.7	10.0	16.7	8.1	14.8	13.3	11.4	3.3	0.21	0.28
5	0.3487	133.5	92.9	0.0144	0.9975	5.99	42.1	2.1	7.0	10.0	17.0	7.9	14.9	13.5	11.4	3.5	0.25	0.30
6	0.353	139	93.2	0.0187	0.9968	5.99	44.7	2.4	7.5	10.0	17.5	7.6	15.1	13.7	11.3	3.7	0.32	0.32
7	0.3577	142.5	93.5	0.0234	0.9960	5.99	46.3	2.7	7.7	10.0	17.7	7.3	15.0	13.9	11.2	3.9	0.40	0.35
8	0.3625	144.5	93.8	0.0282	0.9952	6.00	47.2	3.0	7.9	10.0	17.9	7.0	14.9	13.9	10.9	3.9	0.48	0.38
9	0.368	145.5	94.1	0.0337	0.9943	6.01	47.7	3.3	7.9	10.0	17.9	6.7	14.6	14.0	10.7	4.0	0.57	0.42
10	0.3733	146	94.3	0.0390	0.9933	6.01	47.9	3.5	8.0	10.0	18.0	6.5	14.5	14.0	10.5	4.0	0.67	0.44
12	0.3838	146	94.8	0.0495	0.9916	6.02	47.9	4.0	8.0	10.0	18.0	6.0	14.0	14.0	10.0	4.0	0.84	0.50
14	0.3935	146.2	95.2	0.0592	0.9899	6.03	48.0	4.4	8.0	10.0	18.0	5.6	13.6	14.0	9.6	4.0	1.01	0.55
16	0.404	146.2	95.6	0.0697	0.9881	6.04	48.0	4.8	7.9	10.0	17.9	5.2	13.1	14.0	9.2	4.0	1.19	0.60
18	0.413	145.5	95.9	0.0787	0.9866	6.05	47.7	5.1	7.9	10.0	17.9	4.9	12.8	13.9	8.8	3.9	1.34	0.65
21	0.4283	143.3	96.3	0.0940	0.9840	6.07	46.6	5.5	7.7	10.0	17.7	4.5	12.2	13.8	8.3	3.8	1.60	0.72
24	0.447	136.5	96.7	0.1127	0.9808	6.09	43.5	5.9	7.1	10.0	17.1	4.1	11.2	13.6	7.7	3.6	1.92	0.83
27	0.46	136	96.9	0.1257	0.9786	6.10	43.3	6.1	7.1	10.0	17.1	3.9	11.0	13.5	7.4	3.5	2.14	0.86
30	0.4762	131.7	97.1	0.1419	0.9758	6.12	41.3	6.3	6.7	10.0	16.7	3.7	10.4	13.4	7.1	3.4	2.42	0.93
35	0.5045	124.8	97.6	0.1702	0.9710	6.15	38.1	6.8	6.2	10.0	16.2	3.2	9.4	13.1	6.3	3.1	2.90	1.10
40	0.5295	122.5	97.8	0.1952	0.9667	6.18	37.0	7.0	6.0	10.0	16.0	3.0	9.0	13.0	6.0	3.0	3.33	1.17
45	0.554	120	97.9	0.2197	0.9625	6.20	35.9	7.1	5.8	10.0	15.8	2.9	8.7	12.9	5.8	2.9	3.75	1.23
50	0.581	115.8	98.2	0.2467	0.9579	6.23	33.9	7.4	5.4	10.0	15.4	2.6	8.0	12.7	5.3	2.7	4.21	1.36
62	0.644	107.5	98.5	0.3097	0.9472	6.30	30.1	7.7	4.8	10.0	14.8	2.3	7.1	12.4	4.7	2.4	5.28	1.61
75	0.709	104	98.7	0.3747	0.9361	6.38	28.5	7.9	4.5	10.0	14.5	2.1	6.6	12.2	4.3	2.2	6.39	1.77
90	0.788	99.8	99	0.4537	0.9226	6.47	26.5	8.2	4.1	10.0	14.1	1.8	5.9	12.0	3.8	2.0	7.74	2.00
106	0.8705	94.7	99.1	0.5362	0.9085	6.57	24.1	8.3	3.7	10.0	13.7	1.7	5.4	11.8	3.5	1.8	9.15	2.26
120	0.941	93	99.1	0.6067	0.8965	6.66	23.4	8.3	3.5	10.0	13.5	1.7	5.2	11.8	3.5	1.8	10.35	2.37
140	1.046	90.3	99.4	0.7117	0.8786	6.80	22.1	8.6	3.3	10.0	13.3	1.4	4.7	11.6	3.0	1.6	12.14	2.64
160	1.1485	87	99.4	0.8142	0.8611	6.93	20.6	8.6	3.0	10.0	13.0	1.4	4.4	11.5	2.9	1.5	13.89	2.90
194	1.251	86.5	99.5	0.9167	0.8436	7.08	20.3	8.7	2.9	10.0	12.9	1.3	4.2	11.4	2.7	1.4	15.64	3.03

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

PROJECT: Blue Ridge Paper

DESCRIPTION: SLUDGE,ASH,LIME,GRAVEL
BORING: B06-1
SAMPLE: 2S
DEPTH (ft.): 16.9
FILE No.: 05127
TEST No.: CIUC-2
DATE: 2/9/2006
TESTED BY: EJL
PRC (lb/div): 0.463

TEST CONDITIONS		
INITIAL DIAL READING (in.):	0.59	
SPECIFIC GRAVITY:	2.58	est.
INITIAL WET WT. (gms):	883.1	
INITIAL DRY WT. (gms):	465.8	
CELL PRESSURE (psi):	105	
BACK PRESSURE (psi):	75	
EFFECTIVE CONFINING PRESSURE (psi):	30	
PORE PRESSURE @ PRESHEAR (psi):	75.4	
AXIAL STRAIN RATE (in./min.):	0.005	
MEMBRANE THICKNESS (in.):	0.012	

	INITIAL	PRE-SHEAR	FINAL			
HEIGHT (in.):	6.000	5.600		15.2400	14.224	(cm)
AREA (in^2):	6.417	5.852		41.3986	37.7548	(cm^2)
TOTAL DENSITY (pcf):	87.4	89.0				
DRY DENSITY (pcf):	46.1	54.1				
WATER CONTENT (%):	89.6		64.3			
VOLUME TOTAL (cc):	630.92	537.02				
VOLUME SOLIDS (cc):	180.53					
VOLUME VOIDS (cc):	450.38	356.49				
VOID RATIO:	2.4948	1.9747				
SATURATION (%):	92.7	84.0				

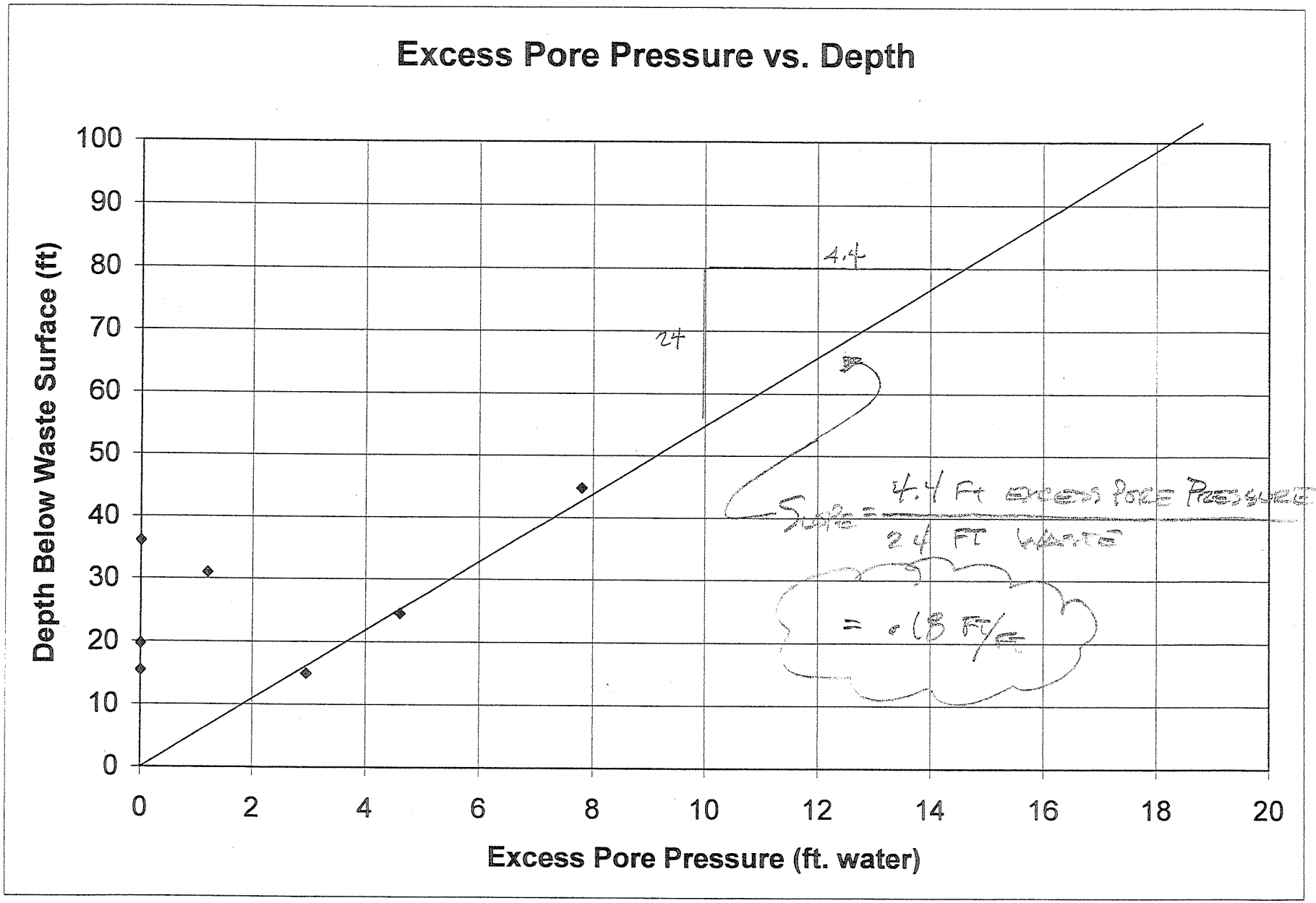
TIME (min)	DIAL (in.)	LOAD (lb)	PWP (psi)	DELTA L (in.)	AREA CF	CORR. AREA (sq. in.)	IND LOAD (lbs.)	IND PWP (psi)	DEV STRESS (psi)	SIGMA 3 (psi)	SIGMA 1 (psi)	SIGMA 3' (psi)	SIGMA 1' (psi)	P (psi)	P' (psi)	Q (psi)	STRAIN (%)	A
0	0.59	45	75.4	0.0000	1.0000	5.85	0.1	0	0.0	30.0	30.0	30.0	30.0	30.0	30.0	0.0	0.00	0.00
0.5	0.5915	93	76.7	0.0015	0.9997	5.85	22.4	1.3	3.8	30.0	33.8	28.7	32.5	31.9	30.6	1.9	0.03	0.34
1	0.594	119	77.9	0.0040	0.9993	5.86	34.4	2.5	5.9	30.0	35.9	27.5	33.4	32.9	30.4	2.9	0.07	0.43
1.5	0.5955	130.3	78.4	0.0055	0.9990	5.86	39.6	3.0	6.8	30.0	36.8	27.0	33.8	33.4	30.4	3.4	0.10	0.44
2	0.597	140	78.9	0.0070	0.9988	5.86	44.1	3.5	7.5	30.0	37.5	26.5	34.0	33.8	30.3	3.8	0.13	0.46
2.5	0.5985	150	79.4	0.0085	0.9985	5.86	48.8	4.0	8.3	30.0	38.3	26.0	34.3	34.2	30.2	4.2	0.15	0.48
3	0.6	159.5	79.9	0.0100	0.9982	5.86	53.2	4.5	9.1	30.0	39.1	25.5	34.6	34.5	30.0	4.5	0.18	0.50
3.5	0.6018	168	80.3	0.0118	0.9979	5.86	57.1	4.9	9.7	30.0	39.7	25.1	34.8	34.9	30.0	4.9	0.21	0.50
4	0.6034	177	80.9	0.0134	0.9976	5.87	61.3	5.5	10.4	30.0	40.4	24.5	34.9	35.2	29.7	5.2	0.24	0.53
4.5	0.605	185	81.4	0.0150	0.9973	5.87	65.0	6.0	11.1	30.0	41.1	24.0	35.1	35.5	29.5	5.5	0.27	0.54
5	0.6068	192.5	81.9	0.0168	0.9970	5.87	68.4	6.5	11.7	30.0	41.7	23.5	35.2	35.8	29.3	5.8	0.30	0.56
6	0.61	206	82.8	0.0200	0.9964	5.87	74.7	7.4	12.7	30.0	42.7	22.6	35.3	36.4	29.0	6.4	0.36	0.58
7	0.616	218	83.7	0.0260	0.9954	5.88	80.2	8.3	13.6	30.0	43.6	21.7	35.3	36.8	28.5	6.8	0.46	0.61
8	0.62	229.5	84.4	0.0300	0.9946	5.88	85.6	9.0	14.5	30.0	44.5	21.0	35.5	37.3	28.3	7.3	0.54	0.62
9	0.6235	240	85.2	0.0335	0.9940	5.89	90.4	9.8	15.4	30.0	45.4	20.2	35.6	37.7	27.9	7.7	0.60	0.64
10	0.6275	249	85.9	0.0375	0.9933	5.89	94.6	10.5	16.1	30.0	46.1	19.5	35.6	38.0	27.5	8.0	0.67	0.65
12	0.6355	265	87.1	0.0455	0.9919	5.90	102.0	11.7	17.3	30.0	47.3	18.3	35.6	38.6	26.9	8.6	0.81	0.68
14	0.644	276.5	88	0.0540	0.9904	5.91	107.3	12.6	18.2	30.0	48.2	17.4	35.6	39.1	26.5	9.1	0.96	0.69
16	0.6535	286	89	0.0635	0.9887	5.92	111.7	13.6	18.9	30.0	48.9	16.4	35.3	39.4	25.8	9.4	1.13	0.72
18	0.6625	282.5	89.9	0.0725	0.9871	5.93	110.1	14.5	18.6	30.0	48.6	15.5	34.1	39.3	24.8	9.3	1.29	0.78
21	0.6773	303.5	90.9	0.0873	0.9844	5.94	119.8	15.5	20.2	30.0	50.2	14.5	34.7	40.1	24.6	10.1	1.56	0.77
24	0.692	315	91.7	0.1020	0.9818	5.96	125.2	16.3	21.0	30.0	51.0	13.7	34.7	40.5	24.2	10.5	1.82	0.78
27	0.707	327	92.2	0.1170	0.9791	5.98	130.7	16.8	21.9	30.0	51.9	13.2	35.1	40.9	24.1	10.9	2.09	0.77
30	0.723	337	92.8	0.1330	0.9763	5.99	135.3	17.4	22.6	30.0	52.6	12.6	35.2	41.3	23.9	11.3	2.38	0.77
35	0.744	349	93.4	0.1540	0.9725	6.02	140.9	18.0	23.4	30.0	53.4	12.0	35.4	41.7	23.7	11.7	2.75	0.77
40	0.769	357	94	0.1790	0.9680	6.05	144.6	18.6	23.9	30.0	53.9	11.4	35.3	42.0	23.4	12.0	3.20	0.78
45	0.7935	362.5	94.5	0.2035	0.9637	6.07	147.2	19.1	24.2	30.0	54.2	10.9	35.1	42.1	23.0	12.1	3.63	0.79
50	0.819	375	94.7	0.2290	0.9591	6.10	152.9	19.3	25.1	30.0	55.1	10.7	35.8	42.5	23.2	12.5	4.09	0.77
60	0.867	394.5	95.2	0.2770	0.9505	6.16	162.0	19.8	26.3	30.0	56.3	10.2	36.5	43.2	23.4	13.2	4.95	0.75
75	0.9423	410	95.6	0.3523	0.9371	6.24	169.1	20.2	27.1	30.0	57.1	9.8	36.9	43.5	23.3	13.5	6.29	0.75
90	1.0416	423.5	95.9	0.4516	0.9194	6.37	175.4	20.5	27.6	30.0	57.6	9.5	37.1	43.8	23.3	13.8	8.06	0.74
105	1.092	441	96.2	0.5020	0.9104	6.43	183.5	20.8	28.5	30.0	58.5	9.2	37.7	44.3	23.5	14.3	8.96	0.73
120	1.168	450	96.3	0.5780	0.8968	6.53	187.7	20.9	28.8	30.0	58.8	9.1	37.9	44.4	23.5	14.4	10.32	0.73
140	1.2685	469	96.4	0.6785	0.8788	6.66	196.5	21.0	29.5	30.0	59.5	9.0	38.5	44.8	23.8	14.8	12.12	0.71
160	1.368	492	96.4	0.7780	0.8611	6.80	207.1	21.0	30.5	30.0	60.5	9.0	39.5	45.2	24.2	15.2	13.89	0.69
180	1.469	511	96.4	0.8790	0.8430	6.94	215.9	21.0	31.1	30.0	61.1	9.0	40.1	45.6	24.6	15.6	15.70	0.68

APPENDIX B

DETERMINATION OF PORE PRESSURE WITHIN THE WASTE

Water Levels From Piezometers in the Area 6A-West Landfill
Used in the Determination of Pore Pressures Within the Area Dand E Wastes

Piezometer	Elevation (approx)	Depth (tpvc)	Casing stick-up	Water Level (tpvc)							
				1/16/2006	1/17/2006	1/18/2006	1/18/2006	1/19/2006	1/19/2006	1/27/2006	2/2/2006
P-06-04A	2764	39.3	3.2	33.27	38.17	39.00	dry		dry	dry	dry
P-06-04B	2764	23.0	3.3	20.50	19.80	20.52	21.05		21.98	dry	dry
P-06-01A	2733	27.7	3.2			23.00	23.20	23.30	23.20	23.3	23.10
P-06-01B	2733	17.3	1.9			dry	dry	dry	dry	dry	dry
P-06-02A	2730	49.0	4.2			39.90	40.25	41.00	41.00	41.2	41.20
P-06-02B	2730	35.1	4.1			27.30	28.20	32.80	33.30	33.6	33.90
P-06-02C	2730	18.1	3.2				dry	16.30	16.25	15.5	15.15


Excess Pore Pressure vs. Depth
Depth Below Waste Surface (ft)
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Excess Pore Pressure (ft. water)
4.4
24
Slope = 4.4 Ft excess pore Pressure / 24 Ft waste
= .18 Ft/Ft

Title: Blue Ridge Paper
Comments: A-A'
Name: Shl\Bpp\NC\6e\Geotech\SlopeW\waste bishop.gsz
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 115
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

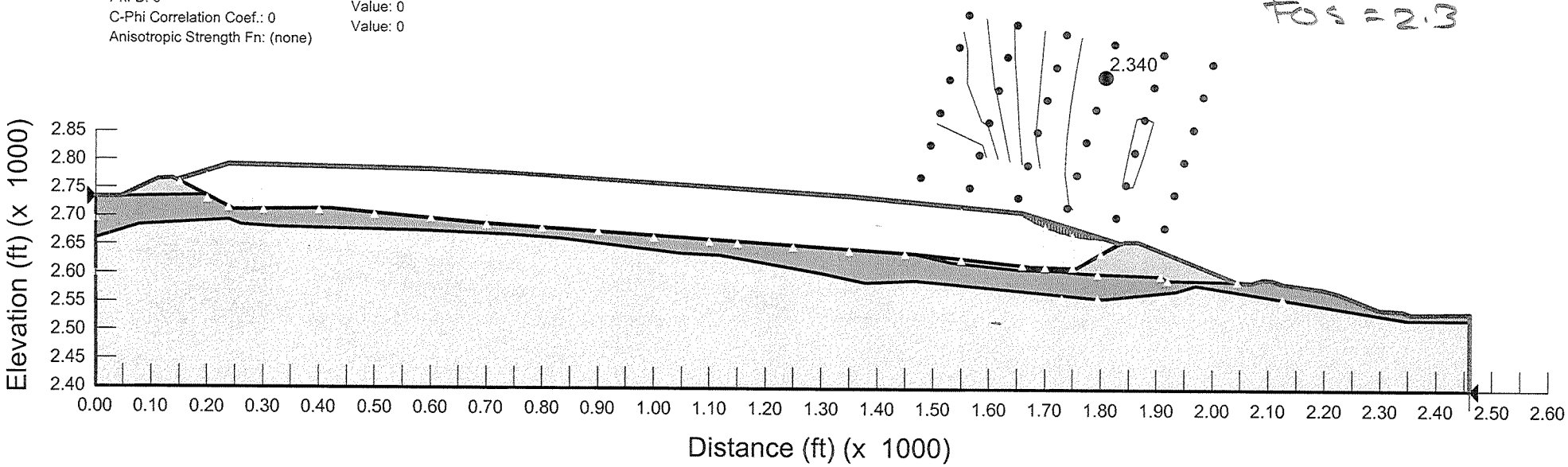
Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.934~~
Horz Seismic Load: 0

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 6
Region 6 = Material Number: 1

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

STATIC
WASTE ALONE
1S FAILURE CIRCLES
FOS = 2.3



Title: Blue Ridge Paper
Comments: A-A'
Name: Blue Ridge Paper\NC\6e\Geotech\SlopeW\waste bishop q.gsz

Material #: 1
Name: Soil
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 115
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

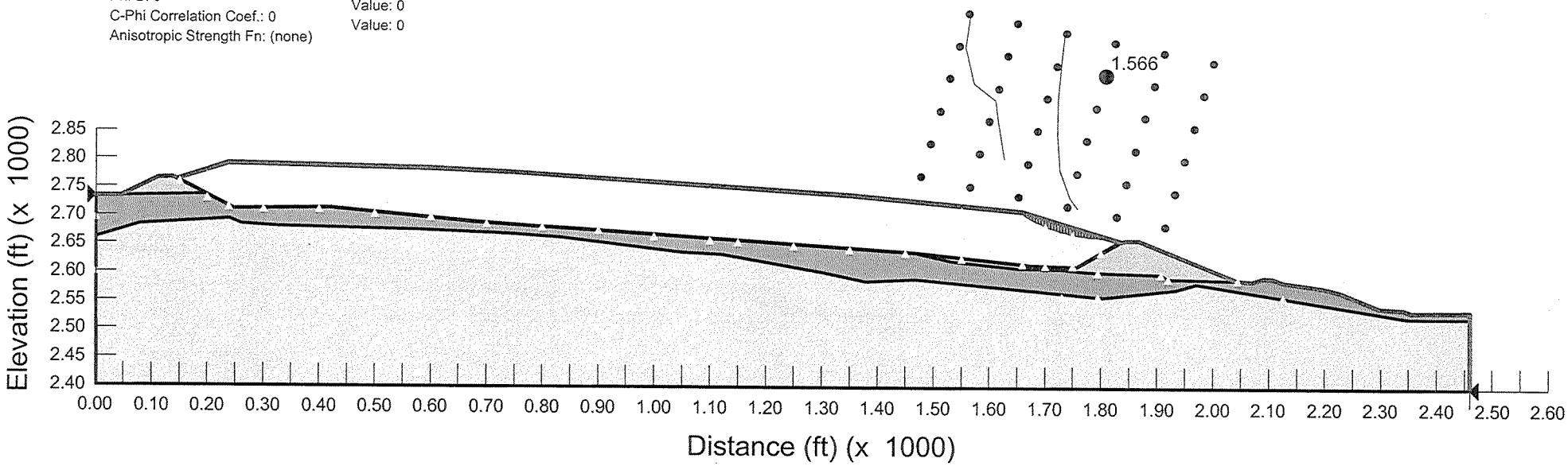
Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.296~~
Horz Seismic Load: 0.13

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 6
Region 6 = Material Number: 1

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

PSEUDO-STATIC
WASTE ALONE
(S) FAILURE CIRCLE
FOS = 1.6



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\waste dike foundation.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

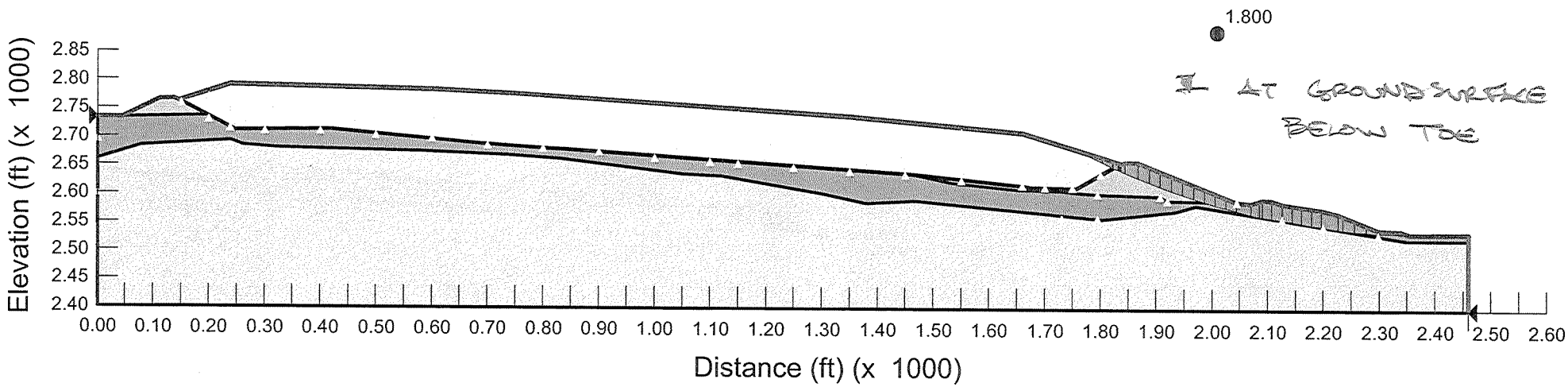
Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.575~~
Horz Seismic Load: 0

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 6
Region 6 = Material Number: 1

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

STATIC
WASTE/DIKE/FOUNDATION



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\dike foundation q.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

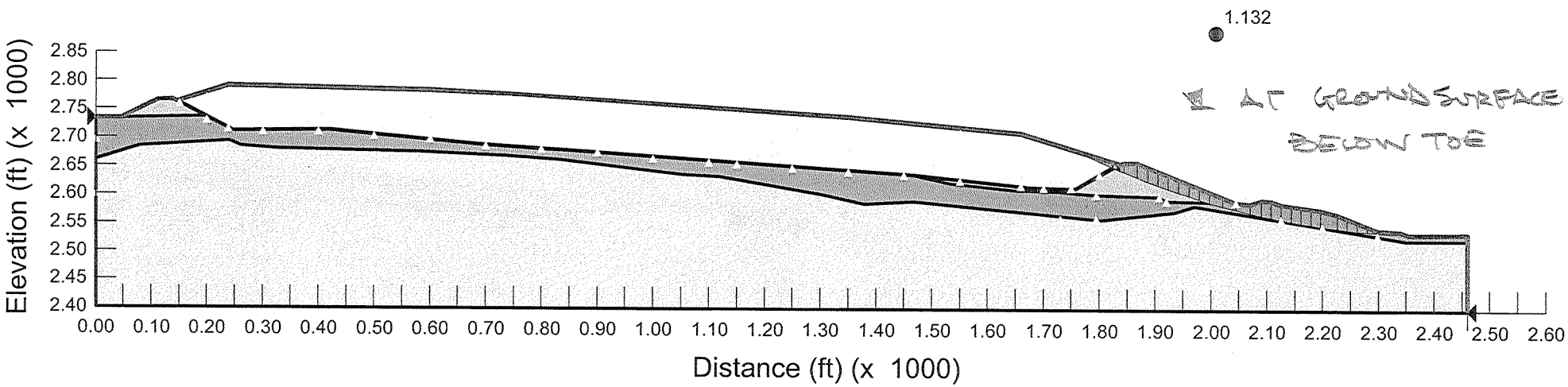
Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~0.985~~
Horz Seismic Load: 0.13

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 6
Region 6 = Material Number: 1

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

PSEUDO STATIC
WASTE/DIKE/FOUNDATION



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\dike foundation.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

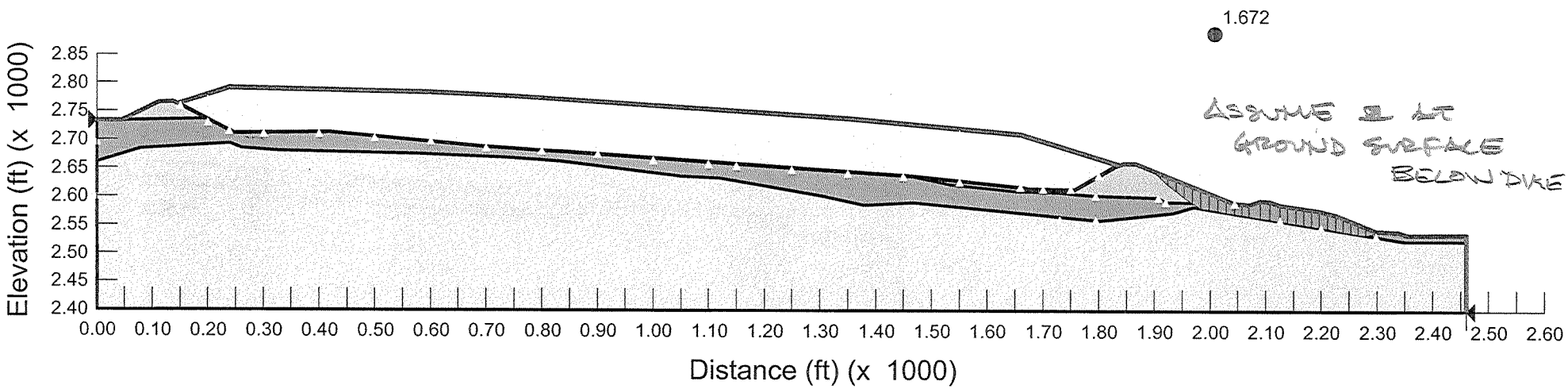
Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.575~~
Horz Seismic Load: 0

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

STATIC
DIKE AND FOUNDATION SOIL
FOS = 1.7



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\dike foundation seismic.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

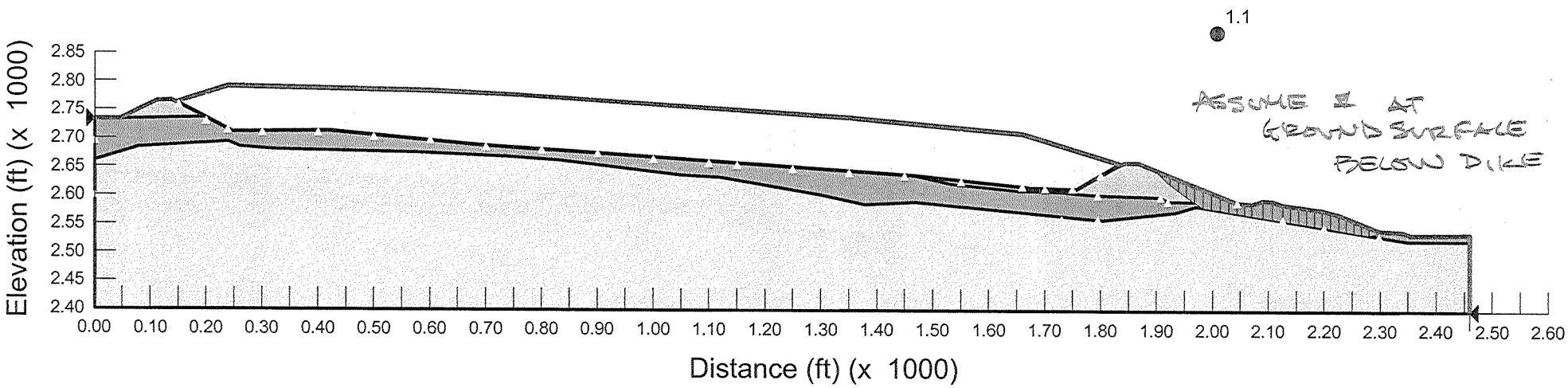
Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.0~~
Horz Seismic Load: 0.13

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

PSEUDO-STATIC
DIKE AND FOUNDATION SOIL
FOS = 1.1



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\fully saturated.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

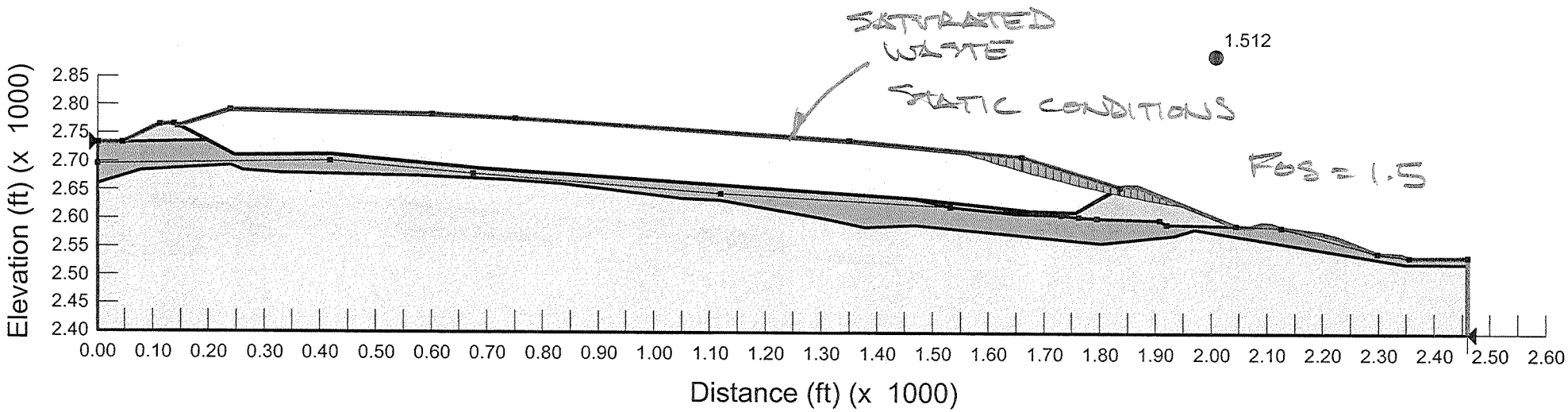
Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

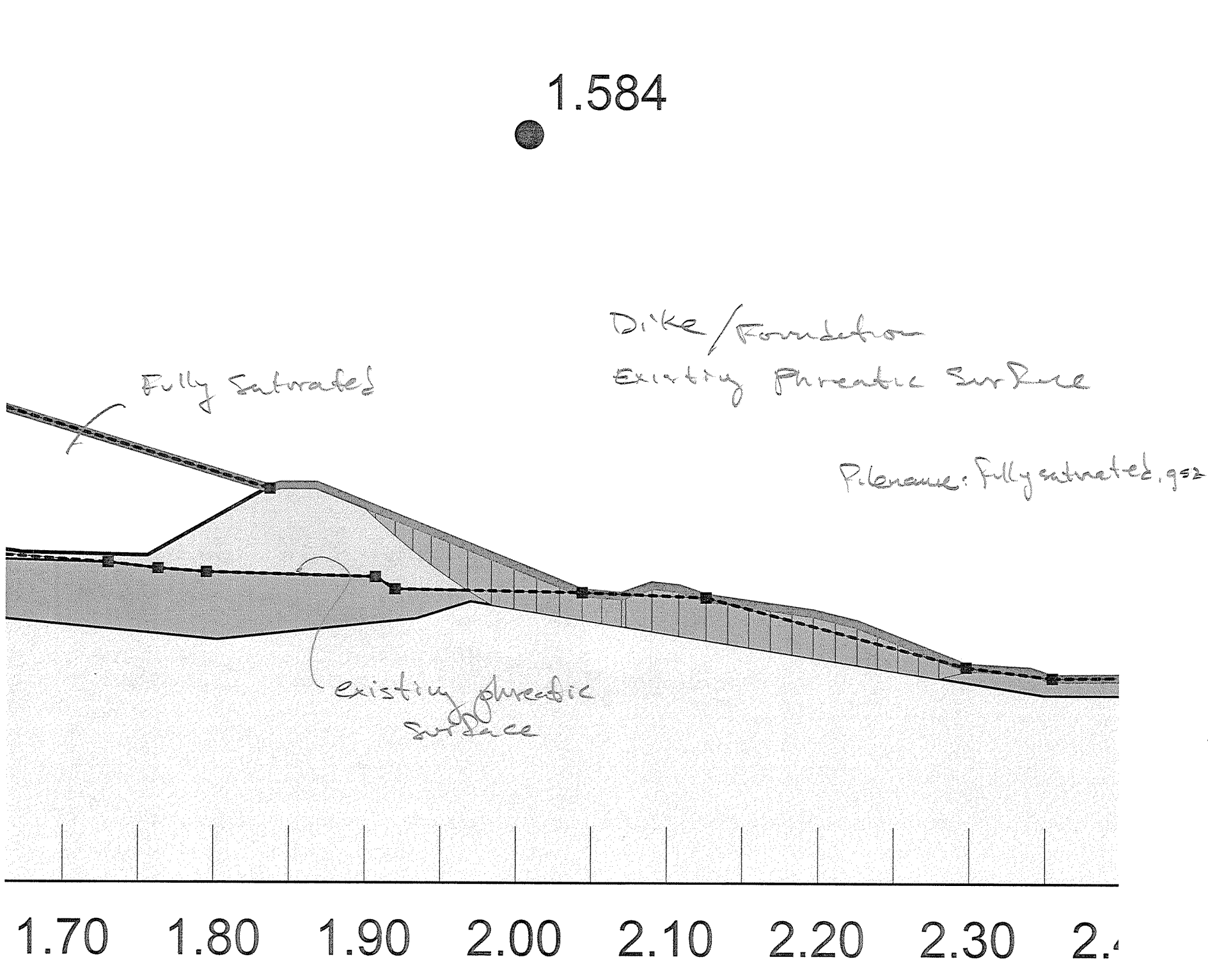
Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

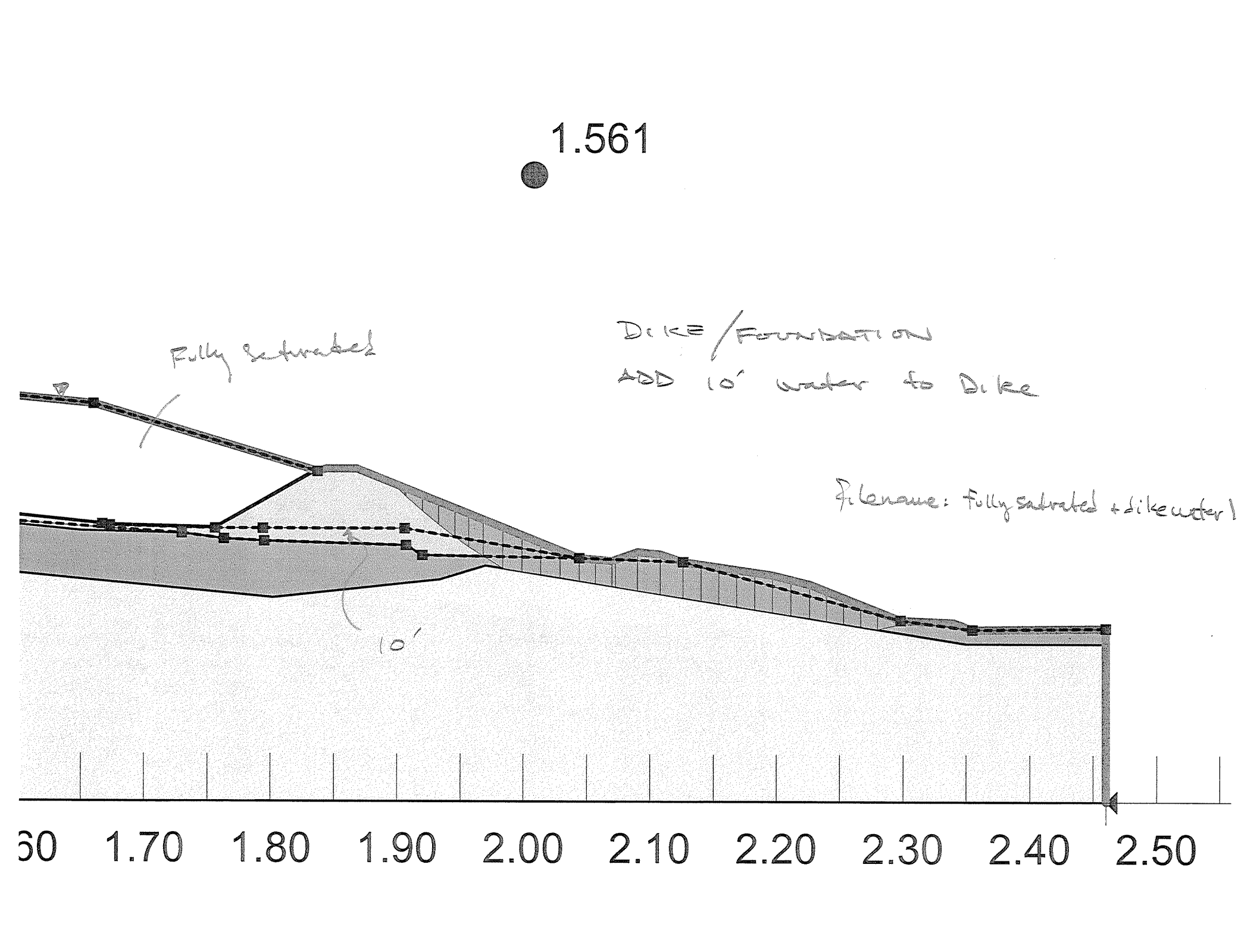
Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

Method: Bishop, Ordinary and Janbu
Factor of Safety: 1.361
Horz Seismic Load: 0

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4



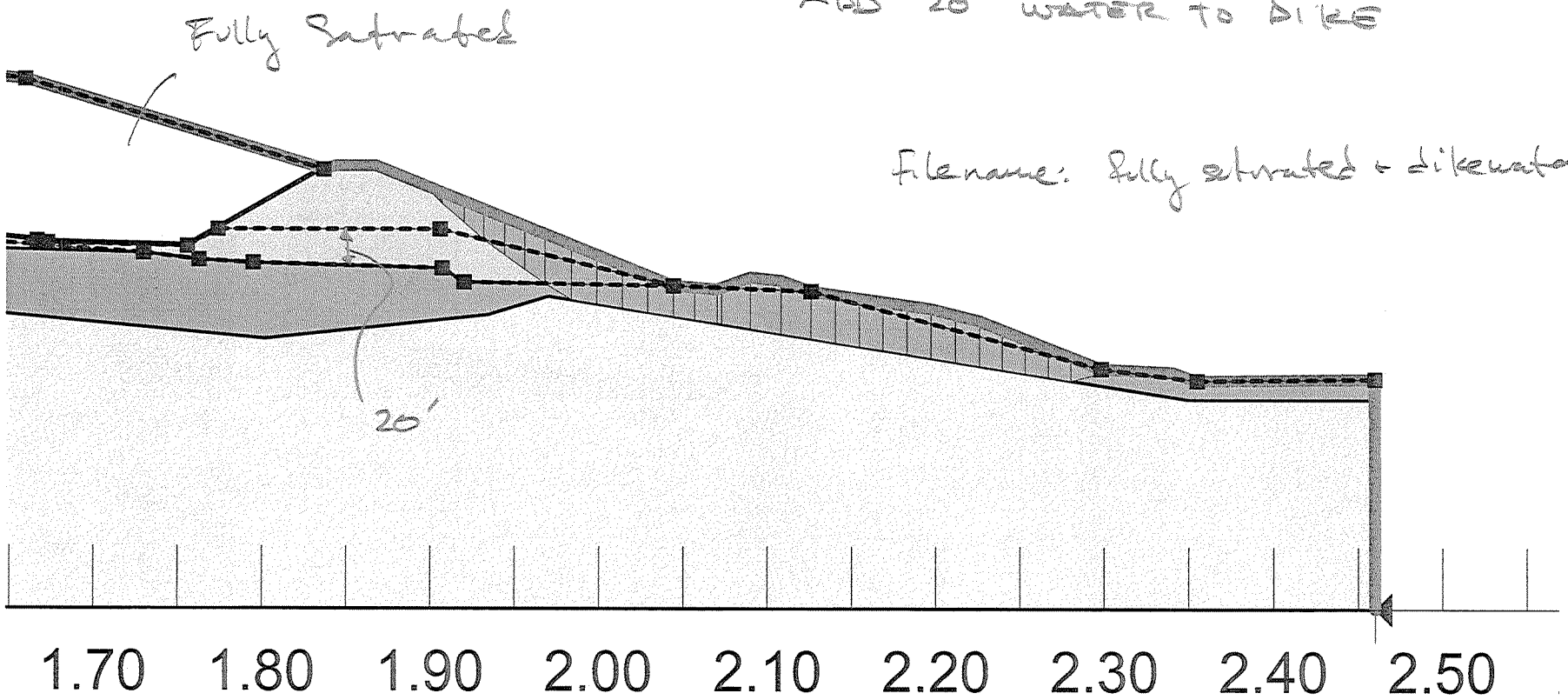

1.584
Dike/Foundation
Existing Phreatic Surface
Fully Saturated
Filename: Fully saturated.gsz
existing phreatic surface
1.70
1.80
1.90
2.00
2.10
2.20
2.30


1.561
Fully Saturated
DIKE / FOUNDATION
ADD 10' water to Dike
Filename: fully saturated + dike water
10'
60
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40
2.50

1.527

DIKE / FOUNDATION

ADD 20' WATER TO DIKE

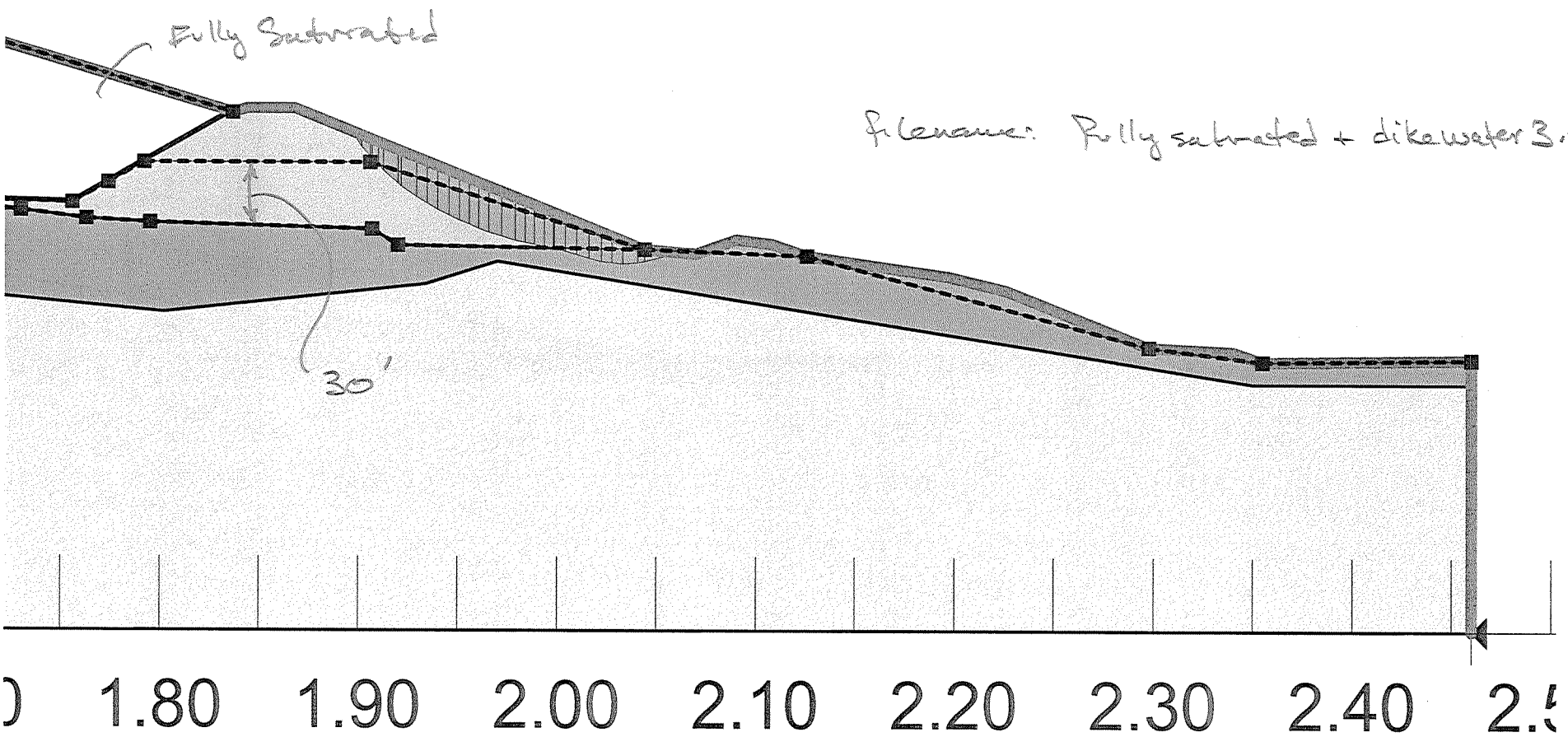


filename: fully saturated + dikewater 2

1.299

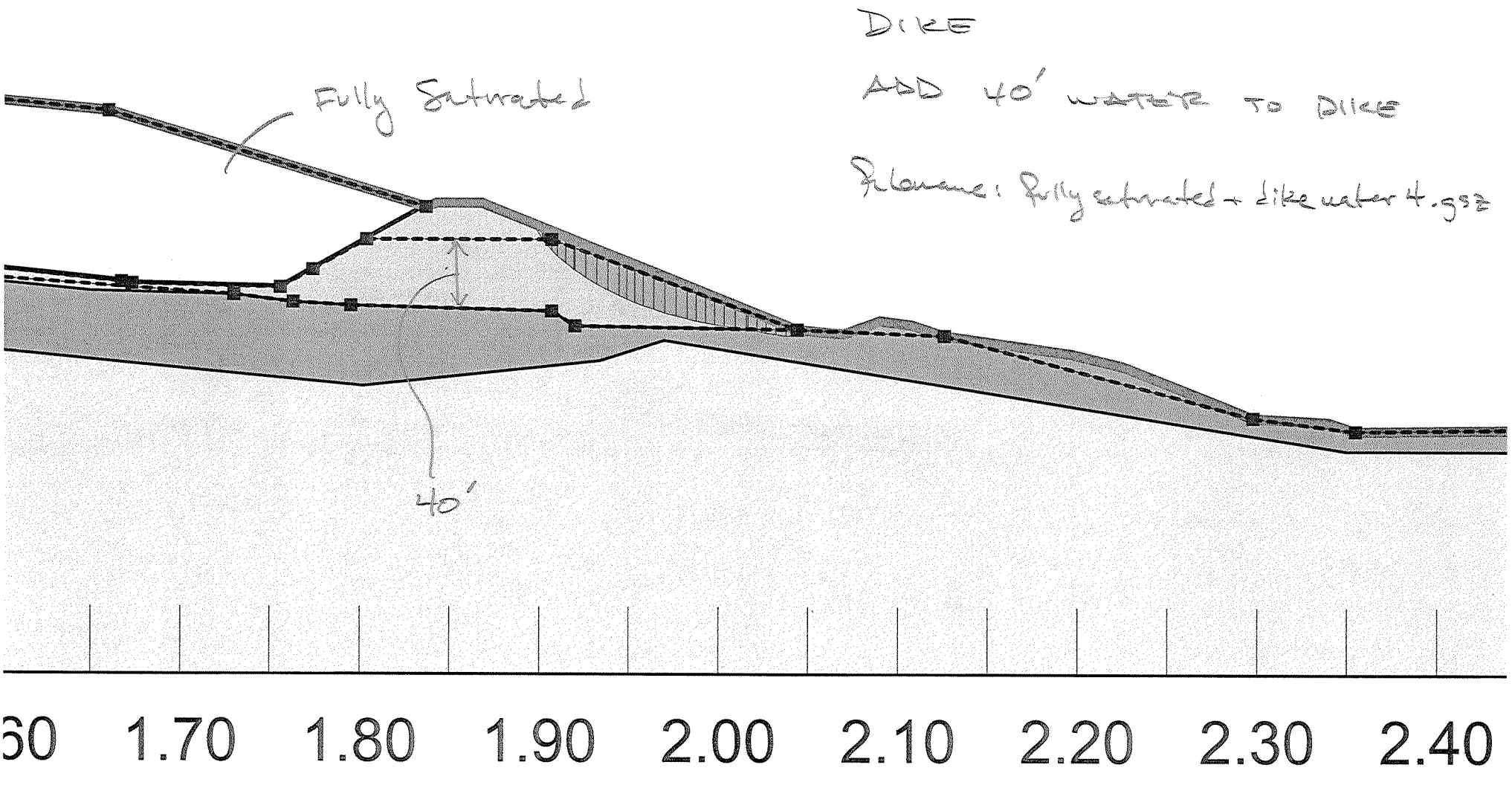
DIKE / FOUNDATION

ADD 30' WATER TO DIKE



filename: Fully saturated + dikewater 3.gsz

1.096


Dike
Add 40' water to Dike
Release: fully saturated + dike water 4.952
Fully Saturated
40'
60
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40

INFINITE SLOPE CALCULATION

PROJECT	COMP. BY	JOB NO.
INFINITE SLOPE CALCULATION	MSR	99063
	CHK. BY	DATE 7/20/99

CALCULATE STABILITY OF SOIL COVER AND WASTE OPERATING FACE USING INFINITE SLOPE CALCULATION (LAMB & WHITMAN)

COVER SOIL

ASSUME $\phi = 30°$

FINAL GRADE = 3:1 = 18.4° = i

$$FOS = \frac{\tan \phi}{\tan i} = \frac{\tan 30}{\tan 18.4} = 1.7$$

WASTE

ASSUME $\phi = 36°$

OPERATING FACE GRADE = 3:1 = 18.4° = i

$$FOS = \frac{\tan \phi}{\tan i} = \frac{\tan 36}{\tan 18.4} = 2.2$$

THIS ASSUMES NO SEEPAGE ON COVER OR WASTE SIDESLOPES

FOS > 1.5 OK

Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\liner lift peak4.gsz

2:1 operating Face Slope on unbuttressed liner with peak strengths
FOS = 1.4 ok

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 115
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

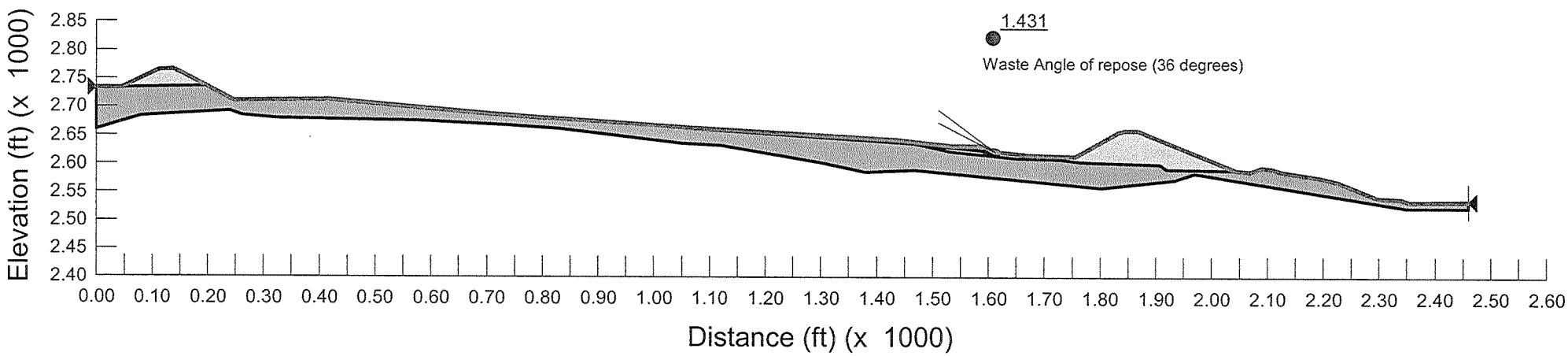
Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Spencer
Factor of Safety: 1.431
Horz Seismic Load: 0

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

Region 1 = Material Number: 3
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 2
Region 6 = Material Number: {GeometryItems.Regions[6].MaterialID}

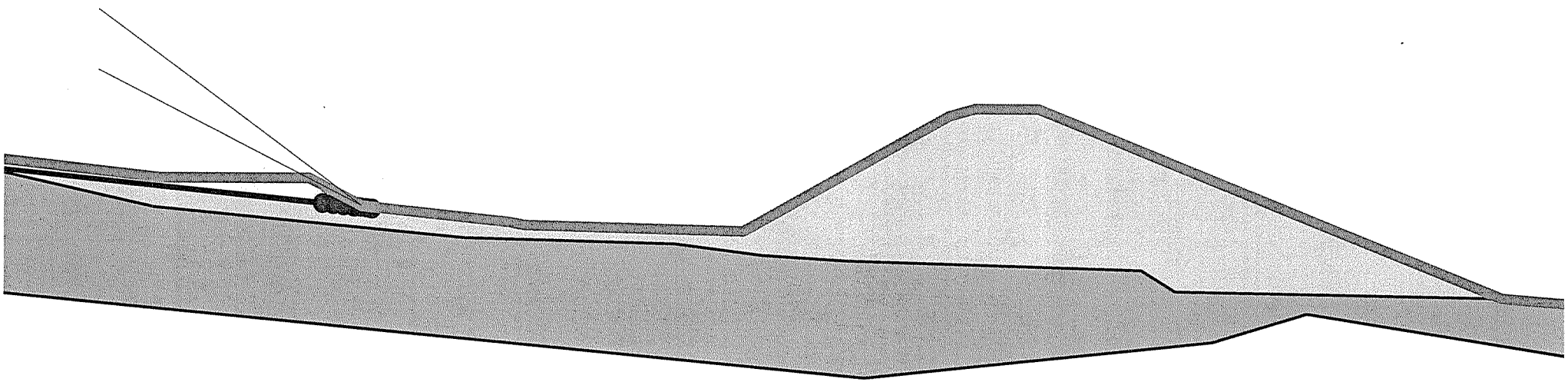


2:1 operating Face Slope on unbuttressed liner with Peak strength

FOS = 1.4

1.431

Waste Angle of repose (36 degrees)

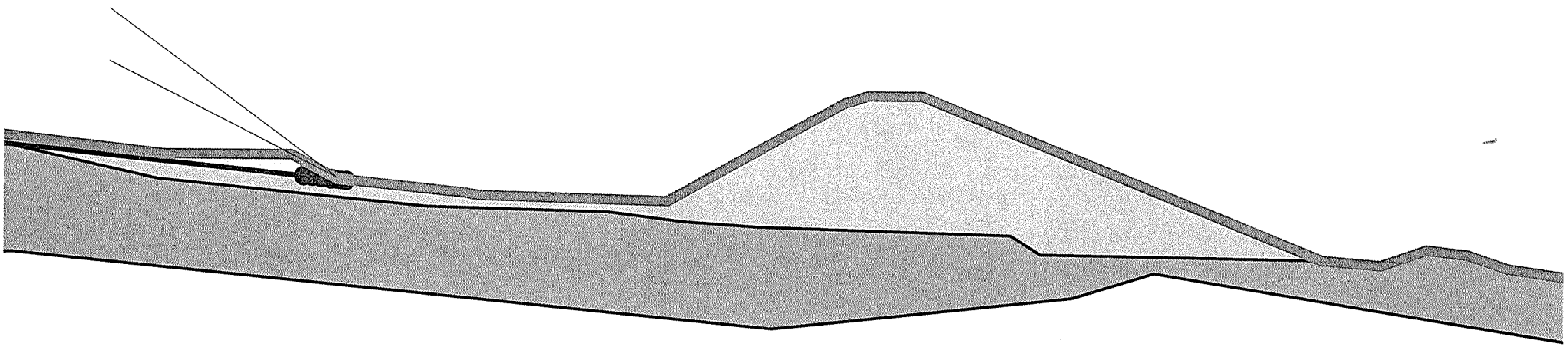


2:1 operating Face Slope on unbuttressed liner with L.D. strengths

FOS = 1.2 ok

1.228

Waste Angle of repose (36 degrees)



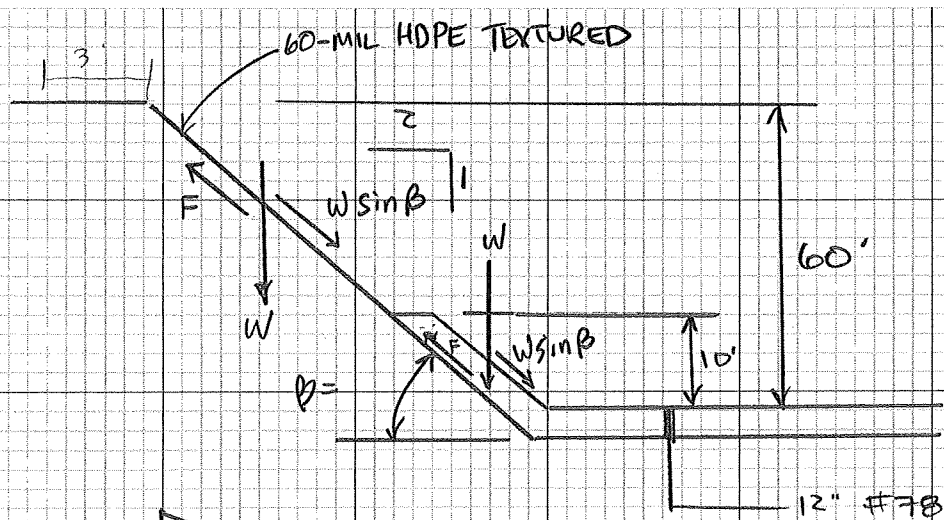
APPENDIX C

ENGINEERING CALCULATIONS

APPENDIX C-1

ANCHOR TRENCH DESIGN AND GEOMEMBRANE STRESS CALCULATIONS

PROJECT BRPP	COMP. BY MME	JOB NO. 07089.00
ANCHOR TRENCH CALCS.	CHK. BY	DATE 7.16.08



β = 1 : 2, $\tan\beta = \frac{1}{2}$, $\beta = 26.6°$

GEOMEMBRANE STRESS: SPEC YIELD STRENGTH = 132 LB/IN = 1584 LB/FT

① MAX STRESS FROM LINER WEIGHT: T = 0.092 LB/FT FS = ∞ OK

② MAX STRESS FROM L.C. STONE: T = 5.7 LB/FT FS = 277 OK

③ ANCHOR TRENCH AT REST:
MUST BE > 5.7 + 0.092 = 5.792 LB/FT
T_{K0} = 280.1 LB/FT FS = 48 OK

④ ANCHOR TRENCH PASSIVE:
MUST BE > AT REST < YIELD STRENGTH
T_{KP} = 651.4 LB/FT FS = 2.5 OK, 2.3 OK

∴ 3' x 2' x 1' ANCHOR TRENCH ACCEPTABLE

KPN
05/07/08

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA

ANCHOR TRENCH CALCULATION
REF. REQUIREMENTS FOR HAZARDOUS WASTE LANDFILL DESIGN, CONSTRUCTION AND CLOSURE, EPA CERI-88-33
DATE: 7/16/2008
FILE: ANCHOR.MCD

DESIGN PARAMETERS

$\beta := 26.6 \cdot deg$ **Maximum Slope Angle**

$\phi := 29 \cdot deg$ **Soil Internal Friction Angle**

$\delta := 26 \cdot deg$ **Minimum Interface Friction Angle**

$L := 3 \cdot ft$ **Anchor Runout Length**

$d_{at} := 2 \cdot ft$ **Anchor Trench Depth**

$d_{cs} := 1 \cdot ft$ **Cover Soil Depth**

$\gamma_{cs} := 100 \cdot \frac{lb}{ft^3}$ **Cover Soil Density**

$DR := 1.5$ **Design Ratio**

CALCULATED PULLOUT CAPACITIES

$q := d_{cs} \cdot \gamma_{cs}$

$K_o := 1 - \sin(\phi)$

$K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$

$K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$

$$T_{kp} := \frac{(q \cdot L \cdot \tan(\delta)) + (K_p + K_a) \cdot \tan(\delta) \cdot \left[\left(.5 \cdot \gamma_{cs} \cdot d_{at}^2 \right) + \left(q \cdot d_{at} \right) \right]}{DR \cdot \cos(\beta) - (\sin(\beta) \cdot \tan(\delta))}$$

Passive Stress

$T_{kp} = 691.4 \frac{lb}{ft}$

$$T_{ko} := \frac{(q \cdot L \cdot \tan(\delta)) + \left[(K_o + K_a) \cdot \tan(\delta) \cdot \left[\left(.5 \cdot \gamma_{cs} \cdot d_{at}^2 \right) + \left(q \cdot d_{at} \right) \right] \right]}{DR \cdot \cos(\beta) - (\sin(\beta) \cdot \tan(\delta))}$$

At-rest Stress

$T_{ko} = 280.1 \frac{lb}{ft}$

Sevee & Maher Engineers, Inc.

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA

GEOMEMBRANE STRESS CALCULATION
REF. REQUIREMENTS FOR HAZARDOUS WASTE LANDFILL DESIGN, CONSTRUCTION AND CLOSURE, EPA CERI-88-33
DATE: 7/16/2008
FILE: GEOSTRES.MCD

DESIGN PARAMETERS

$\beta := 26.6 \cdot deg$	**Maximum Slope Angle**
$G := 0.941$	**Geomembrane Specific Gravity**
$\delta := 26 \cdot deg$	**Minimum Interface Friction Angle**
$D := 60 \cdot ft$	**Vertical Height of Landfill**
$\gamma_w := 62.4 \cdot \frac{lb}{ft^3}$	**Density of Water**
$t := 0.060 \cdot in$	**Geomembrane Thickness**

CALCULATED GEOMEMBRANE TENSILE FORCE, T

$W := \left(G \cdot \gamma_w \cdot t\right) \cdot (D \cdot \sin(\beta))$ $\quad W = 7.888 \cdot \frac{lb}{ft}$

$F := W \cdot \cos(\beta) \cdot \tan(\delta)$ $\quad F = 3.44 \cdot \frac{lb}{ft}$

$T := W \cdot \sin(\beta) - F$ $\quad T = 0.092 \cdot \frac{lb}{ft}$

GEOMEMBRANE DESIGN STRESS

Geomembrane - 60-mil, HDPE, Textured

Specification - Min. 132 lbs/in Yield Strength
Min. 13 percent Yield Elongation

Allowable Stress, FS=5, 316.8 lb/ft Yield Strength
FS=2, 6.5 percent Yield Elongation

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA

LEACHATE COLLECTION STONE STRESS CALCULATION
REF. REQUIREMENTS FOR HAZARDOUS WASTE LANDFILL DESIGN, CONSTRUCTION AND CLOSURE, EPA CERI-88-33
DATE: 7/16/2008
FILE: SOILSTRS.MCD

DESIGN PARAMETERS

$\beta := 26.6 \cdot deg$	**Maximum Slope Angle**
$\gamma_s := 110 \cdot \frac{lb}{ft^3}$	**Soil Density**
$\delta := 26 \cdot deg$	**Minimum Interface Friction Angle**
$D := 10 \cdot ft$	**Vertical Height of Stone Layer**
$t_s := 1 \cdot ft$	**Thickness of the Stone Layer**

CALCULATED GEOMEMBRANE TENSILE FORCE, T

$W := (\gamma_s \cdot t_s) \cdot (D \cdot \sin(\beta))$ $\quad W = 492.5 \frac{lb}{ft}$

$F := W \cdot \cos(\beta) \cdot \tan(\delta)$ $\quad F = 214.8 \frac{lb}{ft}$

$T := W \cdot \sin(\beta) - F$ $\quad T = 5.7 \frac{lb}{ft}$

GEOMEMBRANE DESIGN STRESS

Geomembrane - 60-mil, HDPE, Textured

Specification - Min. 132 lbs/in Yield Strength
Min. 13 percent Yield Elongation

Allowable Stress, FS=5, 316.8 lb/ft Yield Strength
FS=2, 6.5 percent Yield Elongation

A membrane must have sufficient modulus in addition to penetration and tear resistance. This ensures that excessive stretching of the FML will not occur and that local sheet deformations due to settlement will be resisted by a larger sheet area. West German standards require that the membrane support 89.9 pounds (40N) per 1.97 inches (50mm) width at less than 5% deformation, i.e. approximate modulus of 900 lb/in. Additionally, the West German standards require that the ultimate multi-axis strain determined from a burst test should be at least 10% at failure. Currently such multi-axis data is available (EPA,1983) only in the form of Mullen-burst test which is not suitable for membranes. A possible alternative is the large scale hydrostatic test reviewed in Appendix D.

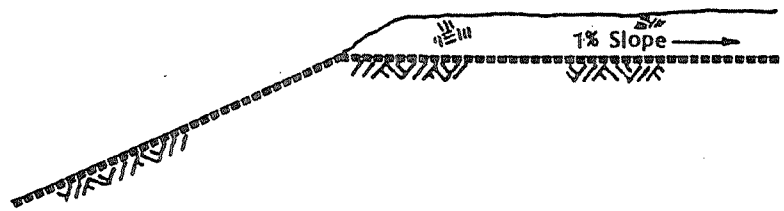
FML ANCHORAGE

The geotextiles and geomembranes lining the sides of waste facilities must be anchored at the top of these slopes to prevent movement of the systems into the cell. An anchor must provide sufficient restraint to prevent this movement but should not be so rigid or strong that the FML will tear before the anchor yields. The anchor should therefore be designed to provide a reaction force that is greater than that required to stabilize the synthetics and less than the ultimate strength of the attached components. Generally, the FML is anchored at the top of the berm using a (a) friction method, (b) trench and backfill method or (c) anchoring to a concrete structure, Figure 3.9. The trench and backfill technique is most often recommended by manufacturers, probably due to its simplicity and economy. Excavation of the anchor trench is accomplished by a trenching machine or by using a bulldozer blade tilted at an angle.

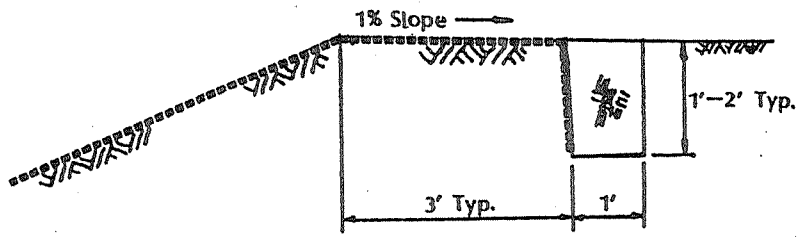
FML panels should be anchored following the field seaming operation. After the seaming crew has completed the seams for a particular panel, the panel should be anchored by backfilling the trench with soil or by anchoring the FML to the concrete structure. It is important that the panel not be anchored until it has been completely seamed to allow positioning as needed for optimum seaming. Anchoring the FML after seaming avoids stress tears on or along the seam from thermal contraction and expansion.

Anchor trench geometries include vertical walled trenchs, shallow "V" trenches, and horizontal embedment. Each trench geometry requires a different set of analysis assumptions. The vertical-walled trench requires the least amount of space but creates construction problems due to the vertical trench faces and greater difficulty in properly recompacting soil within the trench. Horizontal embedment requires the most land surface but makes the fewest analysis assumptions. Based on the accuracy of analysis assumptions, the three geometries can be ranked best to worst as horizontal, shallow "V", and vertical trench.

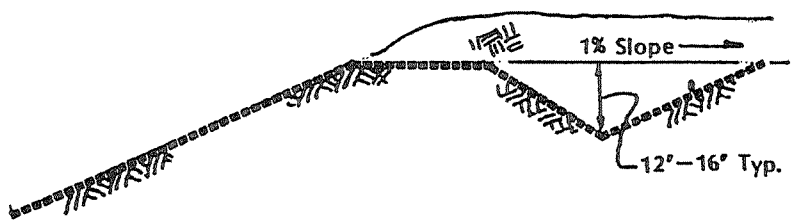
It should be noted that most anchor trenches are currently constructed to meet general recommendations provided by the FML installer. These recommendations are based on past experience and are purely empirical. No definitive field testing on actual anchorage capacities was found in the preparation of this study. In view of this lack of correlation between design capacities and actual field capacities, the designer is cautioned to compare design geometries with that recommended by the FML installer. When significant differences in proposed geometries exist, a limited field



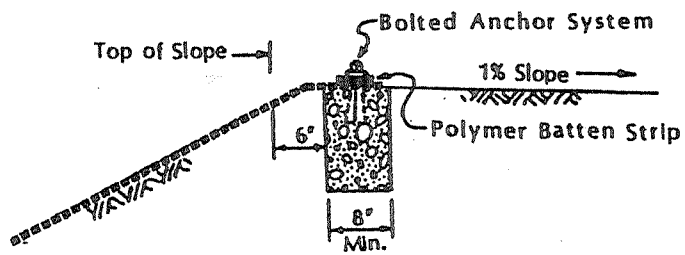
HORIZONTAL ANCHOR



TRENCH ANCHOR



SHALLOW "V" ANCHOR



CAST CONCRETE ANCHOR

Figure 3.9 FML ANCHORAGE DETAILS

pullout test should be performed to establish the actual ultimate force capacity of the anchor trench.

Both the shallow "V" and the horizontal embedment anchors rely exclusively on the frictional bond developed between the sheeting and the adjacent soil. Figure 3.10 shows the forces assumed and variables used in the analysis of these anchors. The pullout capacity, T, of horizontal and "V" anchors are given by

$$T_{horiz} = \frac{q\ L\ \tan\delta}{\cos\beta\ -\ \sin\beta\ \tan\delta} \qquad \text{Eq(3.19)}$$

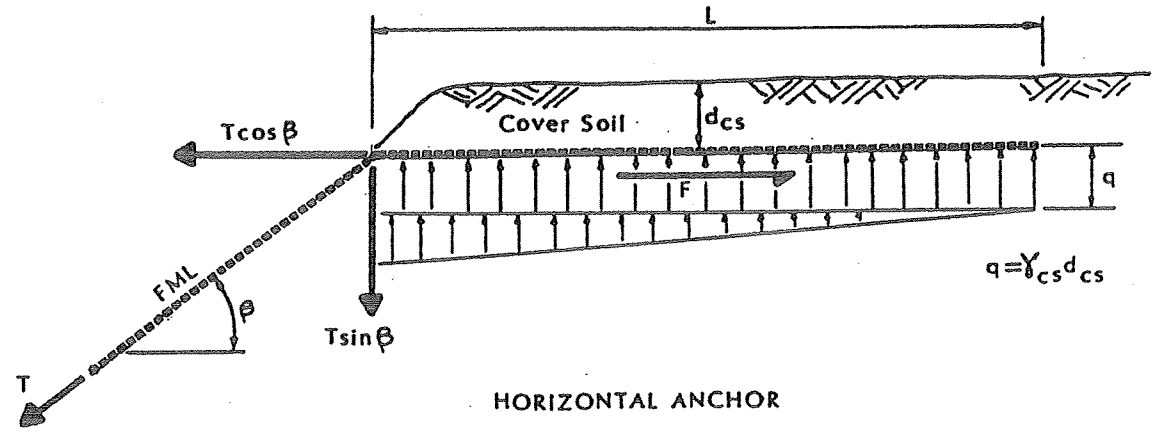
$$T_{"V"} = \frac{[q(L-L_V+L_V/\cos i)\ +\ (d_V L_V\ \gamma_{cs}/2\cos i)]\ \tan\delta}{\cos\beta\ -\ \sin\beta\ \tan\delta} \qquad \text{Eq(3.20)}$$

For deep waste cells, the runout length, L, required to develop sufficient frictional resistance may become excessive. Both frictional anchor concepts do, however, result in a significant simplification of analysis assumptions and a corresponding increase in confidence of the resulting calculated anchor capacity. Direct shear tests should be performed to establish the soil-geosynthetic friction angle, δ , used in these calculations.

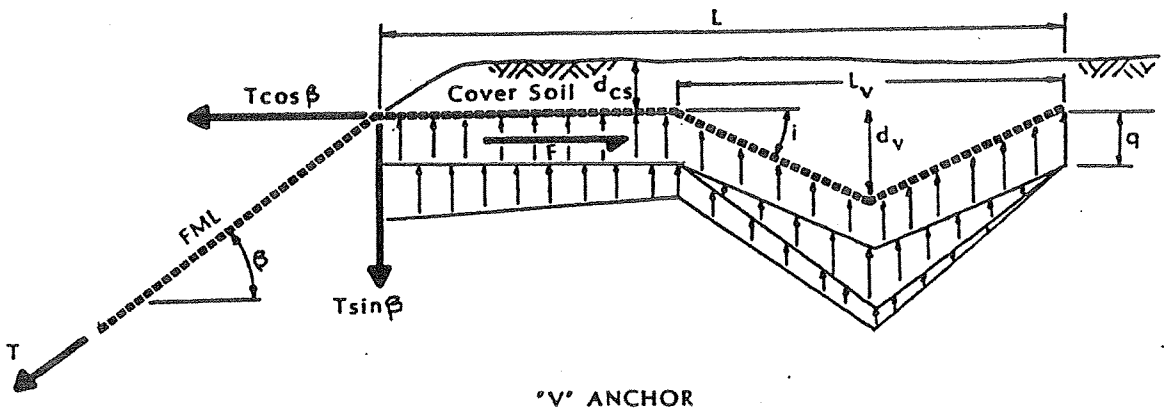
The analysis assumptions used in the vertical wall anchor trench are shown on Figure 3.10 for a trench anchor. The earth pressure assumptions made in the analysis were first proposed by Koerner(1986) and do not attempt to replicate the distribution of the actual field pressures but to estimate the total horizontal force component provided by the soil. The method sums forces in the horizontal plane to predict the anchor capacity. The most glaring assumption needed in this analysis is whether the embedded sheet will be stiff enough to produce a passive resistance force wedge. While appropriate for concrete anchors ,this assumption is poor for FML. The 90 degree entrant angle of the FML sheet into the trench produces a very difficult design condition. The tension forces in the horizontal sheet must be resisted by horizontal earth pressures from the soil adjacent to the sheet. Actual horizontal earth pressures during this process are largest at the surface and decrease to zero at some depth beneath the surface. Vertical force components resulting from the earth pressures at the ground surface and excess sheet tension may require pullout restraint obtained from further embedment of the sheeting below the point at which the horizontal earth pressure is zero. Unfortunately, no available analysis procedure correctly models the anchoring of an FML in a trench. It is reasonable to assume, however, that the earth pressure acting against the FML on the inside of the trench will be bounded by the passive and at-rest earth pressure assumptions. The anchorage capacity of the trench system can therefore be bounded using the following expression

$$T_{trench} = \frac{q\ L\ \tan\delta\ +\ (K'+K_a)\tan\ [0.5\ \gamma_{cs} d_{at}^2\ +\ q d_{at}]}{\cos\beta\ -\sin\beta\ \tan\delta} \qquad \text{Eq(3.21)}$$

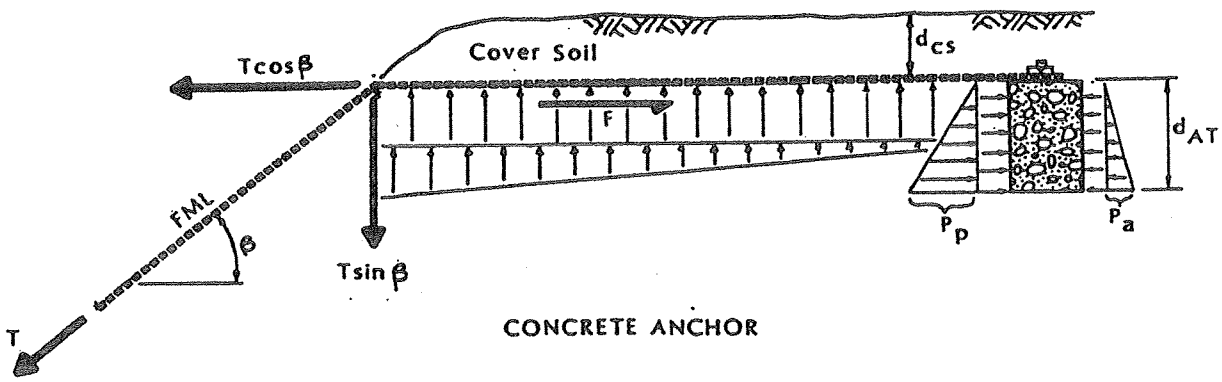
where K' is bounded by K_p and $K_{at\text{-}rest}$. For design it is recommended that



HORIZONTAL ANCHOR



'V' ANCHOR



CONCRETE ANCHOR

Figure 3.10 Forces and Variables - Anchor Analysis

the FML be sized so that it will not fail in tension if the full K_p pressure develops and T_{trench} calculated using $K_{at\text{-}rest}$ should exceed the pullout capacity to prevent failure in other modes.

The Design Ratio for the anchor should be low enough that the anchor will slip and prevent the FML or geotextile from tearing. An overly conservative design of the anchor may indeed lead to a needless tearing failure of the FML. Since the function served by the anchor is short lived, the designer can be justified in using a Design Ratio less than 2.0. An anchor design is shown on Example 3.17 using a vertical trench, horizontal, and a shallow "V" anchor trench.

The FML can also be anchored to concrete structures along the top of the berm by securing the geosynthetic with batten strips attached to anchor bolts embedded in the concrete. This technique is also applicable for bonding the FML to metal structures, such as pipes. A common approach entails placing the anchor bolts on 15 to 30 centimeter centers. The liner is placed over the bolts, an adhesive is generally applied to the FML, and the batten strip is secured and bolted in place. The analysis assumptions used in the vertical wall anchor trench are the same as shown on Figure 3.10 for a trench anchor. The anchor capacity is calculated using Eq(3.20) assuming K' is equal to K_p. Compatibility of the adhesive/sealant with the type of synthetic and liquid impounded must be verified to ensure the seal is maintained. Details of anchoring techniques are discussed by EPA (1984) and Kays (1977).

SURFACE IMPOUNDMENT CONSIDERATIONS

FML Protection

The liner system, including soil and flexible membrane components, plays a significant role in containing the wastes within the SI by preventing the migration and escape of hazardous waste and its constituents. To enhance the longevity of the liner, a protective covering will usually be required over the uppermost component to prevent damage from mechanical or environmental factors. The liner system will often have an FML as the uppermost component, which is sensitive to many of the following conditions (EPA, 1983):

1. Ultraviolet degradation of some polymers;
2. Infrared radiation;
3. Mechanical damage during placement of waste;
4. Wind;
5. Wave action;
6. Oxygen and ozone;
7. Freeze/thaw;
8. Hail/rain;
9. Animals; and
10. Vandalism.

A compacted soil liner is not as susceptible to these forces. However, a soil covering will provide additional protection from weathering effects which may change the properties or cause erosion of the liner. Weather effects include freeze/thaw, wave action or wind.

between the limiting stresses p_a and p_p which are established by the indicated stress circle construction. These limiting stress values will be referred to as *active* and *passive* stresses, respectively.

Relationships between the vertical stress and the active and passive stress values may be established as follows from the geometry of the stress diagram:

Active stress:

$$\frac{p_v - p_a}{2} = \left(p_a + \frac{p_v - p_a}{2}\right) \sin \phi$$

$$p_v - p_a = (p_a + p_v) \sin \phi$$

$$p_a \sin \phi + p_a = p_v - p_v \sin \phi$$

$$p_a = p_v \frac{1 - \sin \phi}{1 + \sin \phi} \qquad (7\text{–}14)$$

For uniform soil conditions,

$$p_a = \gamma h \frac{1 - \sin \phi}{1 + \sin \phi} \qquad (7\text{–}15)$$

By a similar procedure the following expression for the passive stress value may be developed.

Passive stress:

$$p_p = \gamma h \frac{1 + \sin \phi}{1 - \sin \phi} \qquad (7\text{–}16)$$

Stress-Strain Relations. Variation of lateral stress between the active and passive values given above can be brought about only through lateral strains or movements within the soil mass. Specifically, if the soil to the left of point a in Fig. 7–18(a) is moved an infinitesimal distance away from the point while the vertical stress remains constant, the lateral pressure at a will gradually decrease to the value p_a. It is evident that for these conditions, p_a is the minor and p_v the major principal stress. If the soil to the left of point a is forced to move in the opposite direction, the lateral stress will gradually increase until the value p_p is reached. For these conditions, p_v is the minor and p_p the major principal stress.

Lateral pressure values which are intermediate between p_a and p_p are entirely possible. In fact, in a natural soil formation it is perhaps more likely that an intermediate rather than a limiting stress condition exists. The lateral pressure under these conditions is termed *pressure at rest.*

Opportunity for Strain Due to Wall Movement. If the soil to the left of the vertical plane in Fig. 7–18(a) could be removed and replaced

APPENDIX C-2

HEAD ON LINER CALCULATION

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA

MAXIMUM HEAD ON LINER CALCULATION
REF. GIROUD, ET AL., 1993
DATE: 8/13/2008
FILE: LINEHEAD.MCD

DESIGN PARAMETERS

$K := 1 \cdot \frac{cm}{sec}$ — **Leachate Collection Stone Permeability**

$L := 200 \cdot ft$ — **Length from Peak of "Saw-Tooth" to LC Header**

$t := 15 \cdot in$ — **Leachate Collection Stone Thickness**

$e := 0.10167 \cdot \frac{in}{hr}$ — **Impingement Rate, 25-yr/24-hr Storm (6.1 inches) Assume 40 percent will infiltrate as leachate**

$\beta := 0.058$ — **Base Slope of the Landfill**

$$T_{max} := L \cdot \frac{\sqrt{\left(4 \cdot \frac{e}{K}\right) + \tan(\beta)^2} - \tan(\beta)}{2 \cdot \cos(\beta)}$$

$T_{max} = 0.242$ ft — **Maximum Head on the Liner, recommended maximum 1 ft.**

```
**********************************************************************************
**********************************************************************************
**                                                                              **
**                                                                              **
**                                                                              **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                   **
**                   HELP MODEL VERSION 3.05a  (5 JUNE 1996)                     **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                              **
**                                                                              **
**********************************************************************************
**********************************************************************************

PRECIPITATION DATA FILE:     C:\HELP3\BRPP\NC60BASE.D4
TEMPERATURE DATA FILE:       C:\help3\BRPP\NC60BASE.D7
SOLAR RADIATION DATA FILE:   C:\help3\BRPP\NC60BASE.D13
EVAPOTRANSPIRATION DATA:     C:\help3\BRPP\NC60BASE.D11
SOIL AND DESIGN DATA FILE:   C:\Help3\BRPP\NC60BASE.D10
OUTPUT DATA FILE:            C:\Help3\BRPP\NC60BASE.OUT

TIME:  12:54      DATE:    7/17/2008

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

     TITLE:  BRPP - LANDFILL 6D SOUTH - NO CAP 60-FT WASTE ON BASE

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

     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   0
          THICKNESS                     =    720.00   INCHES
          POROSITY                      =      0.4000 VOL/VOL
          FIELD CAPACITY                =      0.3600 VOL/VOL
          WILTING POINT                 =      0.2800 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.3672 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.139999997000E-05 CM/SEC


                                  LAYER  2
                                  --------

                  TYPE 2 - LATERAL DRAINAGE LAYER
```

MATERIAL TEXTURE NUMBER 21

THICKNESS	=	15.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	8.00	PERCENT
DRAINAGE LENGTH	=	200.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

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

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7470	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999997000E-08	CM/SEC

LAYER 5

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	60.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4710	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	90.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.166	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.200	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.240	INCHES
INITIAL SNOW WATER	=	2.623	INCHES
INITIAL WATER IN LAYER MATERIALS	=	293.318	INCHES
TOTAL INITIAL WATER	=	295.941	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.28	3.52	4.27	3.34	3.52	3.28
4.48	4.23	3.00	2.65	2.69	3.05

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING

COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.08	3.43	3.81	3.13	4.04	3.51
	4.03	3.94	2.52	2.24	2.86	3.14
STD. DEVIATIONS	1.33	1.85	2.32	1.66	1.36	1.47
	1.52	1.79	1.45	1.26	2.00	1.73
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.780	1.028	1.656	2.174	2.836	3.071
	2.916	2.482	1.640	1.100	1.212	0.565
STD. DEVIATIONS	0.394	0.555	1.306	2.108	2.821	3.049
	2.920	2.473	1.760	1.179	0.781	0.339
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.7210	0.5925	0.5919	0.6148	0.6989	0.7255
	0.7553	0.8516	0.9315	0.9150	0.8870	0.7734
STD. DEVIATIONS	0.5048	0.4737	0.5305	0.4921	0.5207	0.4624
	0.4821	0.4013	0.2996	0.3471	0.3335	0.5046
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 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	0.0344	0.0311	0.0282	0.0303	0.0334	0.0358
	0.0360	0.0406	0.0459	0.0437	0.0437	0.0369
STD. DEVIATIONS	0.0241	0.0250	0.0253	0.0243	0.0248	0.0228
	0.0230	0.0192	0.0148	0.0166	0.0164	0.0241

DAILY AVERAGE HEAD ON TOP OF LAYER 5

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

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.73 (4.479)	144205.4	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	21.459 (17.8486)	77896.57	54.018
LATERAL DRAINAGE COLLECTED FROM LAYER 2	9.05838 (4.46032)	32881.914	22.80214
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00000 (0.00000)	0.015	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.037 (0.018)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.015	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.000 (0.000)		
CHANGE IN WATER STORAGE	9.034 (18.3931)	32791.62	22.740

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 15

	(INCHES)	(CU. FT.)
PRECIPITATION	2.99	10853.700
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.04762	172.86519
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 3	0.070	
MAXIMUM HEAD ON TOP OF LAYER 3	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	2.1 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 5	0.000	
SNOW WATER	122.47	444571.0310

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3958
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2800

*** 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 15

LAYER	(INCHES)	(VOL/VOL)
1	279.6013	0.3883
2	0.4888	0.0326
3	0.0000	0.0000
4	0.1793	0.7470
5	28.2600	0.4710
SNOW WATER	122.914	

****

APPENDIX C-3

GEOTEXTILE CUSHION CALCULATION

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA

GEOTEXTILE CUSHION CALCULATION
REF. DESIGNING WITH GEOSYNTHETIC CUSHIONS, BOSCHUK
CIVIL ENGINEERING NEWS, OCTOBER 1994
DATE: 7/16/2008
FILE: CUSHION.MCD

DESIGN PARAMETERS

$M := 16 \frac{oz}{sy}$ $M := 542.5 \frac{g}{m^2}$ **Geotextile Weight**

$H := 1.0$ in $H := .0254$ m **Stone maximum diameter**

$MF_s := 1.0$ **Modification Factor for Stone Shape**

$MF_{pd} := .2$ **Modification Factor for Stone Packing**

$MF_a := 0.17$ **Modification Factor for Overburden Pressure**

$FS_{cr} := 1.5$ **Modification Factor for Creep Puncture**

$$P_{allow} := \left[(50) + 0.00045 \cdot \frac{M}{H^2}\right] \cdot \left(\frac{1}{MF_s \cdot MF_{pd} \cdot MF_a \cdot FS_{cr}}\right)$$

$P_{allow} = 8.4 \cdot 10^3$ kPa **Allowable Pressure**

$\gamma_{waste} := 80 \frac{lb}{ft^3}$ **Density of Waste, 80 percent**

$\gamma_{soil} := 125 \frac{lb}{ft^3}$ **Density of Gravel, 20 percent**

$d := 95$ ft **Depth of Landfill**

$P_{reqd} := (80 \cdot .80 + 125 \cdot .20) \cdot d$

$P_{reqd} = 8.455 \cdot 10^3 \frac{lb}{ft^2}$ $P_{reqd} := 404.8$ kPa **Required Pressure**

$FS := \frac{P_{allow}}{P_{reqd}}$ $FS = 20.8$ **Factor of Safety, recommended minimum 2.0**

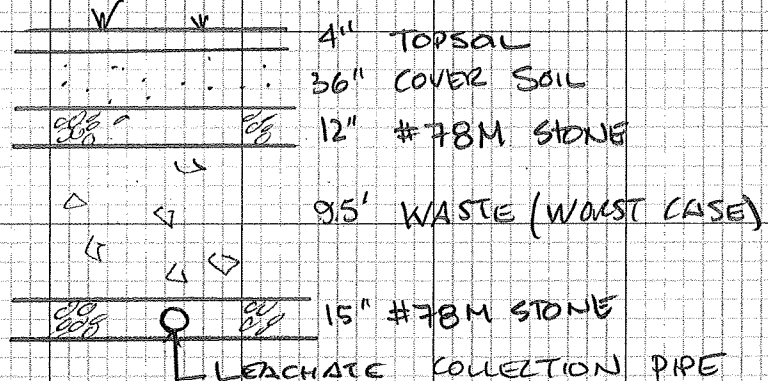
APPENDIX C-4

HDPE STRENGTH CALCULATION

PROJECT BRPP	COMP. BY HME	JOB NO. 07089.00
PIPE STRENGTH CALCULATIONS	CHK. BY	DATE 7-16-08

REF: ① GUIDELINES FOR HDPE PIPE IN DEEP FILLS LJP JAN 98
② PLEXCO ENG MANUAL II EM 2, 1997

PARAMETERS:



ASSUMPTIONS:

1) DENSITY WASTE = 80 LBS/CF
2) DENSITY COVER/STONE = 125 LBS/CF
3) PIPE BEDDING IS STONE @ 90% PROCTOR

RESULTS:

6" Ø LEACHATE COLLECTION LATERAL
- SDR 11 HDPE
- 3/8" Ø PERFORATIONS, 2 EVERY 6"
- SAFETY FACTOR = 3.4 > 2 (OK)
- DEFLECTION = 4.7% < 7.5% (OK)

12" Ø LEACHATE COLLECTION HEADER
- SDR 11 HDPE
- 3/8" PERFORATIONS, 2 EVERY 6"
- SF = 3.3 > 2 (OK)
- DEF. = 5% < 7.5% (OK)

12" Ø strip drain SF = 3.3 > 2 OK

PIPE CALCULATIONS
EFFECTIVE WALL THICKNESS OF 6" ϕ SDR 11 PERFORATED PIPE

PROJECT: Blue Ridge, Canton NC.Landfill 6 D-South Expansion 07089.00
CALC. BY: HME **DATE:** July 16, 2008
DATE_____ **CHECKED BY**_____

Pipe Information

$OD := 6.625 \cdot in$ **Pipe Outside Diameter (inches)**

$DR := 11$ **Pipe Dimension Ratio**

Perforations

$Dperf := 0.375 \cdot in$ **Diameter of perforations (inches)**

$Nperf := 4$ **Number of perforations per foot**

Calculations

$Tmin := \frac{OD}{DR}$ **Minimum wall thickness (inches)**

$Tmin = 0.602 \cdot in$

$Aperf := Dperf \cdot Tmin \cdot Nperf$ **Cross sectional area of perforations per 12" segement (sq. in.)**

$Aperf = 0.903 \cdot in^2$

$Apipe := Tmin \cdot (12 \cdot in)$ **Wall area without perforations (sq. in.)**

$Apipe = 7.227 \cdot in^2$

$Aeff := Apipe - Aperf$ **Effective area (reduced by area of perforations)**

$Aeff = 6.324 \cdot in^2$

$Teff := \frac{Aeff}{12 \cdot in}$ **Resulting effective wall thickness per 12" segment (in.)**

$Teff = 0.527 \cdot in$

$DReff := \frac{OD}{Teff}$ $DReff = 12.571$ **Effective DR due to theoretical wall area reduction**

Pipe Calculations
Pipe Strength in Deep Fill

Pipe Location: Blue Ridge Landfill 6-D South L.C. Pipe
Pipe Size & Type: 6" dia. SDR 11 HDPE Perforated Pipe

Project: Blue Ridge, Canton NC. Landfill 6 Expansion 07089.00
Calc. by: HME **Date:** July 16, 2008
Date_____**Checked by**_____

Project Parameters

Depth of Overburden $H := 99.5 \cdot ft$

Depth of Waste Over Pipe $D_{waste} := 95 \cdot ft$

Depth of Soil over Pipe $D_{soil} := 4.5 \cdot ft$

Depth of groundwater $Hgw := 0 \cdot ft$

Unit weight of waste $\gamma w := 80 \cdot \frac{lbf}{ft^3}$

Unit weight of soil $\gamma s := 125 \cdot \frac{lbf}{ft^3}$

Hyperbolic Parameter:

Modulus Number $k := 100$

Modulus Exponent $n := 0.4$

(for 90% Compaction)

Pipe Parameters:

Effective DR: $DR := 12.571$

Long term compressive yield streght $Sc := 1600 \cdot psi$

Outside Diameter $OD := 6.625 \cdot in$

Short Term Modulus: $Estm := 100000 \cdot psi$

Long Term Modulus: $El := 23000 \cdot psi$

Poisson Ratio of Soil: $\mu := .35$

Temperature Design Factor: $f := 0.78$

(for 100 deg. F)

Overbuden weight

Weighted soil/waste unit weight

$$\gamma wt := \gamma w \cdot \frac{D_{waste}}{H} + \gamma s \cdot \frac{D_{soil}}{H}$$

$$\gamma wt = 82.035 \circ \frac{lbf}{ft^3}$$

Pipe Dimensional Parameters

Pipe Wall Thickness $t := \frac{OD}{DR}$ $t = 0.527 \circ in$

Mean Radius $r := \frac{OD - t}{2}$ $r = 3.049 \circ in$

Long Term Compressive Yeild Strength due to Temperture

$Sct := Sc \cdot f$ $Sct = 1.248 \cdot 10^3 \circ psi$

Constrained Modulus

$$Ms := k \cdot 14.7 \cdot psi \cdot \left(\gamma wt \cdot \frac{H}{14.7 \cdot psi} \right)^n \qquad Ms = 2.522 \cdot 10^3 \circ psi$$

Hoop Thrust Stiffness

$$Sa := \frac{1.43}{EI \cdot t} \cdot Ms \cdot r \qquad Sa = 0.907$$

Vertical Arching Factor, (Eq. 1 of "Guidelines for HDPE Pipes in Deep Fills")

$$VAF := .88 - .71 \cdot \left(\frac{Sa - 1}{Sa + 2.5} \right) \qquad VAF = 0.899$$

Radial Direct Earth Pressure, Eq. 3a for Deep Fills

$$Prd := VAF \cdot \gamma wt \cdot H \qquad Prd = 7.341 \cdot 10^3 \circ \frac{lbf}{ft^2}$$

Ring Compressive Stress, Eq. 4 for Deep Fills

$$S := \frac{Prd \cdot DR}{\left[\frac{288 \cdot (in)^2}{ft^2} \right]} \qquad S = 320.419 \circ psi \qquad N := \frac{Sct}{S} \qquad N = 3.895$$ **Safety Factor**

Watkins - Gaube Deflection

Secant Modulus, Eq. 6

$$Es := \frac{Ms \cdot (1 + \mu) \cdot (1 - 2 \cdot \mu)}{1 - \mu} \qquad Es = 1.572 \cdot 10^3 \circ psi$$

Rigity, Eq. 5

$$Rf := \frac{12 \cdot Es \cdot (DR - 1)^3}{EI} \qquad Rf = 1.27 \cdot 10^3$$

******Input Df factor from Figure 1 Guidlines for HDPE Pipe in Deep Fills******

Plexco

$$Df := 1.3$$

Soil Strain (Settlement of Fill Layer at pipe), Eq. 7

$$\varepsilon s := \frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2} \right) \cdot Es} \qquad \varepsilon s = 3.607 \circ \%$$

Pipe Deflection

$$DEFL := Df \cdot \varepsilon s \qquad DEFL = 4.689 \circ \%$$ **Not to exceed 7.5% for design.**

Allowable Deflection, Eq. 9

$e := .05$

$fD := 4.28$ **Deformaton factor for shape**

Allowable Deflection=ΔY/Dm

$Dallow := \frac{e}{fD} \cdot (DR - 1)$ $Dallow = 13.518 \circ \%$

Constrained Buckling (Use Prism Load with VAF=1),Eq. 11

$Rh := 1$ **Geometry Factor**

$Cf := .8$ **Construction Factor**

$\phi := .55$ **Calibration Factor**

Pcr **Pressure Critical - psi**

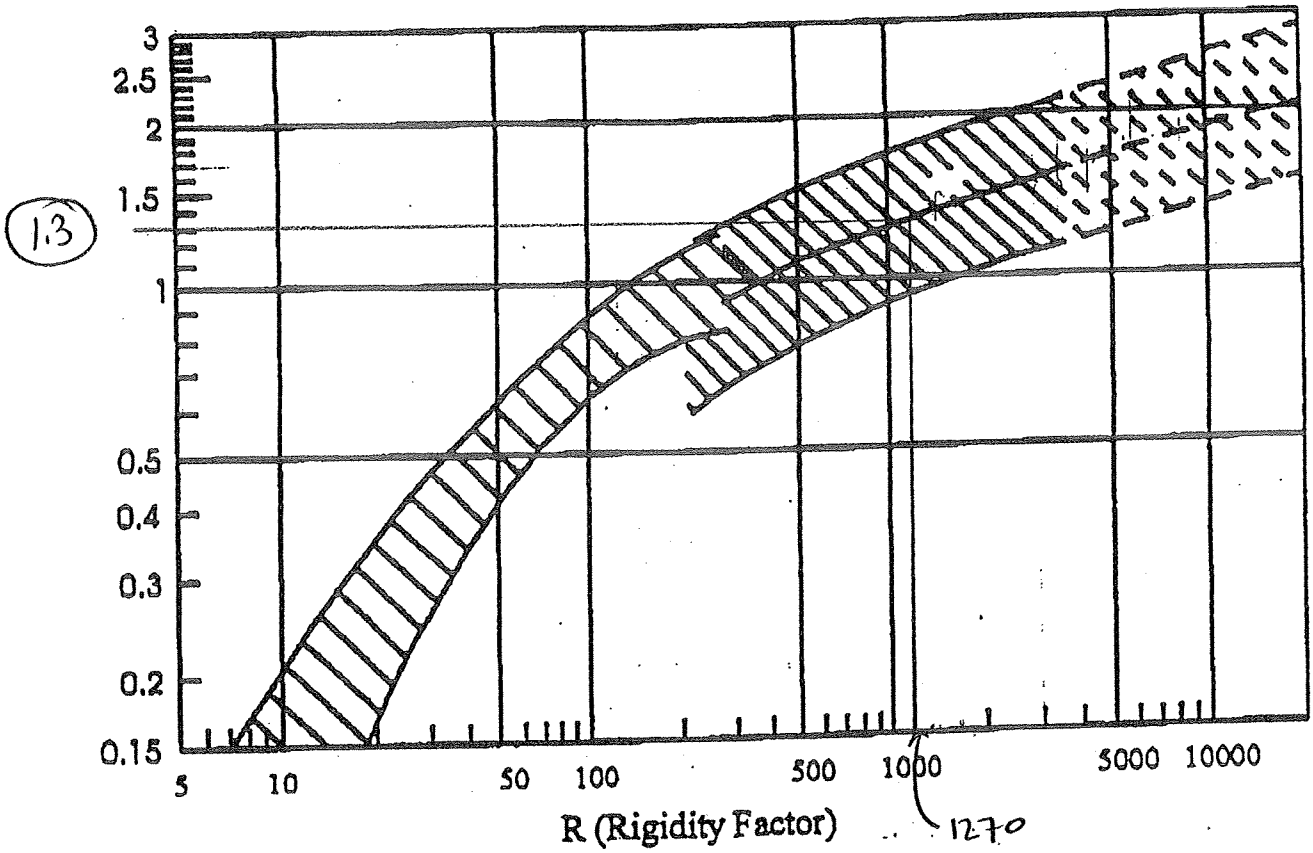
$$Pcr := \frac{Cf \cdot \phi \cdot Rh \cdot El^{\frac{1}{3}} \cdot \left(\frac{Es}{1 - \mu}\right)^{\frac{2}{3}}}{DR - 1} \qquad Pcr = 194.802 \circ psi$$

$$SF := \frac{Pcr}{\left[\frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2}\right)}\right]} \qquad SF = 3.437$$

Safety Factor against Buckling

Rule of Thumb for Design $2 \leq SF \leq 4$

6"Ø Perforated
SDR 11



1.3

Figure 1. Rigidity Factor vs Deformation Factor
If D_F is less than one on graph, use D_F =1.

3.0 Deflection of Pipes Using Watkins-Gaube Curve

The Watkins-Gaube method is a straight-forward approach. It is based on the concept that the deflection of a pipe embedded in a layer of soil is proportional to the settlement (compression) of the soil layer and that the constant of proportionality is a function of the relative stiffness between the pipe and soil. Watkins used laboratory testing to establish proportionality constants, called Deformation Factors, D_F, for metal pipes. See Figure 1. Gaube [6] extended Watkins' work to include PE pipes. In order to predict pipe vertical deflection, the designer must determine (1) the relative stiffness between the pipe and the soil in the pipe zone (zone of soil adjacent to the pipe, ie. embedment zone in a pipe trench) and (2) the estimated settlement of the pipe zone soil after placement of fill to the finished grade. Both these determinations can be done using conventional geotechnical models. This bypasses some of the problems associated with using E' values, but creates a few new ones. The E' values were back-calculated from actual installations and thus

PIPE CALCULATIONS
EFFECTIVE WALL THICKNESS OF 12" ϕ SDR 11 PERFORATED PIPE

PROJECT: Blue Ridge, Canton NC. Landfill 6 D-South Expansion 07089.00
CALC. BY: HME **DATE:** Aug 11, 2008
DATE_____ **CHECKED BY**_____

Pipe Information

$OD := 12.75 \cdot in$ **Pipe Outside Diameter (inches)**

$DR := 11$ **Pipe Dimension Ratio**

Perforations

$Dperf := 0.375 \cdot in$ **Diameter of perforations (inches)**

$Nperf := 4$ **Number of perforations per foot**

Calculations

$Tmin := \frac{OD}{DR}$ **Minimum wall thickness (inches)**

$Tmin = 1.159 \cdot in$

$Aperf := Dperf \cdot Tmin \cdot Nperf$ **Cross sectional area of perforations per 12" segement (sq. in.)**

$Aperf = 1.739 \cdot in^2$

$Apipe := Tmin \cdot (12 \cdot in)$ **Wall area without perforations (sq. in.)**

$Apipe = 13.909 \cdot in^2$

$Aeff := Apipe - Aperf$ **Effective area (reduced by area of perforations)**

$Aeff = 12.17 \cdot in^2$

$Teff := \frac{Aeff}{12 \cdot in}$ **Resulting effective wall thickness per 12" segment (in.)**

$Teff = 1.014 \cdot in$

$DReff := \frac{OD}{Teff}$ $DReff = 12.571$ **Effective DR due to theoretical wall area reduction**

Pipe Calculations
Pipe Strength in Deep Fill

Pipe Location: Landfill 6 D-South Expansion U.D. Pipe
Pipe Size & Type: 12" dia. SDR 11 HDPE Perforated Pipe

Project: Blue Ridge, Canton NC. Landfill 6 D-South 07089.00
Calc. by: HME **Date:** Aug 11, 2008
Date_____**Checked by**_____

Project Parameters

Depth of Overburden $H := 105 \cdot ft$

Depth of Waste Over Pipe $D_{waste} := 100 \cdot ft$

Depth of Soil over Pipe $D_{soil} := 5 \cdot ft$

Depth of groundwater $Hgw := 0 \cdot ft$

Unit weight of waste $\gamma w := 80 \cdot \frac{lbf}{ft^3}$

Unit weight of soil $\gamma s := 125 \cdot \frac{lbf}{ft^3}$

Hyperbolic Parameter:

Modulus Number $k := 100$

Modulus Exponent $n := 0.4$

(for 90% Compaction)

Pipe Parameters:

Effective DR: $DR := 12.571$

Long term compressive yield streght $Sc := 1600 \cdot psi$

Outside Diameter $OD := 12.75 \cdot in$

Short Term Modulus: $Estm := 100000 \cdot psi$

Long Term Modulus: $El := 23000 \cdot psi$

Poisson Ratio of Soil: $\mu := .35$

Temperature Design Factor: $f := 0.78$

(for 100 deg. F)

Overbuden weight

Weighted soil/waste unit weight

$$\gamma wt := \gamma w \cdot \frac{D_{waste}}{H} + \gamma s \cdot \frac{D_{soil}}{H}$$

$$\gamma wt = 82.143 \circ \frac{lbf}{ft^3}$$

Pipe Dimensional Parameters

Pipe Wall Thickness $t := \frac{OD}{DR}$ $t = 1.014 \circ in$

Mean Radius $r := \frac{OD - t}{2}$ $r = 5.868 \circ in$

Long Term Compressive Yeild Strength due to Temperture

$Sct := Sc \cdot f$ $Sct = 1.248 \cdot 10^3 \circ psi$

Constrained Modulus

$$Ms := k \cdot 14.7 \cdot psi \cdot \left(\gamma wt \cdot \frac{H}{14.7 \cdot psi} \right)^n \qquad Ms = 2.578 \cdot 10^3 \circ psi$$

Hoop Thrust Stiffness

$$Sa := \frac{1.43}{El \cdot t} \cdot Ms \cdot r \qquad Sa = 0.927$$

Vertical Arching Factor, (Eq. 1 of "Guidelines for HDPE Pipes in Deep Fills")

$$VAF := .88 - .71 \cdot \left(\frac{Sa - 1}{Sa + 2.5} \right) \qquad VAF = 0.895$$

Radial Direct Earth Pressure, Eq. 3a for Deep Fills

$$Prd := VAF \cdot \gamma wt \cdot H \qquad Prd = 7.72 \cdot 10^3 \circ \frac{lbf}{ft^2}$$

Ring Compressive Stress, Eq. 4 for Deep Fills

$$S := \frac{Prd \cdot DR}{\left[\frac{288 \cdot (in)^2}{ft^2} \right]} \qquad S = 336.954 \circ psi \qquad N := \frac{Sct}{S} \qquad N = 3.704$$ **Safety Factor**

Watkins - Gaube Deflection

Secant Modulus, Eq. 6

$$Es := \frac{Ms \cdot (1 + \mu) \cdot (1 - 2 \cdot \mu)}{1 - \mu} \qquad Es = 1.607 \cdot 10^3 \circ psi$$

Rigity, Eq. 5

$$Rf := \frac{12 \cdot Es \cdot (DR - 1)^3}{El} \qquad Rf = 1.299 \cdot 10^3$$

******Input Df factor from Figure 1** **Guidlines for HDPE Pipe in Deep Fills******

Plexco

$$Df := 1.38$$

Soil Strain (Settlement of Fill Layer at pipe), Eq. 7

$$\varepsilon s := \frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2} \right) \cdot Es} \qquad \varepsilon s = 3.728 \circ \%$$

Pipe Deflection

$$DEFL := Df \cdot \varepsilon s \qquad DEFL = 5.145 \circ \%$$ **Not to exceed 7.5% for design.**

Allowable Deflection, Eq. 9

$e := .05$

$fD := 4.28$ **Deformaton factor for shape**

Allowable Deflection=ΔY/Dm

$$Dallow := \frac{e}{fD} \cdot (DR - 1) \quad Dallow = 13.518 \cdot \%$$

Constrained Buckling (Use Prism Load with VAF=1),Eq. 11

$Rh := 1$ **Geometry Factor**

$Cf := .8$ **Construction Factor**

$\phi := .55$ **Calibration Factor**

Pcr **Pressure Critical - psi**

$$Pcr := \frac{Cf \cdot \phi \cdot Rh \cdot El^{\frac{1}{3}} \cdot \left(\frac{Es}{1 - \mu}\right)^{\frac{2}{3}}}{DR - 1} \qquad Pcr = 197.686 \cdot psi$$

$$SF := \frac{Pcr}{\left[\frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2}\right)}\right]} \qquad SF = 3.301$$

Safety Factor against Buckling

Rule of Thumb for Design $2 \leq SF \leq 4$

12" ϕ U.D. SDR 11

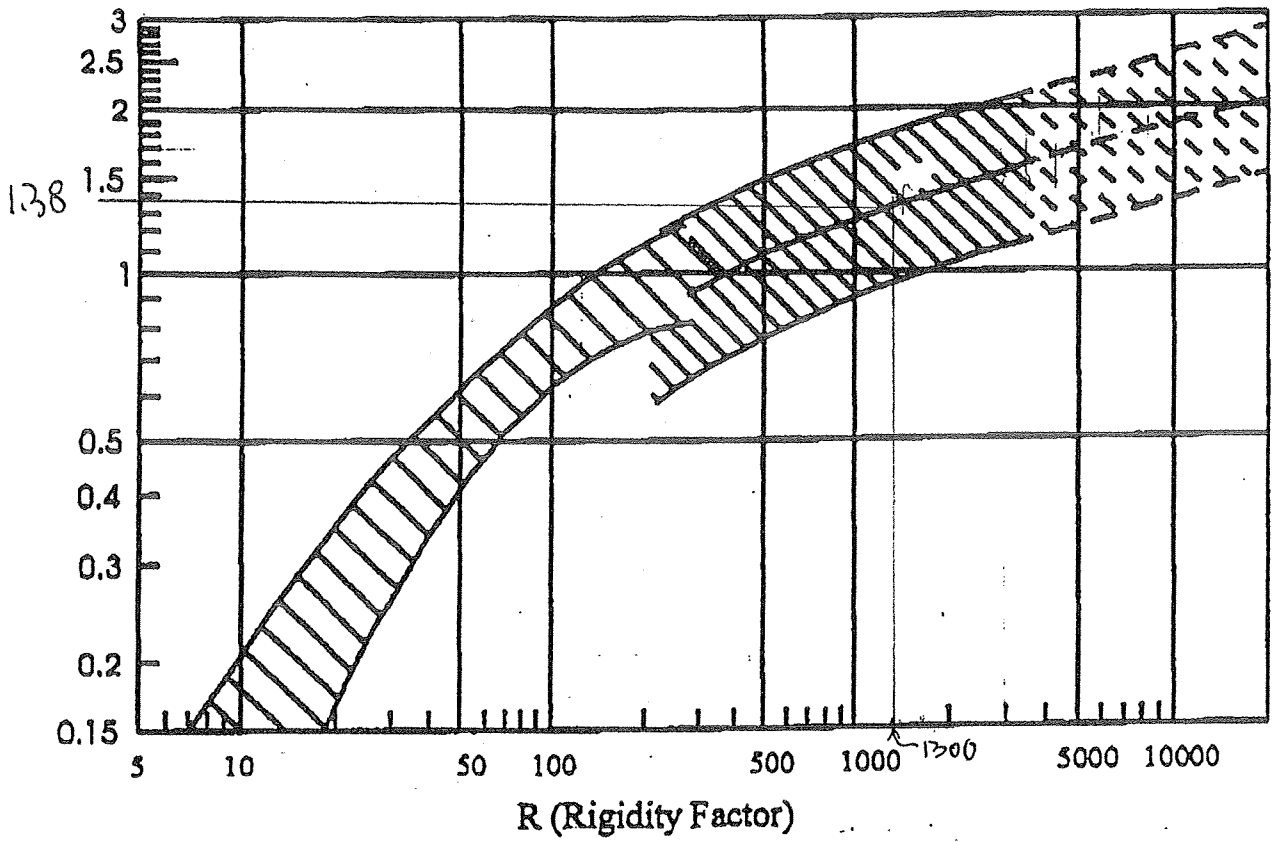


Figure 1. Rigidity Factor vs Deformation Factor
If D_F is less than one on graph, use $D_F = 1$.

3.0 Deflection of Pipes Using Watkins-Gaube Curve

The Watkins-Gaube method is a straight-forward approach. It is based on the concept that the deflection of a pipe embedded in a layer of soil is proportional to the settlement (compression) of the soil layer and that the constant of proportionality is a function of the relative stiffness between the pipe and soil. Watkins used laboratory testing to establish proportionality constants, called Deformation Factors, D_F, for metal pipes. See Figure 1. Gaube [6] extended Watkins' work to include PE pipes. In order to predict pipe vertical deflection, the designer must determine (1) the relative stiffness between the pipe and the soil in the pipe zone (zone of soil adjacent to the pipe, ie. embedment zone in a pipe trench) and (2) the estimated settlement of the pipe zone soil after placement of fill to the finished grade. Both these determinations can be done using conventional geotechnical models. This bypasses some of the problems associated with using E' values, but creates a few new ones. The E' values were back-calculated from actual installations and thus

APPENDIX C-5

PUMP STATION DESIGN CALCULATION

PROJECT BLUE RIDGE	COMP. BY MME	JOB NO. 07089.00
PUMP SYSTEM DESIGN	CHK. BY	DATE

(1)

Evalvate pump system discharge for 6D SOUTH

Reference: ① civil engineering reference manual - 6th edition, Lindeburg, 97
② Leachator extraction system design manual, Leachator pumping systems inc, 5/15/00
③ Rinker pipe design & engineering guide for polyethylene pipe, 04/2002

Design Criteria:
① Minimum pipe size = 6" for cleaning purposes.
② Transport pipe • minimum suspension Velocity = 0.5 ft/sec
• minimum resuspension Velocity = 1.0 ft/sec
③ confirm that pumps can overcome head Losses

Design Procedure:

⇒ Assume pipe size

4" ϕ SDR 11 ⇒ I.D. = 3.63 inches ; A = 0.0719 SF

check velocities in assumed operating range WHERE: Q = VA

$Q = 200\ gpm \left(\frac{CFS}{448.83\ gpm}\right) = 0.446\ CFS$

$V = Q/A = \frac{0.446}{0.0719} = 6.2\ FT/s > 0.5$ (ok)

$Q = 250\ gpm \left(\frac{CFS}{448.83\ gpm}\right) = 0.557\ CFS$

$V = Q/A = \frac{0.557}{0.0719} = 7.75\ FT/s > 1.0$ (ok)

$Q = 300\ gpm \left(\frac{CFS}{448.83\ gpm}\right) = 0.668\ CFS$

$V = Q/A = \frac{0.668\ CFS}{0.0719} = 9.3\ FT/s > 1.0$ (ok)

PROJECT	COMP. BY	JOB NO.
BLUE RIDGE	HME	07089.00
Pump Design	CHK. BY	DATE 7/30/08

(2)

CALCULATE Anticipated Head Losses w/ 4" ø SDR 11 AND 3" ø VNBR Discharge hose.

TOTAL DYNAMIC HEAD: STATIC HEAD (ΔH) + FRICTIONAL Headloss (h_f) + Minor Losses (h_m)

Where: ① static head $(\Delta H) = H_2 - H_1$

H_2 = Height of Reservoir (ft)

H_1 = Height of Sump (ft)

② Frictional Headloss $(h_f) = 0.002083\ L \left[\frac{\left(\frac{100}{C}\right)^{1.85} Q^{1.85}}{(ID)^{4.8655}}\right]$

L = Length of Pipe run (ft)

C = Hazen Williams Constant = (100 Scaled pipe)

Q = flow (gpm)

ID = pipe inside diameter (in)

③ Minor Losses $(h_m) = \Sigma K \frac{V^2}{2g}$

K = loss coefficient (unit loss)

V = Fluid velocity

g = gravity constant (32.2 ft/s²)

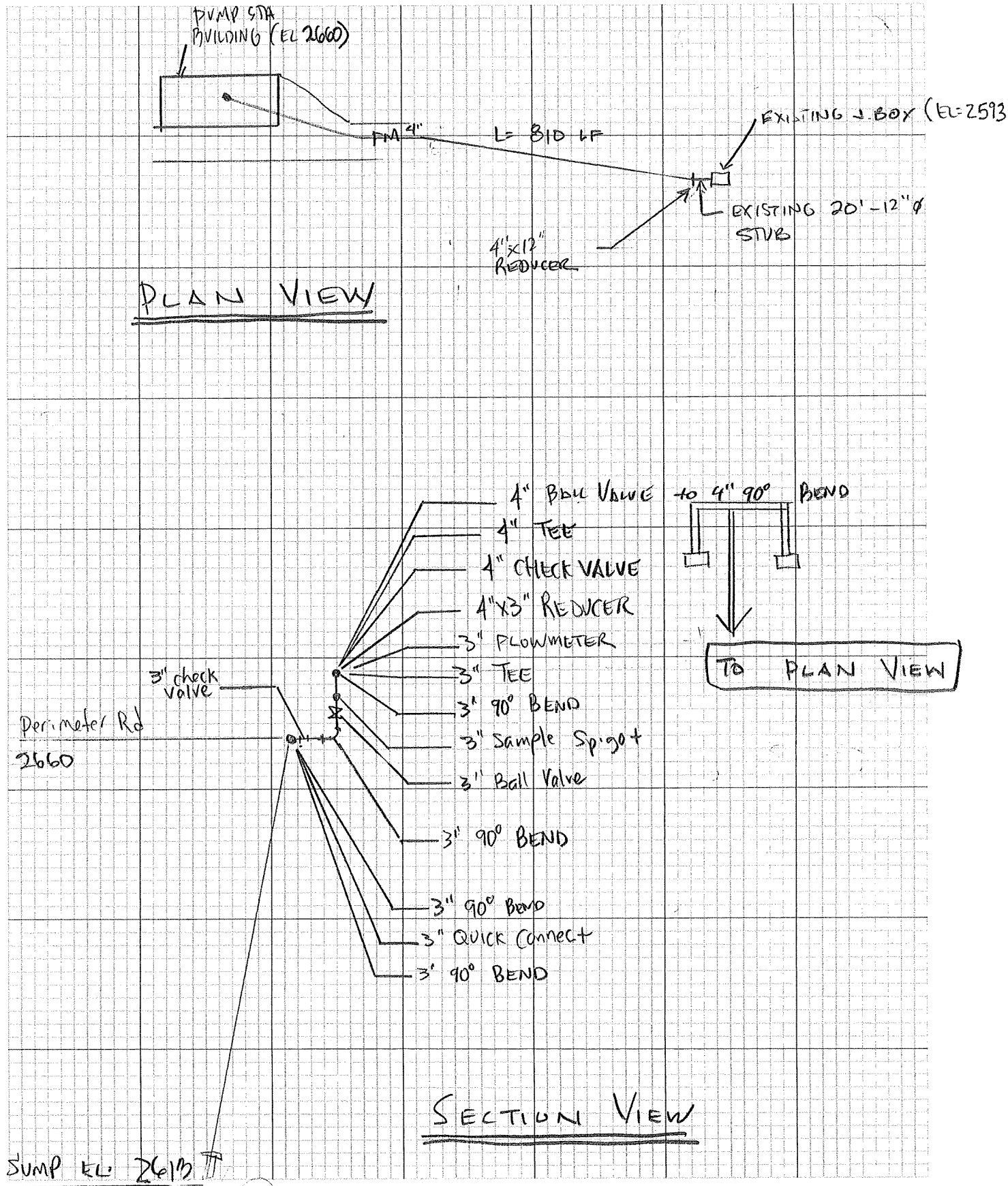
④ For design headloss calculations we assumed the following fittings in each system.

FITTING	QTY.	K
3"-90° BEND	4	0.9
3" - Quick Connect	1	0
3" - Ball Valve	1	0.4
3" - Sample Spigot	1	0
3" - TEE	1	1.8
3" - Flow Meter	1	9.5 *
3"-4" enlargement	1	0.06**
4" check valve	1	2.5
4" TEE	1	1.8
4" Ball valve	1	0.4
4"-90° Bend	1	0.9
PIPE EXIT	1	1.0

** $\left(1 - \frac{D_1}{D_2}\right)^2 = \left(1 - \frac{3"}{4"}\right)^2 = .06$

* globe valve ½ open = 9.5

PROJECT	COMP. BY	JOB NO.
BRPD Leachate collection — Pump Sta Design - Head Losses/Fittings	HME	07089.00
	CHK. BY	DATE
		8-5-08



PROJECT BRPP	COMP. BY HME	JOB NO. 07057.00
Dump Stn Design – Leachate Generation Rates	CHK. BY	DATE 8-5-08

(4)

BASE AREA: 497,820 SF = 11.4 Ac
SIDE SLOPE AREA: 222,870 SF = 5.1 Ac

DETERMINE RUNOFF IN LEACHATE COLLECTION SYSTEM FROM HELP MODEL
LOOK @ January & May

BASE - 10 Ft WASTE: - (Jan)

$$(11.4\ ac)(43{,}560\ \tfrac{ft^2}{ac})(0.7119\ \tfrac{IN}{MO})\left(\tfrac{FT}{12\ IN}\right)\left(\tfrac{7.48\ gal}{cf}\right) = 220{,}360 \text{ gallons/MO}$$

SIDE - NO WASTE: - (Jan)

$$(5.1\ AC)(43{,}560\ \tfrac{SF}{AC})(2.372\ \tfrac{IN}{MO})\left(\tfrac{FT}{12\ IN}\right)\left(\tfrac{7.48\ gal}{cf}\right) = 328{,}468 \text{ gallons/MO}$$

548,628 gal/MO

Base - 10 Ft Waste: (May)

$$(11.4\ Ac)(43560\ \tfrac{ft^2}{Ac})(1.0784\ \tfrac{IN}{MO})\left(\tfrac{1}{12}\ \tfrac{FT}{IN}\right)\left(\tfrac{7.48\ gal}{cf}\right) = 333{,}805 \text{ gal/MO}$$

SIDE - NO Waste: (May)

$$(5.1\ AC)(43560\ SF/AC)(2.1446\ IN/MO)\left(\tfrac{FT}{12\ IN}\right)\left(\tfrac{7.48\ gal}{cf}\right) = 296{,}978 \text{ gal/MO}$$

630,783 gal/MO
= 21,026 gal/day

MAY WORSTE CASE

$$\left(630{,}783\ \tfrac{gal}{MO}\right)\left(\tfrac{MO}{30\ day}\right)\left(\tfrac{day}{24\ Hr}\right)\left(\tfrac{HR}{60\ MIN}\right) = 14.6 \text{ GPM (IF ALWAYS ON)}$$

CHECK PUMP
LP5300MSTG
3X200-06

(1) PUMP ON = 258 gpm

daily capacity = $\tfrac{258\ gal}{min}\left(\tfrac{60\ MIN}{HR}\right)\left(\tfrac{24\ HR}{Day}\right) = 371{,}520$ gal/day > 21,026 gal/day (OK)

PROJECT BRPP	COMP. BY HME	JOB NO. 07089.00	(5)
PUMP STA DESIGN - SUMP	CHK. BY	DATE 8-5-08	

OBJECTIVE: evaluate pump cycle times given sump system configuration.

Design Criteria: pump cycle time shall be at least 30 minutes.

Analysis: ① Assume Sump size 50'x50' @ Bottom w/ 3H:1V sideslopes & 4' Depth

② create stage storage curve for sump assuming porosity of stone is 0.4

Elevation	Area (ft^2)	Vol (ft^3)	Adjusted Vol (ft^3)	gallons
2613 - 0	0	0	0	0
2613.1 - 0.1	2500	2818	1127.2	8431.4
2614 - 1.0	3136	3490	1396	10,442.1
2615 - 2.0	3844	4234	1693.6	12,668.1
2616 - 3.0 (top Sump Stone)	4624	4909	1963.6	14,689.7
2617 - 4.0 (top LC stone)	5184			

Assume PUMP: ON EL 617

OFF EL = 614.17 (Assume: 36" wall thickness (2.3'), 2" Liner, 4" Pump wheels, pump 0.4

CAPACITY BETWEEN ON/OFF = 37,797 gallons

$$\text{MINIMUM PUMP CYCLE TIME} = \frac{\text{operating Sump Volume (MIN)}}{\text{single pump } Q_{OUT}}$$

where $pump Q_{OUT}$ = 258 GPM (for Leachator 200-05)

$$\text{CYCLE TIME} = \frac{37{,}797 \text{ gal}}{258 \text{ gpm}} = 147 \text{ MIN} > 30 \text{ MIN}$$ (OK)

Refill Time (Based on May HELP Model)

$$\frac{37{,}797 \text{ gal}}{14.6 \text{ gpm}} = 2590 \text{ MIN} = 43 \text{ hours}$$

SUMP FILL TIME = 43 HOURS

SUMP PUMP OUT TIME = 2.5 HOURS

PRESSURE PIPE HEAD LOSS CALCULATIONS

DESCRIPTION	ELEVATION HEAD LOSS			FRICTIONAL HEAD LOSS							FITTING HEAD LOSSES																	DISCHARGE LOSS		SYSTEM HEAD	MAX PIPE PRESSURE	Flow VELOCITY
	Sump Elev. (feet)	Highest Elev. (feet)	Elevation Head Loss (feet)	Total Length (feet)	Pipe Flow (gpm)	HW Frict. Factor[1] C	Pipe SDR	Pipe O.D. Nominal (inches)	Pipe ID Average[2] (inches)	Friction Head Loss[3] (feet)	KL Ck Valve	Quantity	Elbow 90	Quantity	Elbow 45	Quantity	Tee (in-line)	Quantity	Flow Meter	Quantity	Contraction 5 to 1	Quantity	Ball Valve	Quantity	velocity	K_{const}	Fitting Head Loss[4]	Outlet Factor	Discharge Head Loss (ft)			
Sump to MH																															
(Q=50gpm)	2613.0	2660.0	47.0	100	50	100	11.0	3	3.063	1.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	2.2	21.7	1.6	1.0	0	50		2.2
				2450	50	100		6	5.350	2.0	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	0.7	11.6	0.1	1.0	0	2		0.7
																													Total:	52	23	
(Q=100gpm)	2613.0	2660.0	47.0	100	100	100	11.0	3	3.063	4.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	4.4	21.7	6.4	1.0	0	58		4.4
				2450	100	100		6	5.350	7.3	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	1.4	11.6	0.4	1.0	0	8		1.4
																													Total:	66	29	
(Q=150gpm)	2613.0	2660.0	47.0	100	150	100	11.0	3	3.063	9.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	6.5	21.7	14.4	1.0	1	72		6.5
				2450	150	100		6	5.350	15.5	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	2.1	11.6	0.8	1.0	0	16		2.1
																													Total:	88	38	
(Q=200gpm)	2613.0	2660.0	47.0	100	200	100	11.0	3	3.063	16.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	8.7	21.7	25.6	1.0	1	90		8.7
				2450	200	100		6	5.350	26.4	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	2.9	11.6	1.5	1.0	0	28		2.9
																													Total:	118	51	
(Q=250gpm)	2613.0	2660.0	47.0	100	250	100	11.0	3	3.063	24.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	10.9	21.7	40.0	1.0	2	113		10.9
				2450	250	100		6	5.350	39.8	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	3.6	11.6	2.3	1.0	0	42		3.6
																													Total:	156	67	
(Q=275gpm)	2613.0	2660.0	47.0	100	275	100	11.0	3	3.063	29.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	12.0	21.7	48.4	1.0	2	127		12.0
				2450	275	100		6	5.350	47.5	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	3.9	11.6	2.8	1.0	0	51		3.9
																													Total:	177	77	
(Q=300gpm)	2613.0	2660.0	47.0	100	300	100	11.0	3	3.063	34.4	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	13.1	21.7	57.6	1.0	3	142		13.1
				2450	300	100		6	5.350	55.8	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	4.3	11.6	3.3	1.0	0	59		4.3
																													Total:	201	87	
(Q=350 gpm)	2613.0	2660.0	47.0	100	350	100	11.0	3	3.063	45.7	0.0	0	0.0	0	0.0	0	1.8	1	9.5	1	0.4	1	6.4	1	15.2	18.1	65.3	1.0	4	162		15.2
				2450	350	100		6	5.350	74.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	0	6.4	1	5.0	21.3	8.3	1.0	0	83		5.0
																													Total:	245	106	
(Q=400 gpm)	2613.0	2660.0	47.0	100	400	100	11.0	3	3.063	58.5	0.0	0	0.0	0	0.0	0	1.8	1	9.5	1	0.4	1	6.4	1	17.4	18.1	85.4	1.0	5	196		17.4
				2450	400	100		6	5.350	95.0	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	0	6.4	1	5.7	21.3	10.8	1.0	1	106		5.7
																													Total:	302	131	

Notes:
1. Friction Factor Assumes scaling in pipe system.
2. Nominal ID from Rinker Pipe Design Guidance Table A-2 Page A-4.
3. Frictional Headloss Determined from Hazen Williams Equation.
4. Minor Headloss = $K(V^2/2g)$

6" Ø 2450 LF

gpm	hd (ft)
50	52
100	66
150	88
200	118
250	156
300	201
350	245
400	302

HME

BRPP

LEACHATOR™ **SUBMERSIBLE PUMPS**

LPS300MSTG3X200-05

PUMP PERFORMANCE DATA

Project Name:		
Model Number:		
Horsepower: 20 HP	**RPM:** 3450	**Voltage/Phase/Hertz:** 230/3/60 or 460/3/60
Duty Point No. 1:		**Duty Point No. 2:**
Shutoff Head: 303' TDH		**Operational Run Out:** 410 GPM

Note: To complete model number, please insert a "2" for 230V or a "4" for 460V in the "X" position.
Example: LPS300MSTG34200-05: = 460V/3/60

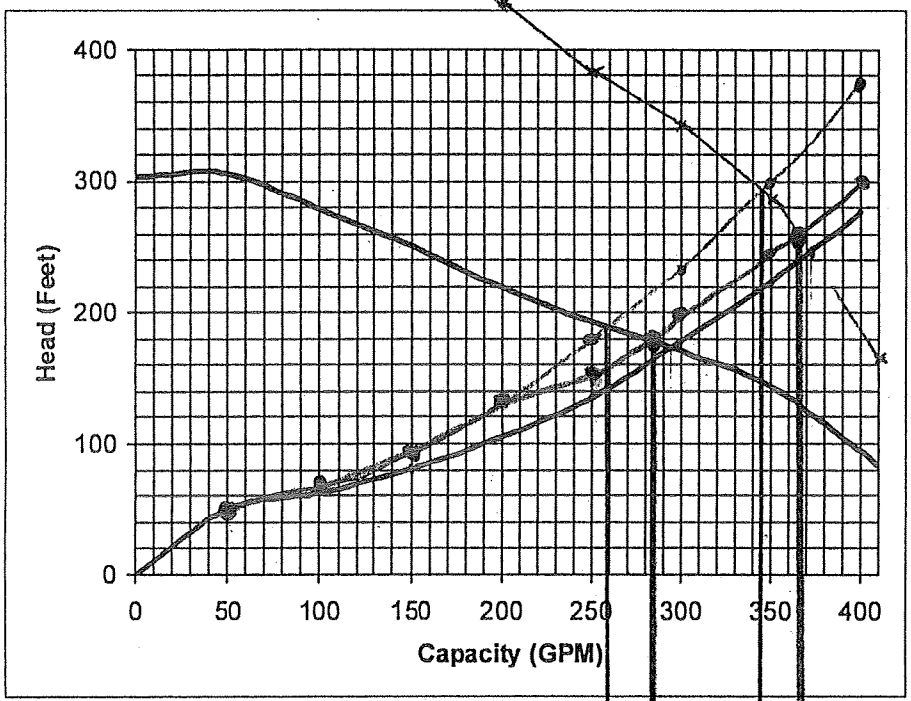
Dimension And Weight

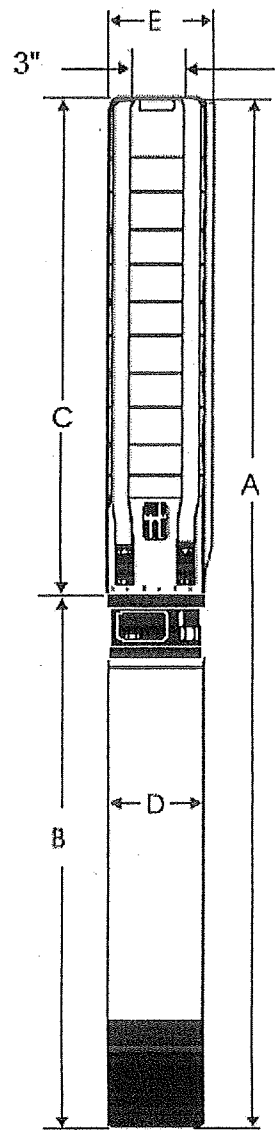
Discharge Size	Dimension In Inches					Approx. Ship Wt.
	A	B	C	D	E	
3" NPT	63.4	30.6	32.8	5.44	5.7	172

Note: Dimensions and weight are approximate (subject to change) and does not include the carriage.

Materials Of Construction

Impeller	304 Stainless Steel
Impeller Seal Ring	Teflon
Motor Adapter	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	431 Stainless Steel
Coupling	329/416 Stainless Steel
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Check Valve Seat	Teflon/316 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Fasteners	304 Stainless Steel
Bearing	Teflon/316 Stainless Steel
Suspension Cables	304 Stainless Steel





Optimum Operating Range: 200 to 410 GPM
Specifications Subject To Change Without Notice

(1) PUMP ON
280 GPM (

(2) PUMPS ON
345 GPM (CFS)

9/9/08 HME

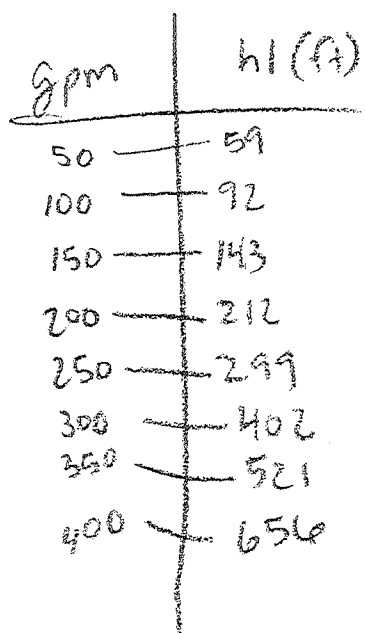
L = 2450'

LOOK @ REMING FM TO EXIST WET WELL

PRESSURE PIPE HEAD LOSS CALCULATIONS

DESCRIPTION	ELEVATION HEAD LOSS			FRICTIONAL HEAD LOSS							FITTING HEAD LOSSES																DISCHARGE LOSS		SYSTEM HEAD	MAX PIPE PRESSURE	Flow VELOCITY
	Sump Elev. (feet)	Highest Elev. (feet)	Elevation Head Loss (feet)	Total Length (feet)	Pipe Flow (gpm)	HW Fric. Factor[1] C	Pipe SDR	Pipe O.D. Nominal (inches)	Pipe ID Average[2] (inches)	Friction Head Loss[3] (feet)	KL Ck Valve	Quantity	Elbow 90	Quantity	Elbow 45	Quantity	Tee (in-line)	Quantity	Flow Meter	Quantity	Contraction 5 to 1	Quantity	Ball Valve	Quantity	velocity	K_{total}	Fitting Head Loss[4]	Outlet Factor	Discharge Head Loss (ft)	(feet)	(psi)	(ft/sec)
Sump to MH																															
(Q=50gpm)	2613.0	2660.0	47.0	100	50	100	11.0	3	3.063	1.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	2.2	21.7	1.6	1.0	0	50		2.2
				2450	50	100		4	3.938	9.0	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	1.3	11.6	0.3	1.0	0	9		1.3
																													Total:	59	26	
(Q=100gpm)	2613.0	2660.0	47.0	100	100	100	11.0	3	3.063	4.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	4.4	21.7	6.4	1.0	0	58		4.4
				2450	100	100		4	3.938	32.5	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	2.6	11.6	1.3	1.0	0	34		2.6
																													Total:	92	40	
(Q=150gpm)	2613.0	2660.0	47.0	100	150	100	11.0	3	3.063	9.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	6.5	21.7	14.4	1.0	1	72		6.5
				2450	150	100		4	3.938	68.8	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	4.0	11.6	2.8	1.0	0	72		4.0
																													Total:	143	62	
(Q=200gpm)	2613.0	2660.0	47.0	100	200	100	11.0	3	3.063	16.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	8.7	21.7	25.6	1.0	1	90		8.7
				2450	200	100		4	3.938	117.1	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	5.3	11.6	5.0	1.0	0	122		5.3
																													Total:	212	92	
(Q=250gpm)	2613.0	2660.0	47.0	100	250	100	11.0	3	3.063	24.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	10.9	21.7	40.0	1.0	2	113		10.9
				2450	250	100		4	3.938	176.9	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	6.6	11.6	7.8	1.0	1	185		6.6
																													Total:	299	129	
(Q=275gpm)	2613.0	2660.0	47.0	100	275	100	11.0	3	3.063	29.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	12.0	21.7	48.4	1.0	2	127		12.0
				2450	275	100		4	3.938	211.0	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	7.2	11.6	9.5	1.0	1	221		7.2
																													Total:	348	151	
(Q=300gpm)	2613.0	2660.0	47.0	100	300	100	11.0	3	3.063	34.4	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	13.1	21.7	57.6	1.0	3	142		13.1
				2450	300	100		4	3.938	247.8	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	7.9	11.6	11.3	1.0	1	260		7.9
																													Total:	402	174	
(Q=350 gpm)	2613.0	2660.0	47.0	100	350	100	11.0	3	3.063	45.7	0.0	0	0.0	0	0.0	0	1.8	1	9.5	1	0.4	1	6.4	1	15.2	18.1	65.3	1.0	4	162		15.2
				2450	350	100		4	3.938	329.6	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	0	6.4	1	9.2	21.3	28.1	1.0	1	359		9.2
																													Total:	521	225	
(Q=400 gpm)	2613.0	2660.0	47.0	100	400	100	11.0	3	3.063	58.3	0.0	0	0.0	0	0.0	0	1.8	1	9.5	1	0.4	1	6.4	1	17.4	18.1	85.4	1.0	5	196		17.4
				2450	400	100		4	3.938	422.0	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	0	6.4	1	10.5	21.3	36.8	1.0	2	460		10.5
																													Total:	656	284	

Notes:
1. Friction Factor Assumes scaling in pipe system.
2. Nominal ID from Rinker Pipe Design Guidance Table A-2 Page A-4.
3. Frictional Headloss Determined from Hazen Williams Equation.
4. Minor Headloss = $K(V^2/2g)$



ADDITIONAL FM = 1640 LF @ $25/LF = $41,000

4" Ø, 2450 LF

8/25/08 HME
BRPP

LEACHATOR™ SUBMERSIBLE PUMPS

LPS300MSTG3X200-05 PUMP PERFORMANCE DATA

Project Name:		
Model Number:		
Horsepower: 20 HP	**RPM:** 3450	**Voltage/Phase/Hertz:** 230/3/60 or 460/3/60
Duty Point No. 1:		**Duty Point No. 2:**
Shutoff Head: 303' TDH		**Operational Run Out:** 410 GPM

Note: To complete model number, please insert a "2" for 230V or a "4" for 460V in the "X" position.
Example: LPS300MSTG34200-05: = 460V/3/60

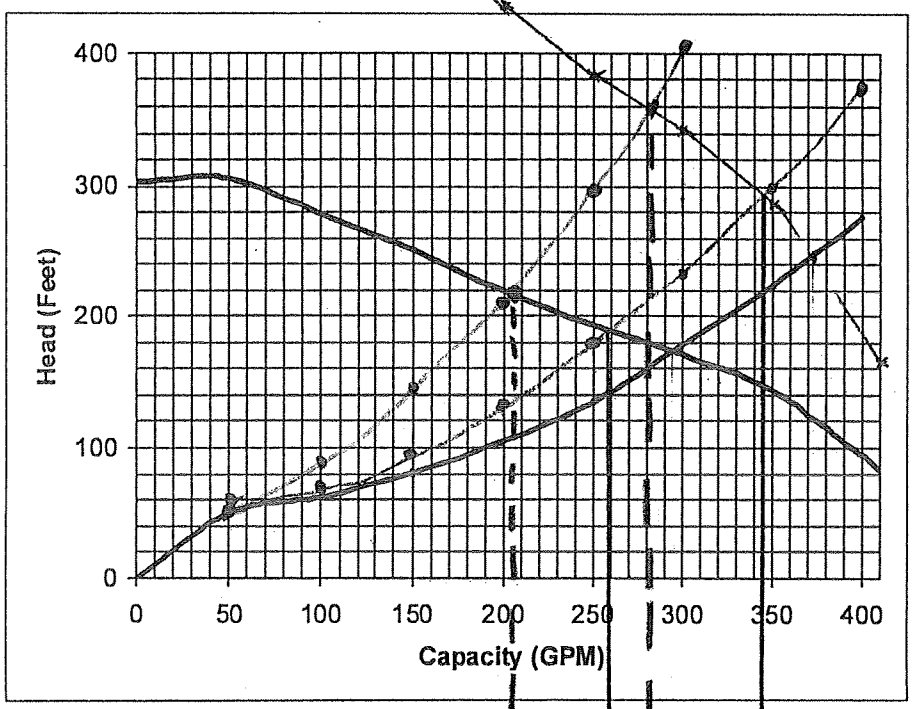
Dimension And Weight

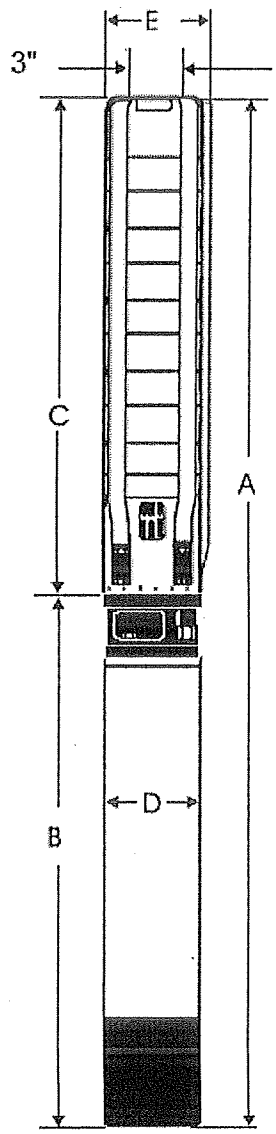
Discharge Size	Dimension In Inches					Approx. Ship Wt.
	A	B	C	D	E	
3" NPT	63.4	30.6	32.8	5.44	5.7	172

Note: Dimensions and weight are approximate (subject to change) and does not include the carriage.

Materials Of Construction

Impeller	304 Stainless Steel
Impeller Seal Ring	Teflon
Motor Adapter	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	431 Stainless Steel
Coupling	329/416 Stainless Steel
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Check Valve Seat	Teflon/316 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Fasteners	304 Stainless Steel
Bearing	Teflon/316 Stainless Steel
Suspension Cables	304 Stainless Steel





Optimum Operating Range: 200 to 410 GPM
Specifications Subject To Change Without Notice

(1) PUMP ON
~~250~~ 265 GPM (0.575 CFS)

(2) PUMPS ON
~~345~~ 780 GPM (0.769 CFS)

8/25/08 HME
BRPP

LEACHATOR™ **SUBMERSIBLE PUMPS**

LPS300MSTG3X200-05

PUMP PERFORMANCE DATA

Project Name:		
Model Number:		
Horsepower: 20 HP	**RPM:** 3450	**Voltage/Phase/Hertz:** 230/3/60 or 460/3/60
Duty Point No. 1:		**Duty Point No. 2:**
Shutoff Head: 303' TDH		**Operational Run Out:** 410 GPM

Note: To complete model number, please insert a "2" for 230V or a "4" for 460V in the "X" position.
Example: LPS300MSTG34200-05: = 460V/3/60

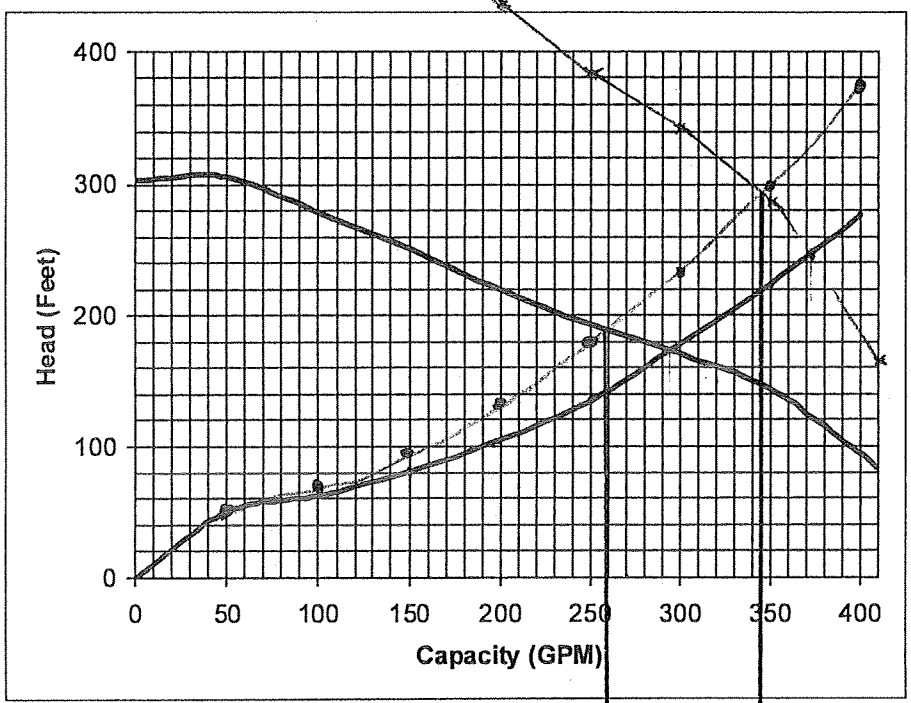
Dimension And Weight

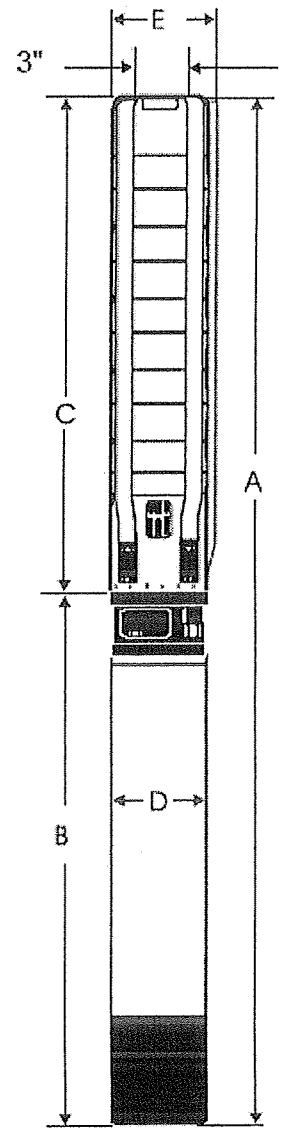
Discharge Size	Dimension In Inches					Approx. Ship Wt.
	A	B	C	D	E	
3" NPT	63.4	30.6	32.8	5.44	5.7	172

Note: Dimensions and weight are approximate (subject to change) and does not include the carriage.

Materials Of Construction

Impeller	304 Stainless Steel
Impeller Seal Ring	Teflon
Motor Adapter	304 Stainless Steel
Inlet Screen	304 Stainless Steel
Pump Shaft	431 Stainless Steel
Coupling	329/416 Stainless Steel
Check Valve Housing	304 Stainless Steel
Check Valve	304 Stainless Steel
Check Valve Seat	Teflon/316 Stainless Steel
Diffuser Chamber	304 Stainless Steel
Fasteners	304 Stainless Steel
Bearing	Teflon/316 Stainless Steel
Suspension Cables	304 Stainless Steel





Optimum Operating Range: 200 to 410 GPM
Specifications Subject To Change Without Notice

(1) PUMP ON
258 GPM (0.575 cfs)

(2) PUMPS ON
345 GPM (0.769 CFS)

PRESSURE PIPE HEAD LOSS CALCULATIONS

DESCRIPTION	ELEVATION HEAD LOSS			FRICTIONAL HEAD LOSS							FITTING HEAD LOSSES																		DISCHARGE LOSS		SYSTEM HEAD	MAX PIPE PRESSURE	Flow VELOCITY
	Sump Elev. (feet)	Highest Elev. (feet)	Elevation Head Loss (feet)	Total Length (feet)	Pipe Flow (gpm)	HW Fric. Factor[1] C	Pipe SDR	Pipe O.D. Nominal (inches)	Pipe ID Average[2] (inches)	Friction Head Loss[3] (feet)	KL Ck Valve	Quantity	Elbow 90	Quantity	Elbow 45	Quantity	Tee (in-line)	Quantity	Flow Meter	Quantity	Contraction 5 to 1	Quantity	Ball Valve	Quantity	velocity	K_{Used}	Fitting Head Loss[4]	Outlet Factor	Discharge Head Loss (ft)			
Sump to MH																																
(Q=50gpm)	2613.0	2660.0	47.0	100	50	100	11.0	3	3.063	1.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	2.2	21.7	1.6	1.0	0	50		2.2
				810	50	100		4	3.938	3.0	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	1.3	11.6	0.3	1.0	0	3		1.3
																													Total:	53	23	
(Q=100gpm)	2613.0	2660.0	47.0	100	100	100	11.0	3	3.063	4.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	4.4	21.7	6.4	1.0	0	58		4.4
				810	100	100		4	3.938	10.7	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	2.6	11.6	1.3	1.0	0	12		2.6
																													Total:	70	30	
(Q=150gpm)	2613.0	2660.0	47.0	100	150	100	11.0	3	3.063	9.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	6.5	21.7	14.4	1.0	1	72		6.5
				810	150	100		4	3.938	22.7	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	4.0	11.6	2.8	1.0	0	26		4.0
																													Total:	97	42	
(Q=200gpm)	2613.0	2660.0	47.0	100	200	100	11.0	3	3.063	16.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	8.7	21.7	25.6	1.0	1	90		8.7
				810	200	100		4	3.938	38.7	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	5.3	11.6	5.0	1.0	0	44		5.3
																													Total:	134	58	
(Q=250gpm)	2613.0	2660.0	47.0	100	250	100	11.0	3	3.063	24.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	10.9	21.7	40.0	1.0	2	113		10.9
				810	250	100		4	3.938	58.5	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	6.6	11.6	7.8	1.0	1	67		6.6
																													Total:	180	78	
(Q=275gpm)	2613.0	2660.0	47.0	100	275	100	11.0	3	3.063	29.2	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	12.0	21.7	48.4	1.0	2	127		12.0
				810	275	100		4	3.938	69.8	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	7.2	11.6	9.5	1.0	1	80		7.2
																													Total:	207	90	
(Q=300gpm)	2613.0	2660.0	47.0	100	300	100	11.0	3	3.063	34.4	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	1	6.4	1	13.1	21.7	57.6	1.0	3	142		13.1
				810	300	100		4	3.938	81.9	2.5	1	0.9	1	0.4	0	1.8	1	9.5	0	0.4	0	6.4	1	7.9	11.6	11.3	1.0	1	94		7.9
																													Total:	236	102	
(Q=350 gpm)	2613.0	2660.0	47.0	100	350	100	11.0	3	3.063	45.7	0.0	0	0.0	0	0.0	0	1.8	1	9.5	1	0.4	1	6.4	1	15.2	18.1	65.3	1.0	4	162		15.2
				810	350	100		4	3.938	109.0	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	0	6.4	1	9.2	21.3	28.1	1.0	1	138		9.2
																													Total:	300	130	
(Q=400 gpm)	2613.0	2660.0	47.0	100	400	100	11.0	3	3.063	58.5	0.0	0	0.0	0	0.0	0	1.8	1	9.5	1	0.4	1	6.4	1	17.4	18.1	85.4	1.0	5	196		17.4
				810	400	100		4	3.938	139.5	2.5	0	0.9	4	0.4	0	1.8	1	9.5	1	0.4	0	6.4	1	10.5	21.3	36.8	1.0	2	178		10.5
																													Total:	374	162	

Notes:

1. Friction Factor Assumes scaling in pipe system.
2. Nominal ID from Rinker Pipe Design Guidance Table A-2 Page A-4.
3. Frictional Headloss Determined from Hazen Williams Equation.
4. Minor Headloss = $K(V^2/2g)$

ble 8.10 can be used to select velocity for the collection tem as well as for the plant treatment system.

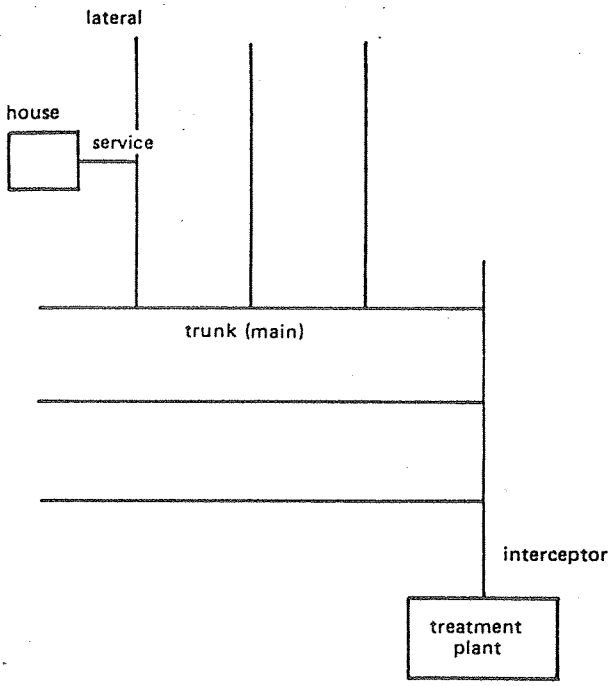


Figure 8.4 Types of Sewer Lines

Table 8.10
Minimum Flow Velocities

pipe carrying	minimum velocity to keep particles in suspension	minimum resuspension velocity
raw sewage	2.5	3.5
grit tank effluent	2	2.5
primary settling tank effluent	1.5	2
mixed liquor	1.5	2
trickling filter effluent	1.5	2
secondary settling tank effluent	0.5	1

← MOST SIMILAR TO LEACHATE

10 PUMPS USED IN WASTEWATER PLANTS

Wastewater plant flows should be gravity fed wherever possible. However, there are still many instances where pumping assistance is required. Table 8.11 lists pump types as a function of type of material to be pumped.

Table 8.11
Pumps Used in Wastewater Plants

type of material being pumped	flow rate (gpm)	pump type
raw sewage	0 to 50	pneumatic ejector
	50 to 200	submersible or end-suction non-clog centrifugal
	200 up	end-suction non-clog centrifugal
settled sewage	0 to 500	end-suction non-clog centrifugal
	500 up	vertical axial or mixed flow centrifugal
sludge (primary, thickened, or digested)		plunger pump
secondary sludge		end-suction non-clog centrifugal
scum		plunger pump or recessed impeller
grit		recessed impeller centrifugal, pneumatic ejector, or conveyor rake

TABLE 4.4 Loss Coefficients

Geometry	K	Geometry	K
Globe valve (fully open)	6.4	Reentrant entrance	0.8
(half open)	9.5	Well-rounded entrance	0.03++
Angle valve (fully open)	5.0	Pipe exit	1.0
Swing check valve (fully open)	2.5	Sudden contraction (2 to 1)*	0.25++
Gate valve (fully open)	0.2	(5 to 1)*	0.41++
(half open)	5.6	(10 to 1)*	0.46++
(one-quarter open)	24.0	Orifice plate (1.5 to 1)*	0.85
Close return bend	2.2	(2 to 1)*	3.4
Standard tee	1.8	(4 to 1)*	29
Standard elbow	0.9	Sudden enlargement+	$(1-A_1/A_2)^2$
Medium sweep elbow	0.75	90° miter bend (without vanes)	1.1
Long sweep elbow	0.6	(with vanes)	0.2
45° elbow	0.4	General contraction (30° included angle)	0.02
Square-edged entrance	0.5	(70° included angle)	0.07

*Area ratio +Based on V_1 ++Based on V_2

In engineering practice, the loss coefficient is often expressed as an *equivalent length* L_e of pipe; if that is done, the equivalent length is expressed as

$$L_e = K\frac{D}{f} \tag{4.4.8}$$

The above analysis, using the Moody diagram and the loss coefficients, can be applied directly to only circular cross-section conduits; if the cross section is non-circular but fairly "open" (rectangular with aspect ratio less than four, oval, or triangular), a good approximation can be obtained by using the hydraulic radius defined by

$$R = A/P \tag{4.4.9}$$

where A is the cross sectional area and P is the wetted perimeter (that perimeter where the fluid is in contact with the solid boundary). Using this formula the diameter of a pipe is $D = 4R$. The Reynolds number then takes the form

$$Re = \frac{4VR}{\nu} \tag{4.4.10}$$

the shape is not "open," such as flow in an anulus, the error in using the above relationships will be ite significant.

A final note in this article defines the energy grade line (*EGL*) and the hydraulic grade line (*HGL*). distance $(z+p/\gamma)$ above the datum (the zero elevation line) locates the *HGL*, and the distance $(z+p/\gamma+V^2/2g)$ above the datum locates the *EGL*. These are shown in Fig. 4.3. Note that the pump H_p is given by

$$H_p = -\frac{\dot{W}_p}{\gamma Q} \tag{4.4.11}$$

negative sign is necessary since the pump power $\dot{W}_p$ is negative.

Either Eq. 6.1.2 or the Moody diagram can be used to determine the friction factor. Equation 6.1.2 is valid over the ranges $0.01 > \varepsilon > 10^{-6}$, and $10^8 > Re > 3000$. For values of Re and ε outside of those ranges, the Moody diagram must be used directly. Numerical values of e are provided in Table 6.1.

In many instances it is acceptable to assume that the friction factor is independent of the Reynolds number. It can be observed in Eq. 6.1.2 that the second term in brackets becomes relatively smaller as Re increases, so that it can be used in the form $f = 1.325[\ln 0.27\varepsilon]^{-2}$, either to estimate f as a constant for a given problem, or to obtain an estimate for an iterative solution in which initially Re is unknown. In many engineering situations this simplified form is acceptable.

TABLE 6.1 Values of the Average Wall Roughness Height e

Type of pipe	e (ft)
Riveted steel	~0.01
Concrete	~0.001-0.01
Wood	~0.001
Cast iron	0.00085
Galvanized iron	0.0005
Wrought iron	0.00015
Drawn tubing	0.000005

The *Hazen-Williams* formula applies only to water as the flowing liquid. It normally expresses the head loss as a function of the discharge Q:

$$h_L = \frac{4.72L}{C^{1.85}D^{4.87}}Q^{1.85} \tag{6.1.3}$$

in which C is the *Hazen-Williams loss coefficient*. Values of C are given in Table 6.2.

TABLE 6.2 Values of the Hazen-Williams Coefficient C

Type of pipe	C
Extremely smooth; asbestos-cement	140
New or smooth cast iron; concrete	130
Wood stave; newly welded steel	120
Average cast iron; newly riveted steel	110
Cast iron or riveted steel after some years of use	95(100)
Deteriorated old pipes	60-80

← ASSUME HDPE W/ SCALE

Note that in the form given the Hazen-Williams formula is applicable only with English units. It is neither as universally applicable, nor as accurate, as is the Darcy-Weisbach equation.

EXAMPLE 6.1

Water is flowing at Q = 20 gal/min in a 500-ft-long, 2-inch-diameter cast iron steel pipe. The water temperature is 50° F. Determine the head loss h_L using (a) the Darcy-Weisbach formula and (b) the Hazen-Williams formula.

THERMOPLASTIC VINYL NITRILE (VNBR) DISCHARGE HOSE

VNBR hose is a tough, lightweight and flexible discharge hose with especially abrasion resistant qualities and good chemical, flame and heat resistant characteristics as well. The VNBR handles high pressures and low pressures to full vacuum as well as long lengths.

The ribbed cover allows a sure surface grip for easy handling and the high number of internal helical wire turns per inch minimizes crushing and kinking damage during system deployment and recovery. For riser lengths over 150', the ribbed surface can present surface friction issues during deployment and recovery.

The VNBR is suitable for cam and groove, water suction or combination nipple couplings. Clamps can be single bolt, double bolt, band or wire. All couplings and clamps used are 300 Series Stainless Steel.

Hose Type	Tube and Cover
Material	Thermoplastic Vinyl Nitrile (VNBR)
Reinforcement	100% Polyester with Helical Inner Wire
Color	Blue
Temperature Range	-20°F to +180°F
Working Pressure	200 to 300 PSI
Suction Capability	Full Vacuum
Approvals	MSHA Approval
Standard Lengths	25', 50', 100', 125' and 150'

Part Number	Nominal Inner Diameter (IN)	Nominal Outer Diameter (IN)	Maximum Working (PSI)	Hose Weight LBS/FT	Minimum Bend (IN)
LPSVNBR-12	1.5	2	300	0.81	6
LPSVNBR-2	2	2.5	300	1.09	8
LPSVNBR-22	2.5	3	300	1.32	10
LPSVNBR-3	3	3.5	250	1.94	12

PIPE CALCULATIONS
EFFECTIVE WALL THICKNESS OF 36" ϕ SDR 11 PERFORATED PIPE

PROJECT: Blue Ridge, Canton NC. Landfill 6 D-South Expansion 07089.00
CALC. BY: KPN **DATE:** Aug 20, 2008
DATE_____ **CHECKED BY**_____

Pipe Information

$OD := 36 \cdot in$ **Pipe Outside Diameter (inches)**

$DR := 11$ **Pipe Dimension Ratio**

Perforations

$Dperf := 0.5 \cdot in$ **Diameter of perforations (inches)**

$Nperf := 6$ **Number of perforations per foot**

Calculations

$Tmin := \frac{OD}{DR}$ **Minimum wall thickness (inches)**

$Tmin = 3.273 \cdot in$

$Aperf := Dperf \cdot Tmin \cdot Nperf$ **Cross sectional area of perforations per 12" segement (sq. in.)**

$Aperf = 9.818 \cdot in^2$

$Apipe := Tmin \cdot (12 \cdot in)$ **Wall area without perforations (sq. in.)**

$Apipe = 39.273 \cdot in^2$

$Aeff := Apipe - Aperf$ **Effective area (reduced by area of perforations)**

$Aeff = 29.455 \cdot in^2$

$Teff := \frac{Aeff}{12 \cdot in}$ **Resulting effective wall thickness per 12" segment (in.)**

$Teff = 2.455 \cdot in$

$DReff := \frac{OD}{Teff}$ $DReff = 14.667$ **Effective DR due to theoretical wall area reduction**

PROJECT	COMP. BY	JOB NO.
BRPP - LANDFILL 6D - SOUTH EXPANSION - SUMP	RPN	
	CHK. BY	DATE
		08/19/08

DETERMINE NUMBER OF PERFORATIONS REQUIRED IN PUMP CONDUIT AT SUMP.

REF CAMERON HYDRAULIC DATA PG 66-67
FLOW THROUGH ORIFICES

$$Q = 19.636\, K d^2 \sqrt{h} \qquad \frac{d}{D} < 0.3$$

Q = Flow (gpm)

d = diameter of ORIFICE (REF) (IN)

D = Diameter of main pipe

K = Discharge coefficient

h = Head diff each size of REF (FT)

$K = 0.52$

$d = 0.5$ IN

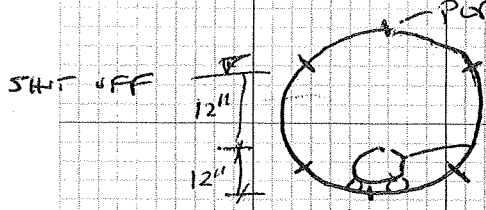
$D = 36$ IN

TRY ONE FOOT of head

$$Q = 19.636 (0.51)(0.5^2)\sqrt{1} = \boxed{2.6 \text{ GAL/MIN}}$$

TRY TWO FEET of head

$$Q = 19.636 (0.51)(0.5^2)\sqrt{2} = \boxed{5.1 \text{ GPM}}$$



TWO PUMP CONDUITS TIED TOGETHER

PROJECT	COMP. BY	JOB NO.
BRPP - SUMP	KAW	
	CHK. BY	DATE
		08/19/08

1/2

Pump Flows 200 - 300 GPM

Normal Flow one pump 200 GPM w/ 1 ft head

Perf Required = 200 GPM / 12.6 GPM/Perf

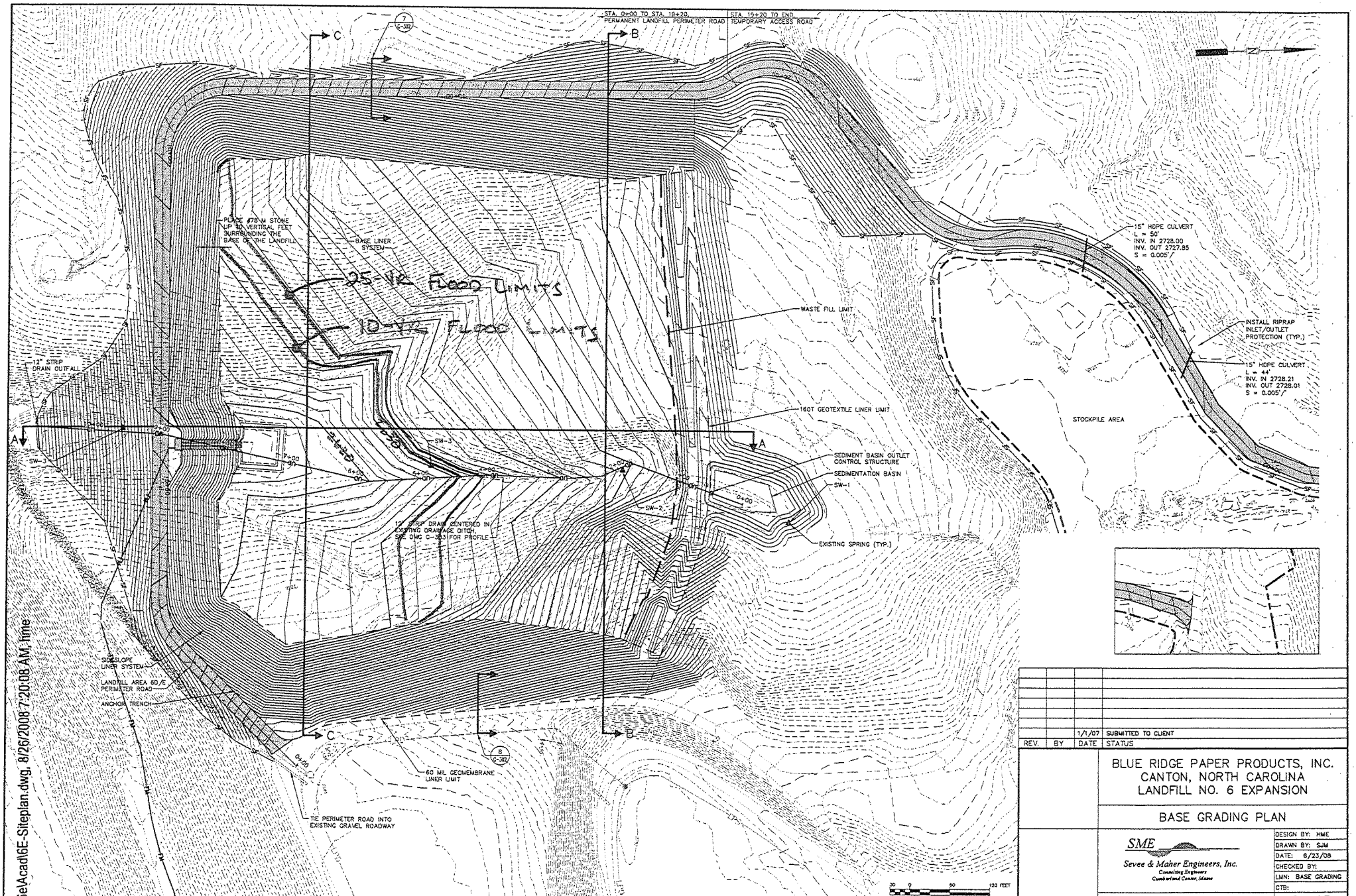
≈ 77 perforations

Assume 6 perforations every 60° at each foot. Only bottom 5 perfs contributing at Normal Flow.

- Calculate length of pipe in sump

$$\frac{77 \text{ perf holes}}{6 \text{ perf holes/ft}} = 12.8 \text{ ft} \quad (2 \text{ pipes; each } 12.8 \text{ ft}) \text{ Minimum}$$

↑ 3 holes per pipe per ft



REV.	BY	DATE	STATUS
		1/1/07	SUBMITTED TO CLIENT

BLUE RIDGE PAPER PRODUCTS, INC.
CANTON, NORTH CAROLINA
LANDFILL NO. 6 EXPANSION

BASE GRADING PLAN

SME
Sevee & Maher Engineers, Inc.
Consulting Engineers
Cumberland Center, Maine

DESIGN BY:	HME
DRAWN BY:	SJM
DATE:	6/23/08
CHECKED BY:	
LMN:	BASE GRADING
CTB:	

JOB NO. 07089.00 DWG FILE 6E-SITEPLAN

C-103

P:\Brpp\NC6e\Acad\6E-Siteplan.dwg, 8/26/2008 7:20:08 AM, hme

25-YR Flood EL = 2633.5' – Pump OFF @ 3.3 days

10-YR Flood EL = 2631.6' – Pump OFF @ 2.7 days

Hydrograph for Pond 3P: sump

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Primary (cfs)	
0.00	0.00	0	2,613.00	0.00	
2.00	0.18	423	2,613.39	0.00	Pump(1) ON
4.00	0.33	1,363	2,614.18	0.33	
6.00	0.49	1,366	2,614.18	0.49	
8.00	0.63	1,447	2,614.24	0.58	
10.00	1.12	3,509	2,615.61	**0.58**	Pump (2) ON
12.00	**59.66**	45,530	2,624.71	**0.77**	
14.00	**3.13**	128,024	2,632.72	0.77	
16.00	1.90	139,960	2,633.32	0.77	
18.00	1.45	146,264	2,633.41	0.77	
20.00	1.07	149,834	2,633.47	0.77	
22.00	0.97	151,528	2,633.49	0.77	
24.00	0.89	**152,677**	**2,633.51**	0.77	
26.00	0.00	**147,865**	**2,633.44**	0.77	
28.00	0.00	142,328	2,633.35	0.77	
30.00	0.00	136,791	2,633.27	0.77	
32.00	0.00	131,255	2,632.95	0.77	
34.00	0.00	125,718	2,632.54	0.77	
36.00	0.00	120,181	2,632.12	0.77	
38.00	0.00	114,644	2,631.68	0.77	
40.00	0.00	109,107	2,631.23	0.77	
42.00	0.00	103,571	2,630.76	0.77	
44.00	0.00	98,034	2,630.29	0.77	
46.00	0.00	92,497	2,629.79	0.77	
48.00	0.00	86,960	2,629.29	0.77	
50.00	0.00	81,423	2,628.76	0.77	
52.00	0.00	75,887	2,628.21	0.77	
54.00	0.00	70,350	2,627.64	0.77	
56.00	0.00	64,813	2,627.04	0.77	
58.00	0.00	59,276	2,626.42	0.77	
60.00	0.00	53,739	2,625.75	0.77	
62.00	0.00	48,203	2,625.06	0.77	
64.00	0.00	42,666	2,624.31	0.77	
66.00	0.00	37,129	2,623.49	0.77	
68.00	0.00	31,592	2,622.62	0.77	
70.00	0.00	26,055	2,621.66	0.77	
72.00	0.00	20,519	2,620.62	0.77	
74.00	0.00	14,982	2,619.45	0.77	Pump (2) OFF
76.00	0.00	9,709	2,618.08	0.58	
78.00	0.00	5,569	2,616.72	0.58	
80.00	0.00	1,429	2,614.23	0.58	Pump (1) OFF
82.00	0.00	1,356	2,614.17	0.00	
84.00	0.00	1,356	2,614.17	0.00	
86.00	0.00	1,356	2,614.17	0.00	
88.00	0.00	1,356	2,614.17	0.00	
90.00	0.00	1,356	2,614.17	0.00	
92.00	0.00	1,356	2,614.17	0.00	
94.00	0.00	1,356	2,614.17	0.00	
96.00	0.00	1,356	2,614.17	0.00	
98.00	0.00	1,356	2,614.17	0.00	

Pump (1) Run Time: 76 hrs / 3.2 da

Pump (2) Run Time: 62 hrs / 2.6 da

Summary for Pond 3P: sump

Inflow Area = 16.000 ac, 31.25% Impervious, Inflow Depth = 3.50" for 25-year event
Inflow = 64.31 cfs @ 12.04 hrs, Volume= 4.665 af
Outflow = 0.77 cfs @ 11.40 hrs, Volume= 4.634 af, Atten= 99%, Lag= 0.0 min
Primary = 0.77 cfs @ 11.40 hrs, Volume= 4.634 af

Routing by Stor-Ind method, Time Span= 0.00-98.00 hrs, dt= 0.02 hrs
Peak Elev= 2,633.51' @ 24.11 hrs Surf.Area= 167,970 sf Storage= 152,686 cf

Plug-Flow detention time= 1,751.4 min calculated for 4.634 af (99% of inflow)
Center-of-Mass det. time= 1,747.1 min (2,545.1 - 798.0)

Volume	Invert	Avail.Storage	Storage Description
#1	2,613.00'	134,954 cf	**Stone Sump (Prismatic)** Listed below (Recalc) 1,364,107 cf Overall - 1,026,721 cf Embedded = 337,386 cf x 40.0% Voids
#2	2,618.25'	51,336 cf	**Waste (Prismatic)** Listed below (Recalc) Inside #1 1,026,721 cf Overall x 5.0% Voids
		186,290 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,613.00	2,568	0	0
2,614.17	3,225	3,389	3,389
2,617.00	5,250	11,992	15,381
2,618.25	12,215	10,916	26,297
2,620.00	25,700	33,176	59,472
2,622.00	42,160	67,860	127,332
2,624.00	59,540	101,700	229,032
2,626.00	79,300	138,840	367,872
2,628.00	100,370	179,670	547,542
2,630.00	123,430	223,800	771,342
2,632.00	147,330	270,760	1,042,102
2,634.00	174,675	322,005	1,364,107

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,618.25	5,250	0	0
2,619.50	12,215	10,916	10,916
2,621.25	25,700	33,176	44,091
2,623.25	42,160	67,860	111,951
2,625.25	59,540	101,700	213,651
2,627.25	79,300	138,840	352,491
2,629.25	100,370	179,670	532,161
2,631.25	123,430	223,800	755,961
2,633.25	147,330	270,760	1,026,721

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**Sump Pump** Elev. (feet) 0.00 2,614.17 2,614.18 2,617.00 2,618.24 2,618.25 Disch. (cfs) 0.000 0.000 0.575 0.575 0.575 0.769

Primary OutFlow Max=0.77 cfs @ 11.40 hrs HW=2,618.27' (Free Discharge)
└─**1=Sump Pump** (Custom Controls 0.77 cfs)

PROJECT	COMP. BY	JOB NO.
BLUE RIDGE SUMP DESIGN	HME	07089.00
STONE WASTE	CHK. BY	DATE 8/29/08

ELEV	= AREA
2613	2568
2614.17	3225
2617	5250
2618.25	12,215
2620	25,700
2622	42,160
2624	59,540
2626	79,300
2628	100,370
2630	123,430
2632	147,330
2634	173,675

ELEV	= AREA
2618.25	5250
2619.5	12,215
2621.25	25,700
2623.25	42,160
2625.25	59,540
2627.125	79,300
2629.25	100,370
2631.25	123,430
2633.25	147,330

$\therefore$ 1 PUMP $258 \frac{g}{MIN}\left(\frac{CF}{7.48 g}\right)\left(\frac{MIN}{60\ sec}\right) = 0.575$ CFS

2 PUMP $345 \frac{g}{MIN}\left(\frac{CF}{7.48 g}\right)\left(\frac{MIN}{60\ sec}\right) = 0.769$ CFS

PUMP OFF EL = 2614.17

PUMP 1 ON EL = 2617

PUMP 2 ON EL = 2618.25

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**********************************************************************
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**                                                                  **
**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE       **
**                   HELP MODEL VERSION 3.05a  (5 JUNE 1996)         **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY    **
**                                                                  **
**                                                                  **
**********************************************************************
**********************************************************************

PRECIPITATION DATA FILE:     C:\HELP3\BRPP\10-WASTE.D4
TEMPERATURE DATA FILE:       C:\help3\BRPP\10-WASTE.D7
SOLAR RADIATION DATA FILE:   C:\help3\BRPP\10-WASTE.D13
EVAPOTRANSPIRATION DATA:     C:\help3\BRPP\10-WASTE.D11
SOIL AND DESIGN DATA FILE:   C:\Help3\BRPP\10-WASTE.D10
OUTPUT DATA FILE:            C:\Help3\BRPP\10-WASTE.OUT

TIME:  10:17     DATE:   8/ 8/2008

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

     TITLE:  BRPP - LANDFILL 6D SOUTH - NO CAP 10-FT WASTE ON BASE

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

     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   0
          THICKNESS                     =    120.00   INCHES
          POROSITY                      =      0.4000 VOL/VOL
          FIELD CAPACITY                =      0.3600 VOL/VOL
          WILTING POINT                 =      0.2800 VOL/VOL
          INITIAL SOIL WATER CONTENT    =      0.3900 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.139999997000E-05 CM/SEC


                                LAYER  2
                                --------

                  TYPE 2 - LATERAL DRAINAGE LAYER
```

MATERIAL TEXTURE NUMBER 21

THICKNESS	=	15.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0323	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	8.00	PERCENT
DRAINAGE LENGTH	=	200.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

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

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7470	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999997000E-08	CM/SEC

LAYER 5

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	60.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4710	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	90.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.166	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.200	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.240	INCHES
INITIAL SNOW WATER	=	2.623	INCHES
INITIAL WATER IN LAYER MATERIALS	=	75.721	INCHES
TOTAL INITIAL WATER	=	78.344	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.28	3.52	4.27	3.34	3.52	3.28
4.48	4.23	3.00	2.65	2.69	3.05

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING

COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.48	3.43	3.81	3.13	4.04	3.51
	4.03	3.94	2.52	2.24	2.86	3.14
STD. DEVIATIONS	2.72	1.85	2.32	1.66	1.36	1.47
	1.52	1.79	1.45	1.26	2.00	1.73
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.780	1.028	1.656	2.174	2.836	3.071
	2.916	2.482	1.640	1.100	1.212	0.565
STD. DEVIATIONS	0.394	0.555	1.306	2.108	2.821	3.049
	2.920	2.473	1.760	1.179	0.781	0.339
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.7119	0.6440	0.8997	0.9889	1.0784	0.9597
	0.9295	0.9422	0.8560	0.7043	0.7012	0.6518
STD. DEVIATIONS	0.4389	0.3317	0.4071	0.3286	0.3943	0.4727
	0.4967	0.4456	0.3927	0.5028	0.4733	0.4960
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 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	0.0340	0.0338	0.0429	0.0488	0.0515	0.0473
	0.0444	0.0450	0.0422	0.0336	0.0346	0.0311
STD. DEVIATIONS	0.0209	0.0176	0.0194	0.0162	0.0188	0.0233
	0.0237	0.0213	0.0194	0.0240	0.0233	0.0237

DAILY AVERAGE HEAD ON TOP OF LAYER 5

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

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	40.12 (5.196)	145642.9	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
EVAPOTRANSPIRATION	21.459 (17.8486)	77896.57	53.485
LATERAL DRAINAGE COLLECTED FROM LAYER 2	10.06762 (3.67298)	36545.469	25.09252
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00000 (0.00000)	0.017	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.041 (0.015)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.017	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.000 (0.000)		
CHANGE IN WATER STORAGE	8.420 (21.1612)	30565.66	20.987

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 15

	(INCHES)	(CU. FT.)
PRECIPITATION	6.10	22143.000
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.04762	172.86519
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 3	0.070	
MAXIMUM HEAD ON TOP OF LAYER 3	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	2.1 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 5	0.000	
SNOW WATER	128.41	466133.8440

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3958
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2800

*** 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 15

LAYER	(INCHES)	(VOL/VOL)
1	46.8640	0.3905
2	0.4903	0.0327
3	0.0000	0.0000
4	0.1793	0.7470
5	28.2600	0.4710
SNOW WATER	128.855	

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**                                                                              **
**                                                                              **
**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                    HELP MODEL VERSION 3.05a  (5 JUNE 1996)                    **
**                    DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                      USAE WATERWAYS EXPERIMENT STATION                       **
**                 FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                              **
**                                                                              **
**********************************************************************************
**********************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\BRPP\NC60SIDE.D4
TEMPERATURE DATA FILE:       C:\help3\BRPP\NC60SIDE.D7
SOLAR RADIATION DATA FILE:   C:\help3\BRPP\NC60SIDE.D13
EVAPOTRANSPIRATION DATA:     C:\help3\BRPP\NC60SIDE.D11
SOIL AND DESIGN DATA FILE:   C:\Help3\BRPP\NCNWSIDE.D10
OUTPUT DATA FILE:            C:\Help3\BRPP\NCNWSIDE.OUT


TIME:  11:11     DATE:   8/ 5/2008


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

     TITLE:  BRPP - LANDFILL 6D SOUTH - NO CAP NO WASTE ON SIDE

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


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


                                  LAYER  1
                                  --------

                  TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER  21
          THICKNESS                      =     12.00   INCHES
          POROSITY                       =      0.3970 VOL/VOL
          FIELD CAPACITY                 =      0.0320 VOL/VOL
          WILTING POINT                  =      0.0130 VOL/VOL
          INITIAL SOIL WATER CONTENT     =      0.1187 VOL/VOL
          EFFECTIVE SAT. HYD. COND.      =  0.300000012000     CM/SEC
          SLOPE                          =     50.00   PERCENT
          DRAINAGE LENGTH                =    300.0    FEET


                                  LAYER  2
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TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

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

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	60.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4710	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	90.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.296	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.176	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.104	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	29.684	INCHES
TOTAL INITIAL WATER	=	29.684	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES

AVERAGE ANNUAL WIND SPEED = 7.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 71.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 75.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 84.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 77.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.28	3.52	4.27	3.34	3.52	3.28
4.48	4.23	3.00	2.65	2.69	3.05

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.08	3.43	3.81	3.13	4.04	3.51
	4.03	3.94	2.52	2.24	2.86	3.14
STD. DEVIATIONS	1.33	1.85	2.32	1.66	1.36	1.47
	1.52	1.79	1.45	1.26	2.00	1.73
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	1.048	1.152	1.634	1.504	1.923	1.981
	1.977	1.780	1.060	1.002	0.856	0.754
STD. DEVIATIONS	0.291	0.407	0.699	0.767	0.444	0.714
	0.691	0.648	0.514	0.495	0.388	0.173

LATERAL DRAINAGE COLLECTED FROM LAYER 1

TOTALS	2.3718	2.3088	2.1187	1.7579	2.1446	1.4812
	1.9926	2.3142	1.2265	1.4305	1.9784	1.9834
STD. DEVIATIONS	1.2132	1.7917	1.8463	1.1295	1.1930	0.8365
	1.1771	1.5140	0.8818	1.1639	1.8028	1.0631

PERCOLATION/LEAKAGE THROUGH LAYER 3

TOTALS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000
	0.0001	0.0001	0.0000	0.0000	0.0001	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	0.0383	0.0409	0.0342	0.0293	0.0356	0.0257
	0.0324	0.0394	0.0208	0.0229	0.0333	0.0310
STD. DEVIATIONS	0.0196	0.0332	0.0301	0.0186	0.0210	0.0149
	0.0193	0.0258	0.0151	0.0195	0.0306	0.0164

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 15

	INCHES		CU. FEET	PERCENT
PRECIPITATION	39.73	(4.479)	144205.4	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	16.671	(1.9300)	60515.37	41.965
LATERAL DRAINAGE COLLECTED FROM LAYER 1	23.10859	(3.51226)	83884.180	58.16993
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00104	(0.00015)	3.783	0.00262
AVERAGE HEAD ON TOP OF LAYER 2	0.032	(0.005)		

CHANGE IN WATER STORAGE	-0.055	(1.4199)	-197.97	-0.137

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 15

	(INCHES)	(CU. FT.)
PRECIPITATION	2.99	10853.700
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 1	3.13842	11392.47270
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000107	0.38793
AVERAGE HEAD ON TOP OF LAYER 2	2.071	
MAXIMUM HEAD ON TOP OF LAYER 2	2.744	
LOCATION OF MAXIMUM HEAD IN LAYER 1 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	5.37	19489.3320

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3970
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0130

*** 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 15

LAYER	(INCHES)	(VOL/VOL)
1	0.6062	0.0505
2	0.0000	0.0000
3	28.2600	0.4710

NCNWSIDE.OUT

SNOW WATER 0.000

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APPENDIX D

ENGINEERING SPECIFICATIONS

SECTION 02200

EARTHWORK

1. GENERAL

1.1 RELATED DOCUMENTS:

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

Extent of earthwork is indicated on drawings.

Definition: "Excavation" consists of removal of material encountered to subgrade elevations indicated and subsequent disposal or replacement (backfill) of materials removed.

1.3 QUALITY CONTROL:

1.3.1 Codes and Standards: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

1.3.2 Testing and Inspection Service: The Contractor shall employ a testing laboratory acceptable to Owner's Representative to perform soil testing of materials at point of source. The Contractor shall perform the following analysis on borrow materials used at the site.

- # 5 Stone:
  - Grain Size (D422) - 1/3000 cy
- #78M Stone:
  - Grain Size (D422) - 1/3000 cy
- #57 Stone:
  - Grain Size (D422) - 1/3000 cy
- Common Borrow (silty sand, sandy silt or clayey soil):
  - Grain Size (D422) - 1/3000 cy
  - Maximum Dry Density (D1557) – 1/3000 cy

1.4 FIELD QUALITY ASSURANCE

1.4.1 Quality Assurance Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

Testing shall be as follows:

- #78M Stone:
  - Grain Size (D422) - 1/3000 cy
- #57 Stone:
  - Grain Size (D422) - 1/1000 cy

- Common Borrow (silty sand, sandy silt, etc.):
  - Grain Size (D422) - 1/1000 cy
  - Moisture/Density (D1556) - 10/acre/lift

If in opinion of Owner's Representative, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction, wetting, drying or removal of material as necessary, and testing at no additional expense.

1.5 JOB CONDITIONS:

1.5.1 Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor.

Additional test borings and other exploratory operations may be made by Contractor at no cost to Owner.

1.5.2 Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.

Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Owner's Representative and then only after acceptable temporary utility services have been provided.

Provide minimum of 48-hour notice to Owner's Representative, and receive written notice to proceed before interrupting any utility.

Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

1.5.3 Use of Explosives: (None anticipated)

General: This work shall consist of furnishing, placing and detonating dynamite in places directed for the excavation of related work items in accordance with these specifications and in reasonably close conformity to the lines and grades shown on the plans or as established.

All blasting plans shall be approved prior to placing the explosive charges.

Do not bring explosives onto site or use in work without prior written permission from authorities having jurisdiction.

The Contractor is solely responsible for the handling, storage, and use of explosive materials.

The explosives shall be detonated by the propagation or electric method and shall be detonated the same day it is placed.

No explosives shall be stored on the site overnight.

1.5.4 Materials: Dynamite and caps shall be from fresh stock and shall have a maximum strength as specified in the approved blasting plan.

1.5.5 Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

Operate warning lights as recommended by authorities having jurisdiction.

Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

2. PRODUCTS

2.1 SOIL MATERIALS:

2.1.1 General: Excavations made at the site for the construction of project facilities will generate unspecified quantities of soil materials. These soils will either be suitable or unsuitable for use as fill in the construction of earth-related portions of the project.

Suitable Materials: Those materials generated from outside excavations that satisfy the specifications for the material for which it is to be used (i.e., compacted silt/sand, common borrow, etc.). Specifications for suitable project materials follow.

Unsuitable Materials: Those materials generated from on-site excavations that do not satisfy the specifications for the project materials identified below. Generally these materials will consist of objectionable quantities of vegetation, organic matter, large stones, debris and frozen material.

2.1.2 #57 Stone: Durable, clean angular rock fragments obtained by breaking and crushing rock material, furnished, and placed to the lines and grades as shown on the Drawings. Sieve analysis by weight:

Sieve Designation	% Passing by Weight
1 1/2"	100
1"	95-100
1/2"	25-60
#4	0- 10
#8	0-5
#200	0-0.6

2.1.3 #78M Stone: #78M Stone shall be furnished and placed to the lines and dimensions as shown on the Drawings to provide a drainage blanket between the synthetic liner and the waste, as identified in the Drawings.

Sieve Designation	% Passing by Weight
3/4"	100
1/2"	98-100
3/8"	75-100
#4	20-45
#8	0-15
#200	0-0.6

2.14 # 5 Stone: : #5 Stone shall be furnished and placed to the lines and dimensions as shown on the Drawings to provide a drainage in the sump area.

Sieve Designation	% Passing by Weight
1 1/2"	100
1"	90-100
3/4"	20-55
1/2	0-10
3/8	0-5
#200	0-0.6

2.1.5 Common Borrow #1 (silty sand, sandy silt): Screened material shall be furnished and placed to the lines and dimensions as shown on the Drawings to construct the cell division berm and any base filling requirements within two (2) feet of the synthetic liner. The soil shall not contain particles of rock which will not pass the 1-inch square mesh sieve. The soil shall have greater than 20 percent passing the U.S. Standard No. 200 Sieve.

2.1.6 Common Borrow #2: Shall be earth suitable for embankment construction for use in any base filling greater than two (2) feet below the synthetic liner. It shall be free of frozen material, perishable rubbish, peat, organic matter, large rock fragments over 12 inches, or other unsuitable material. AASHTO M145 Classifications A-1 through A-5 may be used. Use of other materials as common borrow is at the discretion of the Owner's Representative and only in approved areas.

3. EXECUTION

3.1 EXCAVATION:

3.1.1 Unclassified Excavation includes excavation of materials and obstructions encountered to subgrade elevations indicated, regardless of character.

3.1.2 Excavation Classifications: The following classifications of excavation will be made when rock excavation is encountered in work:

3.1.3 Earth Excavation includes excavation of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.

3.1.4 Rock Excavation:

Rock excavation in trenches and pits includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, 42" wide bucket on track-mounted power excavator equivalent to Caterpillar Model 215, rated at not less than 90HP flywheel power and 30,000 lb. drawbar pull. Trenches in excess of 10'- 0" in width and pits in excess of 30'-0" in either length or width are classified as open excavation.

Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered which cannot be dislodged and excavated with modern track-mounted heavy-duty excavating equipment without drilling, blasting or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973 or No. 977K, or equivalent track-mounted loader, rated at not less than 170HP flywheel power and developing 40,000 lb. break-out force (measured in accordance with SAE J732C).

Typical of materials classified as rock are boulders 3 cu. yd. or more in volume, solid rock, rock in ledges, and rock hard cementitious aggregate deposits.

Intermittent drilling, blasting or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified and worksheets submitted to the Owner's Representative.

Rock payment lines are limited to the following:

In pipe trenches, 6 inches below invert elevation of pipe and 18 inches wider than inside diameter of pipe, but not less than 3 ft.

In open areas, 24 inches below base grade elevation.

3.1.5 Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Owner's Representative. Unauthorized excavation, as well as remedial work directed by Owner's Representative, shall be at Contractor's expense.

Backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Owner's Representative.

3.1.6 Additional Excavation: When excavation has reached required subgrade elevations, notify Owner's Representative who will make an inspection of conditions. Do not backfill excavations without notifying Owner's Representative.

If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by Owner's Representative.

Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in work.

3.1.7 Stability of Excavations: Slope sides of excavations to comply with federal and local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

Maintain sides and slopes of excavations in safe condition until completion of backfilling.

3.1.8 Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.

Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

Provide permanent steel sheet piling or pressure creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops as required and leave permanently in place.

3.1.9 Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

Use appropriate erosion control in temporary ditches, as described in Section 02270, Erosion Control.

3.1.10 Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage. Cover or seed stockpiles when long-term storage indicates the potential for wind or water erosion from the stockpile. Place silt fence around downstream edge of stockpile to prevent transportation of soil.

Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.

Dispose of excess soil material and waste materials as herein specified by Owner's Representative.

3.1.11 Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10', and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

3.1.12 Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide a minimum 6" to 9" clearance on both sides of pipe or conduit as indicated on Drawings.

Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations.

Where rock or unsuitable material is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel, as approved by Owner's Representative, prior to installation of pipe.

For pipes or conduit 6" or larger in nominal size, tanks and other work indicated to receive subbase, excavate to subbase depth or, if not otherwise indicated, to 6" below bottom of work to be supported.

Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.

Do not backfill trenches until tests and inspections have been made and backfilling authorized by Owner's Representative. Use care in backfilling to avoid damage or displacement of pipe systems. Owner's Representative must be notified of any intention to backfill trench or otherwise permanently cover pipe.

3.1.13 Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35° F. (1°C).

3.1.14 Final Grading: Perform grading in accordance with Contract Drawings, in order to obtain subgrade elevations prior to the placement of the geomembrane. During the regrading, the Contractor shall fill voids encountered below the subgrade elevations with on-site materials or materials provided by the Owner.

3.2 COMPACTION:

3.2.1 General: Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated below.

3.2.2 Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D 1557.

Pipeline: Compact top 6" of subgrade and each 12" layer of backfill or fill material at 90% maximum density.

Dikes: Compact each 12-inch layer of fill material at 90% maximum density.

Liner Subgrade: Compact each 12" lift of subgrade at 90 percent maximum density. Maintain these conditions until geomembrane is installed.

3.2.3 Moisture Control: Moisture content of the liner subgrade soil and/or embankments shall be at, but not greater than 6 percent higher than optimum as determined by ASTM D 1557. Where subgrade or layer of soil material must be moisture conditioned to meet the allowable range of water content to achieve compaction, uniformly apply water to surface of subgrade, or layer of soil material. Apply water in manner to prevent free water appearing on surface during or subsequent to compaction operations.

Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.3 BACKFILL AND FILL:

3.3.1 General: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.

In excavations, use satisfactory excavated or borrow material free of frozen material, large stones, brush, roots, sod, or other unsuitable material.

Under grassed areas, use satisfactory excavated or borrow material.

Under piping and conduit, use subbase material where subbase is indicated under piping or conduit; shape to fit bottom 90^{0} of cylinder.

3.3.2 Backfill excavations as promptly as work permits, but not until completion of the following:

Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.

Inspection by Owner's Representative, testing, approval, and recording locations of underground utilities.

Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.

Removal of trash and debris.

Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.3.3 Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

3.3.4 Placement and Compaction: Place backfill and fill materials in layers not more than 15" in loose depth for material compacted by heavy compaction equipment, and not more than 6" in loose depth for material compacted by hand-operated tampers. Liner subgrade soil shall have a maximum in-place compacted lift thickness of 12 inches.

Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content within the optimum range as determined by the soil testing at point of source. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of

piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

To provide for clod break-up of the cover material, a minimum number of 2 passes will be made with deep footed pad roller. To eliminate desiccation cracks the surface will be moistened (as necessary) and reworked with 2 passes of a smooth drum roller. Desiccation is defined as moisture content below optimum, or cracks deeper than 1 inch.

The cover soil shall be compacted and smooth drum rolled at the end of each work day to provide for moisture/density testing and prevent ponding of surface water overnight.

The following equipment will be used for compaction of the cover material:

Caterpillar 815F Pad Foot Roller or equivalent equipment approved by the Engineer. Equivalent equipment shall meet the following specifications:

Minimum Operating Weight	45,900 lbs
Maximum Pad Tip Area	18 square inches
Minimum Pad Height	7.5 inches
Minimum Wheel Diameter	40.5 inches

The passage of compaction equipment in either direction (forward or backward) is considered a "pass."

The following equipment will be used to obtain a smooth roll surface:

Caterpillar CS563 Vibratory Drum Roller or equivalent equipment approved by the Engineer. Equivalent equipment shall meet the following specifications:

Minimum Operating Weight	24,500 lbs
Vibration Frequency	1,400 to 1,800 vpm
Centrifugal Force	
High Amplitude	50,000 lbs
Low Amplitude	35,000 lbs
Maximum Drum Width	7.0 feet

Sealing the lifts will encourage runoff from storms, thus limiting development of excessively moist or wet lenses of soil within the barrier layer. The lift surface shall be scarified or otherwise roughened by tracking with a bulldozer prior to placing the next lift of silt-clay to promote good bonding between lifts.

3.4 MAINTENANCE:

3.4.1 Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

3.4.2 Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, gravel road, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.5 DISPOSAL OF EXCESS AND WASTE MATERIALS:

3.5.1 Removal to Designated Areas on Owner's Property: Transport acceptable excess excavated material to designated soil storage areas on Owner's property. Stockpile soil and seed or spread and seed as directed by Owner's Representative.

Transport waste material, including unacceptable excavated material, trash and debris to designated spoil areas on Owner's property and dispose of as directed.

END OF SECTION

SECTION 02270

EROSION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

Work covered by this Section includes the control of erosion, siltation, and sedimentation.

1.2 PROJECT REQUIREMENTS

1.2.1 Prevention: Take every reasonable precaution and do whatever is necessary to avoid any erosion and to prevent silting of rivers, streams, lakes, reservoirs, impoundment's, and drainage ditches and swales.

1.2.2 Exposure: The exposure of uncompleted cut slopes, embankments, trench excavations, and site graded areas shall be kept as short as possible. Initiate seeding and other erosion control measures on each segment as soon as reasonably possible.

1.2.3 Temporary Protection: Should it become necessary to suspend construction for any length of time, shape all excavated and graded areas in such a manner that runoff will be intercepted and diverted to points where minimal erosion will occur. Provide and maintain temporary erosion and sediment control measures, such as berms, dikes, slope drains, silt stops, and sedimentation basins, until permanent drainage facilities or erosion control features have been completed and are operative.

1.2.4 Handling of Fine Material: Fine material placed or exposed during the work shall be so handled and treated as to minimize the possibility of its reaching any surface waters. Use diversion channels, dikes, sediment traps, or any other effective control measures.

1.2.5 Silt Stops: Provide silt stops wherever erosion control measures may not be totally capable of controlling erosion, such as in drainage channels and where steep slopes may exist.

1.2.6 Special Precautions: Take special precautions in the use of construction equipment to minimize erosion. Do not leave wheel tracks where erosion might begin.

1.2.7 Off-Site Erosion Control: The requirements of this Section also apply to Project-related construction activities away from the Project site, such as at borrow pits, off-site storage areas, and haul and work roads.

1.2.8 Mulching: Mulching shall follow the seeding operation by not more than 24 hours.

1.2.9 Remedial Action: Should any protective measures employed indicate any deficiencies or erosion taking place, immediately provide additional materials or employ different techniques to correct the situation and to prevent subsequent erosion.

1.2.10 Discontinuation: Continue erosion control measures until the permanent measures have been sufficiently established and are capable of controlling erosion on their own.

1.2.11 Federal Permits: Comply with all Federal, state and local laws, ordinances, rules and regulations.

1.3 QUALITY CONTROL:

Provide at least one person who shall be present at all times during erosion control operations and who shall be thoroughly familiar with the types of materials being installed and the best methods for their installation and who shall direct all work performed under this Section.

Material manufacturers and vendors shall be reputable, qualified firms regularly engaged in producing the required types of materials.

Protect and maintain all areas disturbed by the Work, such that erosion is adequately controlled and silt and sediments are not allowed to flow into any watercourse, onto adjacent properties, or into storm drains.

PART 2 - PRODUCTS

2.1 STRAW MULCH:

2.1.1 General: Straw mulches shall be reasonably free from swamp grass, weeds, twigs, debris and other deleterious material, and free from rot, mold, primary noxious weed seeds, and rough or woody materials. Mulches containing mature seed of species which would volunteer and be detrimental to the permanent seeding, or would result in overseeding, or would produce growth which is aesthetically unpleasing, is not permitted.

2.1.2 Straw Mulch: Properly aired native straw, Sudan grass straw, broomsedge straw, legume straw, or similar straw or grass mowings. When air-dried in the loose state, the contents of the representative bale shall lose not more than fifteen (15) percent of the resulting air-dry weight of the bale. Apply at the rate of 2 tons/ac.

2.1.3 Mulch Stabilizers: "Curasol" applied at the rate of 40 gal/ac. or Dow "Mulch Binder" applied at the rate of 45 gal/ac.

2.1.4 Permanent Type Mulch Nets: "Curlex" blanket as manufactured by American Excelsior, or equal.

2.2 SEED AND SOD FOR EROSION CONTROL:

2.2.1 For Temporary Control Use annual or perennial ryegrass.

2.2.2 For Permanent Control See Section "Seeding."

2.3 HAY BALES FOR EROSION CONTROL:

Rectangular shaped bales of straw or straw, weighing at least 40 lbs per bale, free from primary noxious weed seeds and rough or woody materials.

2.4 SILT FENCES:

"Envirofence" by Mirafi, Inc. or an approved equal.

PART 3 - EXECUTION

3.1 STRAW MULCHING:

3.1.1 Install straw mulch immediately after each area has been properly prepared. When permanent seed or seed for temporary erosion control is shown prior to placing the mulch, place mulch on seeded areas within 24 hours after seeding. Engineer may authorize the blowing of chopped mulch provided that 95% of the mulch fibers will be 6" or more in length and that it can be applied in such a manner that there will be a minimum amount of matting that would retard the growth of plants. Straw mulch should cover the ground enough to shade it, but the mulch should not be so thick that a person standing cannot see the ground through the mulch. Remove matted mulch or branches.

3.1.2 Apply a system of pegs and strings, a chemical stabilizer, or temporary type netting to the mulch, where mild winds may blow the mulch, or when ground slopes exceed 15%, or when otherwise required to maintain the mulch firmly in place. Unless otherwise directed, remove the strings and netting prior to the acceptance of the Work.

3.1.3 Apply temporary type netting over the mulch and take whatever measures are necessary to maintain the mulch firmly in place, where high winds exist, or heavy rainstorms are likely, or where ground surfaces are steep, or where other conditions require.

3.1.4 The use of permanent type netting is not permitted without the prior approval of Engineer, unless otherwise specified.

3.2 HAY BALES AND SILT FENCES:

3.2.1 Provide straw bales or silt fences, as required, for the temporary control of erosion and to stop silt and sediment from reaching surface waters, adjacent properties, or entering catch basins, or damaging the Work.

3.2.2 Stake the straw bales as shown in the details to hold them firmly in place. Use a sufficient number of bales to accommodate runoff without causing any flooding and to adequately store any silt, sediment and debris reaching them (minimum of 1 every 50 feet).

3.2.3 Erect silt fences and bury bottom edge in accordance with the manufacturer's recommended installation instructions. Provide a sufficient length of fence to accommodate runoff without causing any flooding and to adequately store any silt, sediment, and debris reaching it.

3.2.4 Leave straw bales and silt fences in place until permanent erosion control measures have stopped all erosion and siltation, then remove and dispose of properly.

3.3 MAINTENANCE

If any temporary erosion and sediment control measures are disturbed, repair them immediately. Check erosion control devices weekly and after any heavy rain storms.

If seed is washed out before germination, repair any damage, refertilize, and reseed.

Maintain mulched and matted areas, silt stops, and other temporary control measures until the permanent control measures are established and no further erosion is likely.

END OF SECTION

SECTION 02480

SEEDING

1. GENERAL

1.1 RELATED DOCUMENTS

The general provisions of the Contract, including General and Supplementary Conditions and General Requirements (if any), apply to the work specified in this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Earthwork: Section 02200

B. Erosion Control: Section 02270

1.3 DESCRIPTION OF WORK

Work specified in this section shall consist of furnishing all labor, materials, and equipment to perform seeding work in conformity with the contract drawings and as specified herein. Excavation, filling, and grading required to establish elevations shown on the Drawings are not specified in this Section. Refer to Section 02200, Earthwork.

1.4 QUALITY ASSURANCE

Subcontract the seeding work to a single firm specializing in landscape work.

1.4.1 Source Quality Control:

1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulations applicable to landscape materials.

2. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agricultural Chemists, wherever applicable or as further specified.

3. Grass Seed: All seed shall be certified as to mixture, germination, and purity, as being in conformity with the following requirements:

    a. Each variety of seed shall have a percentage of germination of not less than 80, a percentage of purity of not less than 85, and shall have not more than one percent of weed content.

    b. All seed shall be from the same or previous year's crop unless recent tests by an approved testing agency demonstrates that older seed meets the above requirements.

4. Inspection: The Owner's Representative reserves the right to inspect any plant materials either at the place of growth or at the site before planting, for compliance with requirements for name, variety, size and quality.

1.5 SUBMITTALS

1.5.1 Certification: For information only, submit 2 copies of certificates of inspection as required by governmental authorities, and manufacturer's or vendors analysis for soil amendments and fertilizer materials. Submit other data substantiating that materials comply with specified requirements.

Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING:

1.6.1 Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at the site.

1.7 JOB CONDITIONS

Contractor must examine the subgrade, verify the elevations, observe the conditions under which work is to be performed and notify the Owner's Representative of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

It shall be the Contractor's responsibility to restore to the line, grade, and surface of all eroded areas with approved material and to keep topsoiled areas in acceptable condition until turf is established and accepted by the Owner's Representative.

Proceed with and complete the seeding work as rapidly as portions of the site become available, working within the required seasonal limitations.

1.7.1 Seeding Seasons: Unless variance is requested in writing and approved by the Owner's Representative, seeding shall be done within the following dates:

Permanent Seeding:	May 1 – August 15
Temporary Seeding:	August 15 – December 30

2. PRODUCTS

2.1 VEGETATIVE SOIL (TOPSOIL)

Vegetative soil shall be loam, sandy loam, silt loam, sandy clay loam, silty clay loam, clay loam or loamy sand. Vegetative layer shall be fertile, friable soil free of roots stumps, stones larger than 3 inches in diameter, live plants, noxious weeds, and foreign matter. It shall contain more than of 1.5% organic matter by weight and should have a pH of above 3.6 before liming, and should have less than 500 parts per million of soluble salts.

An agronomic study should be performed on all vegetative soil sources planned use on the site. Agronomic testing should be performed by the North Carolina Department of Agriculture soil testing laboratory or by commercial laboratories qualified to perform agronomic testing.

2.2 SOIL AMENDMENTS:

1. Lime: Natural limestone containing not less than 90% of total carbonates, ground so that not less than 100% passes a 10-mesh sieve, not less than 90% passes a 20 mesh sieve, and not less than 50% passes a 100 mesh sieve.

2. Fertilizer: Fertilizer shall be a commercial type with 50 percent of the elements derived from organic sources and shall conform to the recommendations of the agronomic testing.

2.3 GRASS MATERIAL:

2.3.1 Grass Seed: Provide fresh, clean, new-crop seed complying with the tolerance for purity and germination established by the Official Seed Analysts of North America. Provide seed of the grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, as specified.

The seed mixtures shall consist of seeds proportioned by weight as follows:

Permanent Seeding		Temporary Seeding	
Tall Fescue	80 lbs/acre	Rye	40 lbs/acre
Sericea lespedeza	20 lbs/acre		
Korean lespedeza	10 lbs/acre		
	100 lbs/acre		

2.4 MISCELLANEOUS LANDSCAPE MATERIALS:

2.4.1 Mulch for Seeded Areas:

1. Hay or straw mulch shall consist of long fibered hay or straw, reasonably free from noxious weeds and other undesirable material. No material shall be used which is too wet, decayed, or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings or other short fibered material shall be used unless directed.

2. Cellulose fiber mulch shall consist of natural wood, recycled paper or humus cellulose fiber containing no materials which will inhibit seed germination or plant growth. Sufficient non-toxic water soluble green dye shall be added to provide a definite color contrast to the ground surface to aid in even distribution. Cellulose fiber mulch shall be supplied in moisture resistant, sealed bags marked with the manufacturer's name, the air dry weight, and composition of the contents.

2.4.2 Mulch Binder: Material for mulch tackifier shall be a non-asphaltic base product, such as Hydro Glass Corporation Hydrotack or an Owner's Representative approved equivalent.

3. EXECUTION

3.1 SEEDING:

A. Locations: All areas disturbed as a result of construction shall require seeding and mulching.

B. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.

C. Rates of Application: Rates of application for limestone, fertilizer, and grass seed shall be in accordance with the Construction Drawings.

D. The hydraulic spray method shall be used for seeding all areas unless alternative methods are approved by the Owner's Representative.

E. Application Procedure:

1. Hydraulic Spray Method: The hydraulic spray method of sowing seed shall be done with an approved machine operated by a competent crew. Seed and fertilizing materials shall be mixed with water in the tank of the machine and kept thoroughly agitated so the materials are uniformly mixed and suspended in the water at all times during operation. The spraying equipment must be designed and operated to distribute seed and fertilizing materials evenly and uniformly on the designated areas at the required rates. If the Owner's Representative finds the application uneven or otherwise unsatisfactory, he may require the hydraulic spray method to be abandoned and the balance of the work done as specified under another method.

F. Mulching:

1. Cellulose fiber mulch shall be applied as a waterborne slurry. The cellulose fiber and water shall be thoroughly mixed and sprayed on the area to be covered so as to form a uniform mat of mulch at a rate that completely covers the ground.

   Cellulose fiber mulch may be mixed with the proper quantities of seed, fertilizer, and agricultural limestone as required, or may be applied separately the next day after seeding.

2. Hay or straw mulch shall be spread evenly and uniformly over any designated areas or as directed by the Owner's Representative in the field so to avoid damage to seeded areas. Unless otherwise directed, mulch shall be applied at the rate of 2 tons (approximately 90-100 bales) per acre. Too heavy application of mulch shall be avoided. Lumps and thick mulch material shall be thinned.

   Unless otherwise authorized, the mulch shall be anchored in place by uniformly applying an acceptable mulch binder. Application of a concentrated stream of mulch binder will not be allowed. Other methods of anchoring mulch such as mulch netting shall be used as approved by the Owner's Representative.

3. Areas which cannot be seeded within the growing season shall be temporary seeded and mulched to provide protection to the soil surface. An organic mulch other than wood fiber alone shall be used along with a mulch netting. The areas

will be reseeded with permanent seed as soon as seeding dates and weather conditions permit.

G. Erosion Control Blanket:

1. Erosion Control Blanket shall be placed at locations indicated on Contract Drawings. The anchoring of the blanket shall be as indicated on the Contract Drawings and as recommended by the manufacturer. All blankets shall be placed after seeding.

3.2 MAINTENANCE AND ACCEPTANCE:

3.2.1 Seeded Areas:

1. Maintain seeded areas by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading and replanting as required to establish a smooth, acceptable grass growth, free of eroded or bare areas.

2. Seeding, March 1 to September 15, Inclusive: The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs and barriers and by repairing damaged areas as directed. Damaged areas and areas which do not produce a satisfactory stand of grass shall be repaired to re-establish the condition and grade of the area prior to the original seeding and then refertilized, reseeded and remulched as specified to produce satisfactory results.

   Areas fertilized and seeded by the hydraulic method will be accepted only upon attainment of a reasonable thick uniform stand of not less than 90 percent coverage of permanent grasses, free from sizable thin or bare spots.

3. Seeding, September 16 to February 28, Inclusive: The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs or barriers and by repairing damaged areas as directed. Damaged areas shall be repaired by re-establishing the grade of the area prior to damage and by reapplying mulch. Refertilizing and reseeding will not be required during this period. Necessary maintenance or repairs will not be paid for but shall be considered incidental to the Contract. Areas fertilized, seeded and mulched between September 16 and February 31 will be accepted only upon attainment of a reasonably thick uniform stand of not less than 90 percent coverage of permanent grasses, free from sizable thin or bare spots.

4. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorously growing condition for two cuttings.

5. Immediately reseed areas which show bare spots.

3.3 RESTORATION

A. Restore improvements damaged by or removed by this work to original condition, as acceptable to Owners or other parties or authorities having jurisdiction including but not limited to fences, curbs, signs, trees, shrubs, vegetation, poles, posts.

END OF SECTION

SECTION 02730

PIPING SYSTEMS

1. GENERAL

1.1 RELATED DOCUMENTS:

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK:

1.2.1 Extent of leachate system work is indicated on drawings and schedules, and by requirements of this section including excavation and backfill required for leachate system.

1.3 QUALITY ASSURANCE:

1.3.1 Manufacturer's Qualifications: Firms regularly engaged in manufacture of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 SUBMITTALS:

1.4.1 Product Data: Submit manufacturer's technical product data and installation instructions for leachate system materials and products.

1.4.2 Record Drawings: At project closeout, submit record drawings of installed piping and products, including stationing and inverts as requested by the Owner's Representative, and in accordance with requirements of Division 1.

1.4.3 Maintenance Data: Submit maintenance data and parts lists of system materials and products. Include this data, product data, and record drawings in maintenance manual; in accordance with requirements of Division 1.

2. PRODUCTS

2.1 PIPES AND PIPE FITTINGS:

2.1.1 General: Provide pipes of one of the following materials, of weight/class indicated. Provide pipe fittings, cleanouts and all accessories of same material and weight/class as pipes, with joining method as indicated on Drawings.

2.1.2 High Density Polyethylene Pipe (HDPE): ASTM D1248,

3" pump discharge house – VNBR
4" force main – SDR 11
6" leachate collection – SDR 11
12" leachate collection/transport – SDR 11
12" underdrain – SDR 11
15" culvert – SDR 17

24" pump carrier pipe – SDR 11
36" pump carrier pipe – SDR 11

Available Manufacturers: Subject to compliance with requirements, manufacturers offering HDPE pipe which may be incorporated in the work include, but are not limited to, the following:

Manufacturers: Subject to compliance with requirements, provide HDPE pipe of one of the following:

Fifepipe, supplier of Driscopipe;
M.L. Sheldon Plastics Corporation; Plastic Pipeline Division;
Plexco; Division of Amsted Industries;
or approved equal

2.2 MANHOLES AND CATCH BASINS:

2.2.1 General: Provide precast reinforced concrete structures as indicated, and complying with ASTM C 478.

2.2.2 Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated.

2.2.3 Base: Precast concrete, with base riser section and separate base slab, or base riser section with integral floor, as indicated.

2.2.4 Steps: Ductile-iron or aluminum, integrally cast into manhole sidewalls.

2.2.5 Frame and Cover: Ductile-iron, heavy-duty as indicated on Drawings.

2.2.6 Pipe Connectors: Resilient, complying with ASTM C 923.

2.2.7 Access Risers: Precast concrete eccentric cone, with steps at 12" o.c., as indicated.

3. EXECUTION

3.1 INSTALLATION OF PIPE AND FITTINGS:

3.1.1 General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

3.1.2 Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.

3.1.3 Lay piping beginning at low point of system, true to grades and alignment indicated, with unbroken continuity of invert.

3.1.4 Place bell ends or groove ends of piping facing upstream.

3.1.5 Install gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements.

3.1.6 HDPE Pipe: Install pipe using manufacturer's recommended method unless otherwise indicated.

3.1.7 Cleaning Pipe: Clear interior of piping of dirt and other superfluous material as work progresses. Maintain swab or drag in line and pull past each joint as it is completed.

In large, accessible piping, brushes and brooms may be used for cleaning.

Place plugs in ends of uncompleted conduit at end of day or whenever work stops.

Flush lines between manholes if required to remove collected debris.

3.1.8 Joint Adapters: Make joints between different types of pipe with standard manufactured adapters and fittings intended for that purpose.

3.1.9 Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.

Make inspections after lines between manholes, or manhole locations, have been installed and approximately 2-ft of backfill is in place, and again at completion of project.

If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects, and reinspect.

3.2 INSTALLATION OF MANHOLES

3.2.1 General: Place precast concrete sections as indicated. Where manholes occur in roadways, set tops of frames and covers flush with finish surface. Elsewhere, set tops 3" above finish surface, unless otherwise indicated.

3.2.2 Install in accordance with ASTM C 891.

3.2.3 Provide rubber joint gasket complying with ASTM C443 at joints of sections.

3.2.4 Apply bituminous mastic coating at joints of sections.

3.3 BACKFILLING:

3.3.1 General: Conduct backfilling operations of open-cut trenches closely following laying, jointing, and bedding or pipe, and after initial inspection and testing are completed.

3.4 FIELD QUALITY CONTROL:

3.4.1 Leakage and Testing: After the completed solid pipeline has been installed, the trench has been compacted to specification requirements, and manhole or joints showing noticeable streams or jets have been repaired and/or replaced the Contractor shall perform all exfiltration tests. The Contractor shall be responsible for furnishing all labor, materials and equipment so that such tests can be accomplished at the times and locations the Engineer deems necessary. The rate of exfiltration shall not exceed 200 gallons per inch of pipe diameter per mile of pipe per day.

THE ATTENTION OF THE CONTRACTOR IS DIRECTED TO THE STRICT REQUIREMENTS RELATIVE TO MAXIMUM RATES OF EXFILTRATION AND TO THE IMPORTANCE OF THESE SPECIFICATIONS RELATIVE TO TIGHT JOINTS REQUIRED. SEWERS NOT MEETING THE ABOVE REQUIREMENTS SHALL BE REPAIRED AS NECESSARY AT THE CONTRACTOR'S EXPENSE.

3.4.2 Exfiltration Tests:

3.4.2.1 Liquid Test:

Water tests shall be performed by filling the pipe with water to a point four feet above the top of the pipe at the upper end and measuring the water loss during a one-hour period.

3.4.2.2 Air Test:

For making low-pressure air tests, the Contractor shall use equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. The equipment shall be provided with an air regulator valve or air safety valve so set that the internal air pressure in the pipeline cannot exceed eight psig.

The leakage test using low-pressure air shall be made on each manhole-to-manhole section of pipeline.

Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested. Pneumatic plugs shall resist internal test pressure without requiring external bracing or blocking.

All air used shall pass through a single control panel.

Low-pressure air shall be introduced into the sealed line until the internal air pressure reaches four psig greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe at the time of the test. However, the internal air pressure in the sealed line shall not be allowed to exceed eight psig.

At least two minutes shall be allowed for the air pressure to stabilize in the section under test. After the stabilization period, the low-pressure air supply hose shall be quickly disconnected from the control panel. The time required in minutes for the pressure in the section under test to decrease from 3.5 to 3.0 psig (greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe) shall not be less than that shown in the following table:

Pipe diameter in inches	Minutes
6	4.0
8	5.0
10	6.5
12	7.5
14	9.0
15	9.5
18	11.5

Note: For larger diameter pipe, minimum time = 7.7 x dia. (ft).

When the sewer section to be tested contains more than one size of pipe, the minimum allowable time shall be based on the largest diameter pipe in the section.

END OF SECTION

SECTION 02731

GEOTEXTILES

1. GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of section.

1.2 DESCRIPTION OF WORK

Extent of geotextile work is indicated on drawings and schedules, and by requirements of this section.

1.3 QUALIFICATIONS AND WARRANTIES

1.3.1 Manufacturer's Qualifications: Firms regularly engaged in manufacture of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.3.2 Installer's Qualifications: Firms regularly engaged in installation of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.4 QUALITY CONTROL DOCUMENTATION

1.4.1 Product Data: Prior to the installation of any geotextile, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.

2. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.

3. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control testes. At a minimum, results shall be given for:

    a. Mass per unit area
    b. Grab strength
    c. Trapezoidal tear strength
    d. Burst strength
    e. Puncture strength
    f. Apparent Opening Size

Quality control tests shall be performed in accordance with the test methods specified in the project specifications for at least every 100,000 ft^2 of geotextile produced.

The Manufacturer shall identify all rolls of geotextiles with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

1.4.2 Product Review: The Owner's Representative shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum average roll properties meet the project specifications.

2. PRODUCTS

2.1 GEOTEXTILE:

2.1.1 General: Provide geotextiles as indicated on Drawings.

2.1.2 Non-Woven Geotextile: 16 oz/sy - The geotextile between the 60-mil textured HDPE geomembrane and the #57 stone shall be Nicolon S1600, or meet the minimum requirements listed below:

PROPERTY	TEST PROCEDURE	MINIMUM VALUE(1)
Weight	ASTM D 5261	16 oz/sy
Grab Strength	ASTM D 4632	380 lbs
Tear Strength	ASTM D 4533	145 lbs
Mullen Burst	ASTM D 3786	750 psi
Puncture Resistance	ASTM D 4833	240 lbs
AOS	ASTM D 4751	60 - 100 U.S Sieve

(1) Values in weaker principle direction. All minimum values represent minimum average roll values (i.e. test results from any sampled roll in a lot, tested in accordance with ASTM D 4759-88 shall meet or exceed the minimum values listed.)

3.0 QUALITY ASSURANCE

3.1 GEOTEXTILE DEPLOYMENT

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Owner's Representative shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager.

The Installer shall handle all geotextiles in such a manner as to assure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.

2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.

4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

6. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to assure that no potentially harmful foreign objects, such as needles, are present.

3.2 SEAMING PROCEDURES

On slopes steeper than 10(horizontal):1(vertical), all geotextiles shall be continuously sewn (i.e. spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches (75 mm) prior to seaming. In general, no horizontal seams shall be allowed on sideslopes (i.e. seams shall be along, not across, the slope), except as part of a patch.

On bottoms and slopes shallower than 10 (horizontal):1 (vertical), geotextiles shall be seamed as indicated above (preferred), or thermally bonded with the written approval of the Owner's Representative.

The Installer shall pay particular attention at seams to assure that no earth cover material could be inadvertently inserted beneath the geotextile.

Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile.

3.3 DEFECTS AND REPAIRS

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

On slopes, a patch made from the same geotextile shall be sewn into place in accordance with the project specifications. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

The Owner's Representative shall observe any repair and report any noncompliance with the above requirements in writing to the Project Manager.

3.4 GEOTEXTILE PROTECTION

All soil materials located on top of a geotextile shall be deployed in such a manner as to assure:

1. The geotextile and underlying lining materials are not damaged.
2. Minimal slippage of the geotextile on underlying layers occurs.
3. No excess tensile stresses occur in the geotextile.

Unless otherwise specified by the Owner's Representative, all lifts of soil material shall be in conformance with the guidelines given in Section 02200 and 02771-4.7.1.

END OF SECTION

SECTION 02732

LEACHATE PUMPING STATION

1. GENERAL

1.1 RELATED DOCUMENTS

The general provisions of the contract, including General and Supplementary Conditions and General Requirements (if any) apply to the work specified in this Section.

1.2 DESCRIPTION

The work of this Section includes furnishing all labor, materials, tools and equipment necessary to furnish and install one package duplex leachate pumping station as specified herein and as shown on the Drawings.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Earthwork: Section 02200

B. Erosion Control: Section 02270

C. Pipe Installation: Section 02730

1.4 DESIGN CRITERIA

It is the intention that this specification shall cover a complete duplex leachate collection electrical pump/level monitoring control system as hereinafter described. All necessary appurtenances which might normally be considered a part of the complete electrical system shall be included for this installation. All of the automatic control equipment is to be supplied by one manufacturer. It shall be factory assembled, wired and tested and covered by complete electrical drawings and instructions.

The control logic function and all other control components used in each control system shall be performed by solid-state components, which shall be standard catalog items of the system manufacturer, with proven field performance. The system manufacturer for system expansion or renewal parts purposes shall stock at least one module of each type used in each system. The modules shall be of a compatible, integrated control family with a full range of control/protective/alternation/telemetry capabilities and associated housings, enclosure system and appurtenances to perform a variety of functions as required by this project and foreseeable expansion. It is the intention of this specification to disallow non-standard, "one of a kind", experimental, unproven combinations of equipment.

The level/pressure sensing equipment shall be standard products manufactured by the control supplier in order to assure proper system interconnections and reliable, long-term operation.

Equipment shall be designed and constructed in accordance with the best practice of the industry and shall be installed in accordance with the manufacturer's recommendations and the Contract Documents. The specifications call attention to certain features but do not purport to cover all details entering into the construction of the equipment

1.5 PRODUCT HANDLING

All materials and equipment shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability or appearance. The equipment shall be stored in a clean, dry location free from construction dust, precipitation and excess moisture. If stored for more than two weeks, the equipment shall receive all maintenance considerations required by the manufacturer for proper storage of the equipment.

1.6 GUARANTEE

All equipment shall be guaranteed against defects in material and workmanship for a period of one year from date of Owner's final inspection and acceptance to the effect that any defective equipment shall be repaired or replaced without cost or obligation to the Owner

1.6 SUBMITTALS

Shop drawings, brochures and samples shall be submitted for all items to be furnished in accordance with the provisions of the General Conditions. Submittals shall include at least the following:

A. Shop Drawings, including all equipment and components.

B. Brochures and/or catalog cuts.

C. Performance curves.

D. Complete master wiring diagrams and elementary or control schematics, including required coordination with other electrical control devices operating in conjunction with the pumping station. Due to the complexity of the control functions, it is imperative the above drawings be clear and carefully prepared to facilitate interconnections with other equipment. Standard preprinted sheets or drawings simply marked to indicate applicability to this contract will not be acceptable.

1.7 Operation and Maintenance Manual of the pumping station including equipment and components.

1.8 Attention is directed to Section 1E of these specifications wherein certain Special Mechanical and Electrical Equipment Requirements are specified. These requirements are a part of this Section and relate to:

A. Substitution of equipment.

B. Special requirements for pumps.

C. Electric motor and power factor correction capacitor requirements.

D. Noise specification for machinery and equipment.

E. Operation and maintenance manuals.

F. Manufacturer's services.

G. Spare parts.

H. Special tools.

1.09 DESIGN CONDITIONS: The system shall be complete with submersible pumps, motors, motor controls, electrical wiring and conduits, piping and valves, liquid level sensors, lift out assembly, and other necessary appurtenances. The systems are to be suitable for installation into a 24" diameter SDR 11 HDPE carrier pipe installed on the sideslope of the landfill and a 36" diameter carrier pipe with a 26.5 degree bend at the tow of the slope.

The operating condition for each of the duplex leachate pumps shall be 280 gpm at 180 feet TDH with 20 HP, 3,450 rpm, 460 Volt, 3 phase motors. Pumps shall be Leachator Model LPS300MSTG3X200-05. The motor shall not be overloaded at any point on the pump curve above the static head.

PART 2 - PRODUCTS

2.01 PUMPS AND CARRIAGE SYSTEM:

A. Pumps: Pumps shall be centrifugal, submersible design, and suitable to handle primary landfill leachate. The pumps will be coupled to a submersible motor that is non-overloading throughout the operating curve of the pump. Contractor shall supply one additional leachate pump for BRPP stores.

Pump design shall include the following features:

1. Integral check valve of 300-series stainless steel.
2. All series 300 stainless steel construction shall include impellers, bowls, guide vanes, and inlet screen.
3. Each impeller shall have a Teflon seal ring to reduce hydraulic losses.

4. All shaft bearings shall be Teflon.
5. A stainless steel flow inducer shall be provided at the pump inlet.

The motor shall be squirrel-cage induction-type motor for submersible application and conform to NEMA standards. All materials coming in contact with leachate shall be 300-series stainless steel or viton. The motor shall not require the use of oil or grease for lubrication. The motor shall have a Kingsbury type thrust bearing capable of handling the maximum thrust load of the pump. Motor pressure equalizing diaphragm assembly shall be viton. A properly sized stainless steel encased power cable suitable for leachate service shall be provided and secured to the discharge hose to prevent cables from becoming wrapped around hoses. Three leachate pumps are to be provided. The additional pump will be handed over to the Owner.

B. Carriage System: The pumps shall be mounted in a stainless steel carriage as manufactured by Myles Industries. The carriage shall be designed for sideslope riser leachate applications. All wheels of the carriage must remain in contact with the inside diameter of the riser pipe to assure a straight path of travel of the pump to the base of the riser pipe and shall prevent the pump from twisting movement due to the starting torque of the motor. The carriage must easily remove the pump in the field should the pump require service. The pump and carriage shall be capable of entry into an 24" SDR 11 (minimum size) riser pipe and must be able to travel over welding beads (0.25") and perforations which are common to leachate collection riser pipe fabrication.The pump must be able to pass through a 36" SDR 11 HDPE 26.5 degree elbow at the toe of the slope The wheels shall be constructed of non-corrosive material with self-lubricating qualities.

A non-corrosive nylon safety/retrieval cable with required fittings shall be provided for each pump.

C. Discharge Hose: Discharge hose for the two leachate pumps shall be 3" thermoplastic vinyl nitrile (VNBR) flexible hose having a rated working pressure of 200 to 300 psi and a temperature range of –20 to +180 degrees Fahrenheit. Hose shall be suitable for leachate service and provided in a length commensurate with the dimensional requirements of the application by field fit by installing contractor. All hose fittings shall be 300-series stainless steel. Hose fittings shall be suitable for the application. All hose bands shall be hi-torque 300-series stainless construction.

A riser side exit disconnect fitting shall be provided, that will allow quick connection/disconnection of the pump discharge hose from the riser exit, and allow the pump to be removed without interference of the stationary fittings. The exit arrangement shall thread through the riser pipe as to provide gas-tight connection. All fittings shall be 300-series stainless steel construction. The exit connections will penetrate the riser wall approximately 6" from the top of the riser pipe by means of 300-series stainless steel, male threaded exit nipple.

2.02 CONTROL PANEL:

A. General: The pump manufacturer shall provide a completely self-contained Duplex Motor Control Panel and a Simplex Motor Control Panel. The control panel shall provide short circuit and overload protection for each pump. On the duplex system an automatic alternator with manual override switch shall be provided to manually select the lead pump duty between the two pumps on successive cycles. The control panel shall conform to National Electrical Manufacturer's Association (NEMA), Joint Industry Council (JIC), and National Electrical Code (NEC) specifications, and shall be Underwriters' Laboratories (UL) listed. The panel shall be factory wired and tested.

B. Enclosure: The motor controls and circuit breakers shall be housed in a NEMA 4 enclosure. The enclosure shall be constructed of 14 gauge steel with continuous seam welds. The enclosure shall be provided with tamperproof double door system consisting of a bland outer door and a second inner door on which all operating controls are located. The controls shall incorporate a "dead front" type of installation. Finish shall be baked enamel; white inside, gray outside. A padlock hasp shall be provided. The control enclosure shall be located just outside of the pump station building.

C. Circuit Breakers: Three-pole main and motor circuit breaker sized to NEC requirements shall be provided. Circuit breakers shall be door operator interlocked to the enclosure so that the door cannot be opened with the circuit breakers energized. The operator shall be provided with an interlock defeat device which requires a hand tool to operate and shall be lockable in the "off" position. Circuit breakers shall be thermal magnetic molded case type. The pump motors shall have an interrupting rating of 18,000 amperes symmetrical. Devices for operation on 120 Volts shall have a 10,000 ampere rating.

D. Starters: Each pump motor shall be provided with a NEMA rated across the line motor starter in combination with a circuit breaker. The starters shall employ gravity drop-out armatures without bell cranks or other mechanical linkages which are subject to failure. Starter coils and contacts shall be easily replaceable with standard hand tools and without removing the starter from the panel. Starters shall be equipped with one ambient compensated quick-trip button to facilitate testing of the overload mechanism. Magnetic motor starters shall be full voltage, non-reversing type. Starters shall be furnished with a thermal overload protector, reset pushbutton, and auxiliary contacts as required. A phase failure relay shall be furnished for each pump motor and shall shut off the pump motor on a phase failure condition.

E. Alternator: In the duplex system an electromechanical alternator shall be provided to alternate the lead pump duty between the two pumps on successive cycles. The alternator shall be a single device; alternator circuits comprised of two or more relays shall not be considered equal. A selector switch shall be provided to bypass the alternator and select either pump as the lead pump. The selector switch shall be as specified.

F. Selector Switch: A hand-off-automatic selector switch shall be provided for each pump. Selector switches shall be of oil-tight construction. Toggle switch types shall not be considered equal. Selector switch contacts shall be heavy duty, double-break, silver.

G. Relays: General purpose relays shall be NEMA 300 Volt open frame industrial control type. Intrinsically safe relays shall be furnished for interconnection of each mercury float switch with the control panel.

H. Terminal Blocks: Terminal blocks shall be provided for all external connections to the control panel and for all connections between the component mounting plate and enclosure mounted components to allow for easy removal of the component mounting plate if required for service. Terminal blocks shall consist of individual snap together contact sections mounted on a common mounting channel. Terminal block sections shall have tubular screw contacts mounted in a nylon housing to resist breakage; phenolic or other rigid, brittle materials shall not be considered equal. Plain screw contacts requiring lugs to be installed on wires shall not be considered equal.

I. Control Circuit: The control circuit of the Duplex Motor Control Panel shall operate at 120 VAC and be fuse protected. Tripping the circuit breaker of either pump shall not disable the control circuit.

J. Elapsed Time Meters: Provide a non-reset meter for each pump to indicate elapsed time of operation of the pump form 0 to 99,999.9 hours.

K. Indicating Lights: In addition to the aforementioned indicating lights, a green "pump running" light shall be provided for each pump. All indicating lights shall be transformer type, oil-tight, press-to-test with colored lens and legend plate.

L. Alarm Circuit: An alarm circuit relay and reset pushbutton shall be furnished as a part of the control panel. The alarm relay shall be activated by the high water level signal. Provide one Type C dry contact for common remote indication of alarm condition. A flasher circuit shall be provided for connection to an alarm light and audible alarm to be located two feet above the top of the pump station.

M. Nameplates: Nameplates shall be furnished and installed for all switches, control stations, motor starters, terminal cabinets, indicating lights, etc. to designate the equipment controlled and function. Nameplates shall be black and white laminated phenolic material having engraved letters approximately 1/2 inch high, extending through the black face into the white layer. Nameplates shall be attached to panels by self-tapping screws or rivets and shall be stainless steel. A special nameplate shall be attached to the pump housing which shall contain identification of housing and bearing numbers.

N. Control panel shall be provided with a 115 Volt, single phase, 60 Hertz utility outlet receptacle.

O. The control panel shall be equipped with an emergency generator hook-up.

P. Lighting: Lighting will be provided at the control panel such that all controls and gauges are clearly visible.

2.03 PUMP CONTROLS:

A. Pump Operation: The pump controls shall be located in the control panel and shall operate the pumps to maintain the liquid level between adjustable operating limits. Starting and stopping of each pump shall be accomplished by a transducer for start and stop levels. The automatic alternator shall alternate the pump sequence after each pump cycle. A means for manually bypassing the alternator and setting either of the pumps on automatic as the lead pump shall be provided. The pumps shall operate in parallel if the liquid level in the basin rises above the lag pump on level. Four transducers are to be supplied for the project. Three will be installed at the pumping station and one will be provided to the owner as a spare.

The pumps shall be controlled using a submersible transducer mounted to one of the pump carriages which will provide a 4-20 MA signal to the associated controller. This system will allow stop/lead/lag/high level operation with automatic pump alternation and digital display of the liquid level in 0.1" increments. The level control unit shall be able to provide digital read out in inches of water.

2.04 STATION WIRING:

A. The pumping station control panels shall be completely wired and tested at the factory. The wiring shall be in accordance with the National Electrical Code and as hereinafter specified.

B. All wiring shall be of annealed 98 percent conductivity, soft drawn copper. Wire insulation shall be either Type THWN or Type XHHW. Except for control and signal leads, no wire smaller than No. 12 AWG shall be used.

C. All wiring between the control panel and junction box shall be in watertight galvanized rigid steel conduit. Liquid-tight flexible metal conduits shall be used for sewage pump motor terminations. Where galvanized finish is removed for threading, a protective finish shall be applied.

2.05 FLOW METER:

A. The flow meters shall be a Krohne magnetic inductive flowmeters with a signal converter providing instantaneous and cumulative reading capability. The meters shall be sized for the flow rates specified.

B. A digital display shall be located in the pump station control panel.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. All materials and equipment shall be installed in a neat, workmanlike manner.

B. All wiring of the equipment shall be in accordance with BRPP standards.

C. Package Pumping Unit: Installation of the pumping station shall be done in accordance with written instructions provided by the manufacturer and as approved.

3.02 PAINTING: Shop painting and the surface preparation is a part of the work specified in this Section and shall be as specified in finish painting.

3.03 CLEAN-UP: Prior to start-up and field testing, all foreign matter shall be removed from the pump chamber piping and pumps. Spillage of lubricants used in servicing the system shall be cleaned from all equipment and concrete surfaces.

3.04 MANUFACTURER'S SERVICES AND SUPERVISION: A minimum of two days shall be provided for installation and startup. The services of a factory trained, qualified representative shall be provided to inspect the completed installation, make all adjustment necessary to place the system in trouble-free operation and instruct the operating personnel in the proper care and operation of the equipment

3.05 MANUFACTURER'S TRAINING: A minimum of one day shall be provided for manufacturer's training.

3.06 LUBRICATION REQUIREMENTS: All lubricating oils required for the first year of operation shall be provided for each station.

3.07 FIELD TESTING: Each entire package pumping system shall be field tested as a system using clean fresh water prior to the acceptance of the station. The pumps shall be operated continuously at the design conditions for at least 15 minutes. All systems, controls, and sequences shall be operated and demonstrated as operating as approved. The Contractor shall perform all tests and shall be responsible for all necessary temporary connections, testing equipment and utilities and shall provide and dispose of all water used. A factory trained representative shall be present for the testing.

END OF SECTION

SECTION 02771

GEOMEMBRANE (HIGH DENSITY POLYETHYLENE (HDPE))

1. GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of section.

The requirements set forth by the Quality Assurance/Quality Control Plan shall apply to the work specified in this Section.

1.2 DESCRIPTION OF WORK

Extent of flexible membrane lining work is shown on drawings.

Refer to other Division-2 sections for earthwork related to lining work.

1.3 QUALITY ASSURANCE, QUALIFICATIONS, AND WARRANTIES

1.3.1 Manufacturer's Experience: The manufacturer supplying the membrane shall satisfactorily demonstrate previous experience by letter of certification. Certification shall indicate that the manufacturer has produced, and has in service in similar applications for a period of not less than two (2) years, at least fifteen (15) million sq ft of HDPE material meeting these Specifications.

1.3.2 Installer's Experience: The Installer proposing to install the lining shall satisfactorily demonstrate previous experience by letter of certification. Certification shall indicate the Installer's successful past installation of at least 5,000,000 sq ft of HDPE membrane lining.

Installation shall be performed under the direction of a single installation supervisor who shall remain on site and be in responsible charge throughout the liner installation, including subgrade acceptance, liner layout, seaming, testing and repairs, and all other activities contracted for with the Installer. The installation supervisor shall have supervised the installation of at least 2,000,000 sf of polyethylene geomembrane. Actual seaming shall be performed under the direction of a master seamer who may be the same person as the installation supervisor, and who has a minimum of 1,000,000 sf polyethylene geomembrane seaming experience using the same type of seaming apparatus as that specified in this project. The installation supervisor or master seamer must be on site whenever seaming is being performed. No seaming may be done by any individual with less than 500,000 sf of polyethylene geomembrane seaming experience.

1.3.3 Manufacturer's Guarantee: The manufacturer of the membrane liner shall enter into agreement with the Owner guaranteeing the membrane as follows:

> The manufacturer warrants the HDPE liner which is manufactured, sold as first quality, and installed with technical assistance and/or by an approved installation contractor to be (1) furnished free of manufacturing defects in workmanship or material for a period of one year from the time of delivery with the basis for judgment of defects being the applicable product specifications in effect at the time the order was placed unless modified by mutual written agreement; (2) shall not develop cracks/holes which go

completely through the membrane due to the effects of normal service for a period of twenty (20) years from the date of delivery. "Normal service" does not include physical damage caused by acts of God, casualty, or catastrophe such as (but not limited to) earthquakes, fire, explosion, floods, lightning, piercing hail, tornadoes, corrosive air pollution, mechanical abuse by machinery, equipment, people or animals, or excessive flexures, pressures or stress from any source other than faulty installation, and (3) immune to chemical attack and degradation by chemicals, specified in the manufacturer's literature, as compatible with, and as not having an adverse effect on the membrane; and (4) immune to chemicals tested by the manufacturer for the Owner.

Should defects or weathering degradation within the scope of the above warranty occur, the manufacturer shall refund to the purchaser-user the pro-rata part for the unexpired term of the warranty of the purchaser-user's original cost of such product, or will supply repair or replacement materials at the then-current price. In the event the manufacturer supplies repair or replacement materials, against the then- current price, the manufacturer will credit the lesser of (1) the pro-rata part of the original sales price of the material so repaired or replaced for the unelapsed period of the warranty, or (2) the pro-rata part of the then-current price of the material so repaired or replaced to the unelapsed period of the warranty. The warranty shall continue in effect on the repaired or replaced material for the unelapsed term of the original warranty. To enable the manufacturer's technical staff to properly determine the cause of any alleged defect and to take appropriate steps to effect timely corrective measures if such defect is within the warranty, any claim for alleged breach of warranty will be made and presented in writing to manufacturer and the installing Contractor within thirty (30) days after the alleged defect was first noticed.

1.4 QUALITY CONTROL DOCUMENTATION

1.4.1 Product Data: Prior to the installation of any geomembrane, the manufacturer or Installer shall provide the Owner's Representative with the following information:

1. Copies of the quality control certificates issued by the resin supplier which include resin supplier's name and production plant, brand name and number, and production date of the resin.

2. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geomembrane meets the specifications.

3. Reports on quality control tests conducted by the Manufacturer to verify that the geomembrane manufactured for the project meets the project specifications.

4. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.

5. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be given for:

    a. Density
    b. Carbon black content
    c. Carbon black dispersion
    d. Thickness

e. Tensile properties
f. Tear resistance

These quality control tests shall be performed in accordance with the test methods specified in the specifications, for every 40,000 ft^2 (4,000 m^2) of geomembrane produced.

The Manufacturer shall identify all rolls of geomembranes with the following:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Roll number
5. Roll dimensions

1.4.2 Product Review: The Owner's Representative shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum properties meet the specifications.

2. PRODUCTS

2.1 HIGH DENSITY POLYETHYLENE (HDPE) MEMBRANE

2.1.1 General: The materials supplied under these Specifications shall be first quality products designed and manufactured specifically for the purposes of this work, and which have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes.

2.1.2 Description of HDPE Material: The membrane shall be a High density polyethylene (HDPE) of 60-mils thickness, white in color, and textured, containing no additives, fillers or extenders. Carbon black 2 to 3 percent shall be added to the resin for ultraviolet resistance.

The lining material shall be manufactured a minimum of 20 feet seamless widths.

2.1.3 Physical Characteristics: The HDPE materials shall have the following physical characteristics:

Test	Test Designation	60-mil Requirement
Sheet thickness, textured (with smooth edges)	ASTM D 5994-96 para. 8.1.3	60-mils plus or minus 10 percent
Asperity height	GM 12	10-mil (min. average)
Specific gravity	ASTM D 1505	min. 0.940
Melt index	ASTM D 1238-95 Condition E	0.1 to 0.3g per 10 minutes
Tensile strength yield	ASTM D 6693	min. 126 lb per in. width
Tensile strength at break	ASTM D 6693	min. 90 lb per in. width
Elongation at yield	ASTM D 6693	min. 12 percent
Elongation at break	ASTM D 6693	min. 100 percent
Modulus of elasticity	ASTM D 638-96	min. 80,000 lb per sq in
Tear resistance	ASTM D 1004-94A	min. 42 lb per min.
Puncture resistance	ASTM D 4833	min. 90 lb
Resistance to soil burial	ASTM D 3083-76	10 percent max. change
Dimensional stability (each direction)	ASTM D 1204-94 212°F, 15 min.	3 percent max. change
Environmental stress crack	ASTM D 5397	300 hrs
Low temperature brittleness	ASTM D 746-95 Procedure B	minus 76°F
Carbon black content	ASTM D 1603-95	2 to 3 percent
Carbon black dispersion	ASTM D 5596	Categories 1 or 2
Shear Strength Shear Peel	ASTM D 6392[1,2]	.9*PM[3] .6*PM[3] Fusion .5*PM[3] Extrusion

Notes

1. For shear tests, the sheet shall yield before failure of the seam. For peel adhesion, seam separation shall not extend more than 25% into the seam. For either test, testing shall be discontinued when the sample has visually yielded.
2. All coupons tested for shear and peel shall be in a free condition (not 90 ° or 180 °). Acceptable locus of break codes for the specimen rupture mode shall be as listed in Section 3.08. D of this specification.
3. The results for 4 of the 5 individual coupon shear strength values must be greater than 90 percent of the parent material strength, with none less than 70 percent of the parent material strength. For peel strength values, 4 of 5 coupons tested must be greater than 60 percent of parent material strength or 70 percent of the specified value, whichever is greater, with none less than 50 percent of parent material strength. The coupons shall have an acceptable mode or rupture for both shear strength and peel strength. Parent material strength shall be determined by sampling actual sheets adjacent to the destructive test location in the same direction the seam is tested (using the lower value of the two sheets) or by using conformance testing results or manufacturer's roll certification information, but not less than 126 ppi.

The geomembrane shall be produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter, and shall not have striations, pinholes or bubbles on the surface.

2.1.4 Factory Bonded Seam: Calendered HDPE sheeting may not be fabricated into large sections at the factory.

2.1.5 Extrusion Joining Resin: Resin for extrusion joining sheets shall be HDPE produced from the same material as the sheet resin. Physical properties shall be the same as those of the resin used in the manufacture of the HDPE liner. The resin shall be supplied in black and/or natural color. Natural resin shall be colored black through addition of 2.0 to 3.0 percent master batch colorant before use.

2.1.6 Documentation: Prior to delivery of the geomembrane to the job site, the Installer shall provide the Owner with a written certification that the product delivered was extruded from the specified resin. The manufacturer shall provide quality control certificates for each batch of resin and each shift's production of geomembrane, and shall follow the quality control testing program as described in Section 4.1. These quality control certificates shall be signed by responsible parties employed by the Manufacturer, and shall be supplied to the Owner. No geomembrane will be permitted to be delivered until the Owner has in his possession such certification.

2.1.7 Roll Identification: Each roll shall have permanently affixed both inside and outside the roll the following information: name of manufacturer; date of manufacture; resin batch code; thickness of the material; roll number; roll length; and roll width.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Pipe Boots, Vents, and Patches: All such devices shall be of the same material as the lining or a compatible approved equal.

2.2.2 Mechanical Fastenings: Mechanical fastenings shall be of the material, size, and type as detailed on the plans or approved shop drawings.

3. QUALITY ASSURANCE

3.1 CONFORMANCE TESTING

Upon delivery of the rolls of geomembrane, the Owner's Representative shall assure that conformance test samples are obtained for the geomembrane. These samples shall then be forwarded to the independent laboratory for testing to assure conformance to the specifications.

At a minimum the following conformance tests shall be conducted:

1. Density
2. Carbon black content
3. Carbon black dispersion
4. Thickness
5. Tensile characteristics

These conformance tests shall be performed in accordance with the test methods specified in section 2.1.3.

3.1.1 Sampling Procedures: The rolls to be sampled shall be selected by the Owner's Representative. Samples shall be taken across the entire width of the roll and shall not include the first 3 feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The Owner's Representative shall mark the machine direction on the samples with an arrow.

Unless otherwise specified, samples shall be taken at a rate of one per 50,000 ft^2 of geomembrane.

3.1.2 Test Results. All conformance test results shall be reviewed and accepted or rejected by the Owner's Representative prior to the deployment of the geomembrane.

The Owner's Representative shall examine all results from laboratory conformance testing and shall report any nonconformance to the Project Manager. The Owner's Representative shall be responsible for checking that all test results meet or exceed the property values listed in Section 2.1.3.

4. EXECUTION

4.1 SUBGRADE PREPARATION

4.1.1 Surface Preparation: The earthwork contractor shall be responsible for preparing the supporting soil for geomembrane placement. The Project Manager shall coordinate the work of the earthwork contractor and the Installer so that the requirements of the specification are met.

Before the geomembrane installation begins, the Owner's Representative shall verify that:

1. A qualified land survey has verified all lines and grades.
2. A qualified geotechnical engineer has verified that the supporting soil meets the density specified in the project specifications.
3. The surface to be lined has been rolled, compacted, or handworked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.
4. The surface of the supporting soil does not contain stones which may be damaging to the geomembrane.
5. There is no area excessively softened by high water content.
6. There is no area where the surface of the soil contains desiccation cracks with dimensions exceeding those allowed by the project specifications.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Owner's Representative prior to commencement of geomembrane deployment in the area under consideration. The Project Manager shall be given a copy of this certificate by the Owner's Representative.

After the supporting soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Owner's Representative any change in the supporting soil condition that may require repair work.

4.1.2 Anchor: The Owner's Representative shall verify that the geomembrane anchor has been constructed according to the design drawings and specifications.

4.2 GEOMEMBRANE DEPLOYMENT

4.2.1 Panel Nomenclature: A field panel is defined as a unit of geomembrane which is to be seamed in the field, i.e. a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the Owner's Representative to assure that each field panel is given an identification code (number or letter-number) consistent with the layout plan.

4.2.2 Panel Deployment Procedure: The Owner's Representative shall review the panel deployment progress of the Installer (keeping in mind issues relating to wind, rain, clay liner desiccation, and other site-specific conditions).

The Owner's Representative shall record the identification code, location, and date of installation of each field panel.

4.2.3 Deployment Weather Conditions: Geomembrane deployment shall not proceed at an ambient temperature below 32°F or above 104°F unless otherwise authorized, in writing, by the Owner's Representative. Geomembrane placement shall not be performed during any precipitation, in the presence of excessive moisture (e.g. fog, dew), in an area of ponded water, or in the presence of excessive winds. Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

4.2.4 Method of Deployment: Before the geomembrane is handled on site, the Owner's Representative shall verify that handling equipment to be used on the site is adequate and does not pose risk of damage to the geomembrane. During handling, the Owner's Representative shall observe and verify that the Installer's personnel handle the geomembrane with care.

The Owner's Representative shall verify the following:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.

2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement.

3. Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

4. All personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities which could damage the geomembrane.

5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.

6. The method used to place the panels minimized wrinkles (especially differential wrinkles between adjacent panels).

7. Adequate temporary loading and/or anchoring (e.g. sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind. In case of high winds, continuous loading, e.g. by sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels.

8. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

4.2.5 Damage and Defects: Upon delivery to the site, the Owner's Representative shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected.

4.3 FIELD SEAMING

4.3.1 Seam Layout: Before installation begins, the Installer must provide the Owner's Representative with a panel layout drawing, i.e. a drawing of the facility to be lined showing all expected seams. The Owner's Representative shall review the panel layout drawing and verify that it is consistent with accepted state-of-practice.

In general, seams should be oriented parallel to the line of maximum slope, i.e. oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet (1.5 m) from the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Owner's Representative.

4.3.2 Seaming Methods: Installer shall submit to the Owner prior to construction a list of the seaming equipment and testing equipment, including manufacturer and model number, that will be used on-site. Field seams shall be made by overlapping adjacent sheets a minimum of 3 in. and a maximum of 6 in. and using one of the following seaming techniques:

4.3.2.1 Hot Air/Hot Wedge: Hot air/hot wedge technique shall be made by either a nozzle which directs hot air between the sheets or a hot metal surface in contact between the sheets. Each seaming unit must include a thermometer giving the temperature of the machine at the nozzle or metal surface. The seaming unit shall maintain a recordable temperature determined by on-site conditions and shall not vary more than 50 deg.F above or below the recommended seaming temperature. The adjacent geomembrane sheet shall be overlapped 6-inches. The overlapped sheets are then pressed together by mechanical means. Seaming equipment that makes a split hot wedge seam will be the preferred method of seaming; single hot wedge seaming will be allowed only with the approval of the Owner.

4.3.2.2 Extrusion Bonding: Extrusion and fusion bonding will be limited to areas where hot wedge cannot be used, such as pipe boots, and to any necessary repairs. The use of extrusion and fusion bonding as the primary seaming method will be allowed only with the approval of the Owner. The adjacent sheets to be seamed shall be overlapped a minimum of 3 inches. The joining procedure shall consist of softening the liner material by heated air. The temperature of the air impinging on the sheet for this purpose shall range from 420 deg.F to 680 deg.F. The exact temperature used shall be determined by the installation supervisor. Directly following the application of heat, a one and one-half inch minimum width strip of the same high density polyethylene resin from which the sheet is made shall be extruded between the overlapped sheets. The temperature of the resin as it emerges from the extrusion die shall range from 428

deg.F to 536 deg.F. The overlapped sheets shall be firmly pressed together by mechanical means to form the extrusion joint.

4.3.2.3 Fusion Bonding: Extrusion and fusion bonding will be limited to areas where hot wedge cannot be used, such as pipe boots, and to any necessary repairs. The major seaming of the liner will be done with hot wedge. Fusion bonding shall be by means of a homogeneous overlap extrusion fusion process which provides continuous dynamic integration of the extrudate bead with the lining material. The composition of the extrudate shall be identical to the lining material. The seaming unit shall be capable of continuously monitoring and controlling the temperature of the extrudate and the zone of contact where the machine is actually fusing the lining material. Temperature of the extrudate shall range from 428 deg.F to 536 deg.F.

4.3.3 Seam Preparation: The Owner's Representative shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the Owner's Representative must assure that the process is completed according to the Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The Owner's Representative shall also verify that seams are aligned with the fewest possible number of wrinkles and "fishmouths."

4.3.4 Trial Seams: Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 5 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 4.3.2.

Five specimens shall be cut from the sample with a 1 inch wide die. The specimens shall be cut by the Installer at locations selected randomly along the trial seam sample by the Owner's Representative. The specimens shall be tested in peel using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two (2) inches per minute and be calibrated to provide accurate results. They should not fail in the seam. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved. The Owner's Representative shall observe all trial seam procedures.

4.3.6 Seaming Weather Conditions:

4.3.6.1 Normal Weather Conditions: The normal required weather conditions for seaming are as follows:

1. Ambient temperature between 32°F and 104°F.

2. Dry conditions, i.e. no precipitation or other excessive moisture, such as fog or dew.

3. No excessive winds.

4.3.6.2 Cold Weather Conditions: To assure a quality installation, if seaming is conducted when the ambient temperature is below 32°F, the following conditions must be met:

1. Geomembrane surface temperatures shall be determined by the Owner's Representative. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32°F.

2. Preheating may be waived by the Owner's Representative based on if the Installer demonstrates that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

3. If preheating is required, the Owner's Representative shall inspect all areas of geomembrane that have been preheated by a hot air device prior to seaming, to assure that they have not been overheated.

4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.

5. All preheating devices shall be approved prior to use by the Owner's Representative.

6. Additional destructive tests (as described in Section 4.5) shall be taken at the discretion of the Owner's Representative.

7. Sheet grinding may be performed before preheating, if applicable.

8. Trial seaming, as described in Section 4.3.4, shall be conducted under the same ambient temperature and preheating conditions as the actual seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 10°F from the initial trial seam test conditions.

4.3.6.3 Warm Weather Conditions: At ambient temperatures above 104°F, no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Owner's Representative that geomembrane seam quality is not compromised.

Trial seaming, as described in Section 4.3.4, shall be conducted under the same ambient temperature conditions as the actual seams.

At the option of the Owner's Representative, additional destructive tests (as described in Section 4.5) may be required for any suspect areas.

4.4 NONDESTRUCTIVE SEAM TESTING

4.4.1 Concept: The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. Vacuum testing and air pressure testing are described in Sections 4.4.2 and 4.4.3, respectively. Liner penetrations shall be tested with a vacuum box or electric spark test as described in Section 4.4.4. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

For all seams, the Owner's Representative shall:

1. Observe nondestructive testing procedures.

2. Record location, data, test unit number, name of tester, and outcome of all testing.

3. Inform the Installer of any required repairs.

4.4.2 Vacuum Testing. The following procedures are applicable to vacuum testing.

1. The equipment shall consist of the following:
   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.
   b. A pump assembly equipped with a pressure controller and pipe connections.
   c. A rubber pressure/vacuum hose with fittings and connections.
   d. A soapy solution.
   e. A bucket and wide paint brush, or other means of applying the soapy solution.

2. The following procedures shall be followed:

   a. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi gauge.
   b. Wet a strip of geomembrane approximately 12 inches by 48 inches with the soapy solution.
   c. Place the box over the wetted area.
   d. Close the bleed valve and open the vacuum valve.
   e. Assure that a leak-tight seal is created.
   f. For a period of not less than 10 seconds, apply vacuum and examine the geomembrane through the viewing window for the presence of soap bubbles.
   g. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches overlap, and repeat the process.
   h. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 4.6.

4.4.3 Air Pressure Testing: The following procedures are applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment shall consist of the following:

   a. An air pump (manual or motor driven), equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.
   b. A rubber hose with fittings and connections.
   c. A sharp hollow needle, or other approved pressure feed device.

2. The following procedures shall be followed:

   a. Seal both ends of the seam to be tested.
   b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.
   c. Insert a protective cushion between the air pump and the geomembrane.
   d. Energize the air pump to a pressure between 25 and 30 psi, close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.
   e. If loss of pressure exceeds 4 psi or does not stabilize, locate faulty area and repair in accordance with Section 4.6.
   f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seal the cut end of the air channel.
   g. Remove needle or other approved pressure feed device and seal.

4.4.4 Membrane Penetrations: Accessible pipe boot seems for all membrane penetrations shall be vacuum tested as described above. Areas not accessible to vacuum testing shall be non destructively tested using an electric spark test. The electric spark test shall employ a continuous length of 24 gauge copper wire, placed under the geomembrane seam within 1/4-inch of the edge. A portable pulse-type detector, equipped with a brush-type electrode, charged with a low amperage current of 20,000 to 30,000 volts, will be advanced along the seam at approximately 20 to 30 feet per minute. Seam defects are detected when a spark arks from the sire to the electrode, closing the circuit and sounding an audible alarm. All seam defects shall be repaired and retested as described herein. Alternative testing methods shall be submitted to the Geosynthetic CQA and the NCDENR for approval prior to commencement of testing.

4.4.5 Test Failure Procedures: The Installer shall complete any required repairs in accordance with Section 4.6. For repairs, the Owner's Representative shall:

1. Observe the repair and testing of the repair.

2. Mark on the geomembrane that the repair has been made.

3. Document the repair procedures and test results.

4.5 DESTRUCTIVE SEAM TESTING

4.5.1 Concept: Destructive seam tests shall be performed to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

4.5.2 Sampling Procedures: Samples shall be located by the Owner's Representative on average every 500 linear feet of seaming. The samples shall be cut by the Installer in a timely fashion, field tested and shipped to the independent laboratory so that test results are available as the work is performed.

All holes in the geomembrane resulting from destructive seam sampling shall be repaired in accordance with repair procedures described in Section 4.6. The continuity of the new seams in the repaired area shall be tested according to Section 4.4.

4.5.3 Sample Dimensions: At each sampling location the installer will cut a portion of the seam, 12" wide by 48" long, centered on the seam. The sample will cut into four sections, one for the independent laboratory, one for the Owner archive, one for the installer, and one for the field testing. The field testing portion of the sample will be cut into 5 coupons and tested in peel, according to Section 2.1.3.

4.5.4 Field Testing: The tensiometer shall be capable of maintaining a constant jaw separation rate of two (2) inches per minute. If the test fails the specification, the failed seam should be bound by two passing tests and the area between the two test repaired in accordance with Section 4.6. Final judgment regarding seam acceptability, based on the failure criteria, rests with the Owner's Representative.

The Owner's Representative shall witness all field tests and mark all samples and portions with their number. The Owner's Representative shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

4.5.5 Laboratory Testing: Samples will be tested according to section 2.1.3. Specimens shall be selected alternately by test from the samples (i.e. peel, shear, peel, shear...). The independent laboratory shall provide verbal test results no more than 24 hours after they receive the samples. The Owner's Representative shall review laboratory test results as soon as they become available.

4.5.6 Destructive Test Failure Procedures: The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the independent laboratory, or by field tensiometer. The Installer has two options:

1. The Installer can repair the seam between two passing test locations.

2. The Installer can trace the welding path to an intermediate location (at 10 feet minimum from the point of the failed test in each direction) and take a sample with a 1 inch wide die for an additional field test at each location (independent laboratory testing only). In the event of a field test failure, the installer shall perform an additional trial weld to verify the settings of the welding machine.

The Owner's Representative shall document all actions taken in conjunction with destructive test failures.

4.6 DEFECTS AND REPAIRS

4.6.1 Identification: All seams and non-seam areas of the geomembrane shall be examined by the Owner's Representative for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be cleaned by the Installer if the amount of dust or mud inhibits examination.

4.6.2 Evaluation. Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 4.5 as appropriate. Each location which fails the nondestructive testing shall be marked by the Owner's Representative and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until appropriate nondestructive and laboratory test results with passing values are available.

4.6.3 Repair Procedures: Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas.

1. The repair procedures available include:

   a. Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
   b. Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized flaws.
   c. Capping, used to repair large lengths of failed seams.
   d. Extrusion welding the flap, used to repair areas of inadequate fusion seams, which have an exposed edge. Repairs of this type shall be approved by the Owner's Representative and shall not exceed 50 feet in length.
   e. Removing bad seam and replacing with a strip of new material welded into place.

2. For any repair method, the following provisions shall be satisfied:

   a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.
   b. All surfaces shall be clean and dry at the time of the repair.
   c. All seaming equipment used in repairing procedures shall meet the requirements of the project manual.
   d. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches.

4.6.4 Repair Verification: Each repair shall be numbered and logged. Each repair shall be nondestructively tested using the methods described in Section 4.5 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 feet long may be of sufficient extent to require destructive test sampling, at the discretion of the Owner's Representative. Failed tests indicate that the repair shall be redone and retested until a passing test results. The Owner's Representative shall observe all nondestructive testing of repairs and shall record the number of each repair, date, and test outcome.

4.6.5 Large Wrinkles: When seaming of the geomembrane is completed, and prior to placing overlying materials, the Owner's Representative shall indicate to the Project Manager which wrinkles should be cut and reseamed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation process, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over onto itself. This is generally the case for a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be tested as outlined above.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, 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 Owner's Representative to assure that wrinkle formation is minimized.

4.7 GEOMEMBRANE PROTECTION

The quality assurance procedures indicated in this Section are intended only to assure that the installation of adjacent materials does not damage the geomembrane.

4.7.1 Soils:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F (0°C) nor above 104°F (40°C) unless otherwise specified.

2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. Equipment used for placing soil shall not be driven directly on the geomembrane.

4. A minimum thickness of 1 foot of soil is specified between a light dozer (ground pressure of 5 psi or lighter) and the geomembrane.

5. In any areas traversed by any vehicles other than low ground pressure vehicles shall have a minimum thickness of 3 feet. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

4.8 COMPLETION OF WORK:

A. Requirements: The installation of the geomembrane shall be considered totally complete when: all required deployment, seaming, repairs, testing, and site clean-up have been completed by the Installer; the Installer has submitted all the required quality control certificates to the Owner; and the Owner and/or his Representative is satisfied that the geomembrane has been installed in accordance with the above Specifications.

END OF SECTION

SECTION 02775

GEOSYNTHETIC CLAY LINER

1. GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements (if any) apply to the work specified in this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Geomembrane Liner: Section 02771

1.3 DESCRIPTION:

A. Furnish and install a geosynthetic clay liner (GCL) as part of the composite liner in the landfill as shown in the drawings. Sufficient liner material shall be furnished to cover all areas shown on the drawings including overlaps at field seams and anchor trenches.

1.4 SUBMITTALS:

A. A plan showing the proposed liner layout.

B. All required manufacturer's quality control certifications, including, but not limited to, the following:

- verification that clay component of the finished product is 70 to 90 percent sodium montmorillonite clay from the Wyoming/North Dakota "Black Hills" region of bentonite deposits;
- verification that the proper mass per unit area of bentonite clay has been added to the finished product;
- verification that the actual geotextiles used in the finished product meet the manufacturer's specification based on the minimum average roll value (MARV) concept; and
- verification that needle-punched non-woven geotextiles have been inspected continuously for the presence of broken needles using an in-line metal detector.
- the manufacture supplying the GCL shall demonstrate previous experience by letter of certification. Certification shall indicate that the manufacture has produced, and has in service in similar applications for a period of not less than one (1) year, at least (5) million sq.ft. of GCL material meeting these Specifications.

C. Furnish certified copy of laboratory test results and material sample as evidence that material is similar and equal in the minimum values listed.

1.5 CONFORMANCE TESTING:

Upon delivery of the GCL to the field site, the QARE officer should see that conformance test samples are obtained. These samples are to be sent to the QARE laboratory for testing to assure that the GCL conforms to the project plan and specifications. Samples should be taken from selected rolls by removing the protective wrapping and cutting a full width 3-foot long sample from the outer wrap of the selected rolls. The rolls should be immediately rewrapped and replaced in the shipping trailers or in the temporary field storage area. Test samples should be identified by type, style, lot, and roll numbers. The machine direction should also be noted on the samples with a waterproof marker. Conformance testing will be performed on a per-lot basis and not less than one conformance test per 100,000 square foot. A lot is defined as a group of consecutively numbered rolls from the same manufacturing line. Material conformance testing will include the following:

A. bentonite Mass per unit area per ASTM D 5993

B. Free swell of clay component per ASTM D 5890

C. Hydraulic conductivity per ASTM D 5887-99

D. Grab strength per ASTM D 4632

E. Peel strength ASTM 6496-99

2. PRODUCTS

2.1 MATERIALS:

A. The GCL liner shall be a needlepunch reinforced GCL comprised of a uniform layer or granular sodium bentonite encapsulated between a two nonwoven geotextiles that meet the following properties.

Material Property	Test Method	Required Values
Bentonite Swell Index	ASTM D 5890	24 mL/2g min.
Bentonite Fluid Loss	ASTM D 5891	18 mL max.
Bentonite Mass/Area[2]	ASTM D 5993	0.75 lb/ft^2 (3.6 kg/m^2)
GCL Grab Strength	ASTM D 4632	95 lbs (660N)
GCL Peel Strength	ASTM D 6496-99	2 lbs/inch
GCL Index Flux	ASTM 5887	1x10^{-8} m^3/m^2/sec.
GCL Permeability	ASTM 5084	5x10^{-9} cm/sec.
GCL Hydrated Internal Shear Strength	ASTM D 6243	500 psf (24 kPa) Typical

B. The liner shall be manufactured by the mechanical bonding of the needlepunch process to enhance the friction characteristics of the liner and to maintain the integrity of the liner under hydration. No glues or adhesive shall be used in lieu of the needlepunch process so as to retain these characteristics.

Needled GCLs are those which, by the process of a needling board (similar to that used in the manufacture of standard nonwoven geotextiles) have fibers of a nonwoven geotextile pushed through the bentonite clay core and integrated into a woven or nonwoven

geotextile without the use of any chemical binders or adhesives.

C. The geocomposite liner shall have a hydraulic conductivity equal to or less than $5x10^{-9}$ cm/sec at 5 psi confining stress.

D. The geotextiles used in the manufacture of the GCL shall be made up from polypropylene fibers. Any and all substitutions shall be approved by the Project Manager prior to their use.

3. EXECUTION

3.1 SHIPPING AND HANDLING:

3.1.1 Covering of the Rolls:

1. Manufacturers should clearly stipulate the type of protective covering and the manner of cover placement. The covering should be verified as to its capability for safe storage and proper transportation of the product.

2. The covering should be placed around the GCL in a workmanlike manner so as to effectively protect the product on all of its exposed surfaces and edges.

3. The central core should be accessible for handling by forklift vehicles. For wide GCLs (e.g. wider than approximately 11.5 feet) handling should be by overhead cranes utilizing two dedicated slings provided on each roll at approximately the 1/3rd points.

4. Clearly visible labels should identify the name and address of the manufacturer, trademark, date of manufacture, location of manufacture, style, roll number, lot number, serial number, dimensions, and weight in accordance with ASTM D 4873.

3.1.2 Storage at the Manufacturing Facility:

1. GCLs should always be stored indoors until they are ready to be transported to the field site.

2. Handling of the GCL should be such that the protective wrapping is not damaged. If it is, it must be immediately rewrapped by machine or hand; in the case of minor tears it may be taped.

3. Placement and stacking of rolls should be done in a manner so as to prevent thinning of the product at points of contact with the storage frame or with one another.

3.1.3 Shipment:

1. The GCLs should be shipped by themselves with no other cargo which could damage them in transit during stops or while off-loading other materials.

2. Method of loading GCLs rolls, transporting them, and off-loading them at the job site should not cause any damage to the GCL, its core or its protective wrapping.

3. Any protective wrapping that is damaged or stripped off the rolls should be repaired immediately or the roll should be moved to an enclosed facility until its repair can be made to the approval of the quality assurance personnel.

4. If any clay has been lost during transportation or from damage of any type, the outer layers of the GCL should be discarded until undamaged product is evidenced. The remaining roll must be wrapped in accordance with the manufacturer's original method to prevent hydration or further damage to the remaining roll.

3.1.4 Storage at the Site:

1. Handling of the GCLs should be done in a competent manner such that damage does not occur to the product nor to its protective wrapping.

2. The location of temporary field storage should not be in areas where water can accumulate. The rolls should be stored on high, flat ground or elevated off the ground so as not to form a dam creating the ponding of water. It is recommended to construct a platform so that GCL rolls are continuously supported along their length.

3. The rolls should not be stacked so high as to cause thinning of the product at points of contact. Furthermore, they should be stacked in such a way that access for conformance testing is possible.

4. If outdoor storage of rolls is to be longer than a few weeks, particular care (e.g. using tarpins) should be taken to minimize moisture pick-up or accidental damage. For storage periods longer than one season, a temporary enclosure should be placed over the rolls or they should be moved within an enclosed facility.

3.2 INSTALLATION:

3.2.1 Installation of the GCL shall include the following considerations:

1. Place in the manner and at the locations shown on the drawings. The GCL shall be installed with the non-woven side facing up.

2. Rolls shall be handled utilizing a 3 inch schedule 80 steel pipe through the core and slings or straps attached to the ends of the pipe (core pipe). The core pipe shall be suspended from a spreader bar so that the edges of the liner are not damaged by the suspending straps or chains. Panels shall be placed with the woven side against the underdrain sand and the non-woven side oriented upwards.

3. Work on the slopes shall be undertaken before the bottom to permit drainage in the event of rainfall. Panels may be pulled up from the bottom of the slope to the anchor trench or anchored first and the roll slowly lowered down the slope. Seams shall be perpendicular to the toe of the slope at all times. Seams at the base of the slope shall be a minimum of 5 feet away from the toe of the slope. Roll end seams or joints will not be allowed on the sideslopes.

4. Seam areas or runs shall be flat and clear of any large rocks, debris or ruts. Contacting surfaces shall be clean and clear of dirt or native soil with all edges pulled tight to maximize contact and to smooth out any wrinkles or creases. Overlaps shall be a minimum of 6 inches and verified by QA/QC personnel. A proper seam shall cover the lap line and leave the match line exposed.

5. Seams shall be augmented with granular bentonite to insure seam integrity. Granular bentonite shall be spread evenly from the panel edge to the lap line at a minimum rate of 1/4 pound per lineal foot. This rate of application will be assured by using one 50-pound bag of granular bentonite (evenly spaced along the seam) per roll of GCL. Accessory bentonite shall be of the same type as the material within the composite liner itself. Fasteners, anchor pins or adhesives may be used on seams to keep panels in place during backfill operations if necessary. All butt seams shall have a minimum of 2-foot overlap.

6. The contractor shall only work on an area that can be completed in one working day. Completion shall be defined as the full installation of the liner and placement of the geomembrane cover (see section 8. below). Prior to deployment of the GCL, the underdrain sand will be smooth to provide a smooth surface free of debris, roots and angular rocks. The GCL subgrade will be inspected and certified by the CQA personnel prior to placement of the GCL. Deployment of the GCL will be visually inspected to assure that no potentially harmful objects are present (e.g., stones, cutting blades, small tools, sandbags, etc.).

7. For any penetrations or structures the liner will contact, a small notch shall be cut along the edge of the area. The liner shall be brought up to the appurtenance and trimmed to fit snugly. The contractor shall then hand apply and compact a pure bead or dry mixture of 1 part bentonite to 4 parts soil (by volume), blended dry, into half of the notch. The liner shall then be inserted into the notch, with the remaining area in the notch refilled with the 1 to 4 mixture and compacted.

8. Large rips, or tears shall be repaired by placing a patch over the defect, with a minimum overlap of 12 inches on all edges. Accessory bentonite shall be placed between the patch and the repaired material at a rate of 1/4 pound per lineal foot of edge.

9. For protection and proper performance, the geomembrane liner (60-mil HDPE textured liner) shall be applied immediately over the GCL liner. During geomembrane installation, care shall be taken to avoid sharp turns and any quick stops or starts so as to avoid pinching or moving the GCL.

10. Overlap joints and seams shall be measured as a single layer of geotextile.

11. Securely anchor GCL as shown on the drawings.

12. The GCL will be rejected if allowed to hydrate before placement of the HDPE geomembrane. Replacement of hydrated GCL shall be the Contractor's responsibility.

13. During deployment of the GCL the material shall not be dragged over the underdrain sand.

3.2.2 Protection of Geosynthetic Clay Liner:

1. Exercise necessary care while transporting and installing the geocomposite to prevent damaging it.

2. Stored rolls shall be on a flat dry surface and tarped to avoid any unnecessary stress on the packaging.

END OF SECTION