McGill
ASSOCIATES

Carmen Johnson
44-07 ~~#~~ 4/11/12

RECEIVED
SEP 11 2008
SOLID WASTE SECTION

September 5, 2008

Mr. Allen Gaither
Solid Waste Permitting Section
Division of Waste Management
North Carolina Department of Environment and Natural Resources
2090 U.S. Highway 70
Swannanoa, North Carolina 28778

RE: Permit To Construct Submittal
MSW Phases 3 & 4
White Oak MSW Landfill
Haywood County, North Carolina
Permit # 44-07

Dear Mr. Gaither:

On behalf of Haywood County, McGill Associates is pleased to present to you this submittal package for a Permit To Construct a lateral expansion of the existing MSW landfill at the White Oak Landfill. MSW Phase 3 will be constructed initially and will provide the County approximately 5 years of waste disposal airspace. MSW Phase 4 will be constructed as Phase 3 reaches its capacity. Proposed MSW Phases 3 and 4 were included in the "MSWLF Facility Site Study, White Oak Landfill", submitted to the North Carolina Department of Environment and Natural Resources-Division of Waste Management on November 4, 1998, although the footprint of each has been enlarged to accommodate current waste disposal tonnages. All of the area included in this MSW Phases 3 & 4 Permit To Construct submittal was included in the area of the 1998 Site Study. Included in this Permit To Construct package is one hard copy and one digital copy of the following information:

Section 1: Project Correspondence
Section 2: Property Deeds and Plat
Section 3: Facility Plan
Section 4: Engineering Plan
Section 5: Construction Quality Assurance Plan
Section 6: Operations Plan
Section 7: Closure and Post-Closure Plan
Section 8: Technical Specifications
Section 9: Erosion Control Plan
Section 10: HELP Model Analysis
Section 11: Landfill Leachate Production Record
Section 12: 404/ Permits, Stream/Wetlands Impact

Section 13: Permit To Construct Drawings

The "Design Hydrogeologic Report, Phases 3 & 4, White Oak MSW Landfill" and "Environmental Monitoring Plan, Proposed Phases 3 & 4 MSW Cell Areas" were prepared by BLE, Inc. and will arrive at your office under separate cover. The County must abandon piezometers, borings, monitoring wells, and gas probes within the grading area for this project in order to obtain a Permit To Operate. The well abandonment work is scheduled to be included in the Contract for the construction of Phase 3. Abandonment logs will be sent to your office upon completion.

We understand that the Raleigh Central Office will be responsible for distributing a copy of this submittal to the hydrogeologic reviewer for the project; therefore, we have sent a hard copy and a digital copy to Mr. Ed Mussler. Please let us know if additional copies of the submittal are needed at this time.

The County anticipates reaching the capacity of existing MSW Phases 1 and 2 in early 2010. We understand that this creates a compressed time period for the development of Phase 3. We will work with you as necessary to promptly address your comments and concerns regarding this project.

We look forward to working with you to obtain a Permit To Construct for this project. As always, don't hesitate to contact us if you have any questions regarding this submittal or if you require additional information.

Sincerely,
McGILL ASSOCIATES, P.A.

JEFFREY R. BISHOP, P.E.
Senior Project Manager

Enclosures

cc: Ed Mussler, NCDENR Solid Waste Section, w/enc
Stephen King, Haywood County Director of Solid Waste, w/enc
David Cotton, Haywood County Manager, w/o enc

07518/letters/ag5sep08.doc

White Oak MSW Landfill
Haywood County, North Carolina

RECEIVED
SEP 11 2008
SOLID WASTE SECTION

Permit To Construct
MSW Phases 3 & 4

SEPTEMBER 2008

PERMIT TO CONSTRUCT
SUBMITTAL PACKAGE

MSW PHASES 3 & 4
WHITE OAK MSW LANDFILL

HAYWOOD COUNTY, NORTH CAROLINA

RECEIVED
SEP 11 2008
SOLID WASTE SECTION

Submitted To:

**North Carolina Department of
Environment And Natural Resources,
Division of Waste Management,
Solid Waste Section
1646 Mail Service Center
Raleigh, North Carolina 27699-1646**

September 5, 2008

Prepared By:

**McGill Associates, P.A.
55 Broad Street
Asheville, North Carolina 28801
828-252-0575**

WHITE OAK MSW LANDFILL
HAYWOOD COUNTY, NORTH CAROLINA

PERMIT TO CONSTRUCT
MSW PHASES 3 & 4

TABLE OF CONTENTS

Section 1:	Project Correspondence
Section 2:	Site Survey and Deeds of Property
Section 3:	Facility Plan
Section 4:	Engineering Plan
Section 5:	Construction Quality Assurance Plan
Section 6:	Operations Plan
Section 7:	Closure and Post-Closure Plan
Section 8:	Technical Specifications
Section 9:	Erosion Control Plan
Section 10:	HELP Model Analysis
Section 11:	Landfill Leachate Production Records
Section 12:	404/401 Permits – Stream/Wetlands Impact
Section 13:	Permit To Construct Drawings

Section 1 - Project Corrospondence

McGill
ASSOCIATES

September 5, 2008

Mr. Allen Gaither
Solid Waste Permitting Section
Division of Waste Management
North Carolina Department of Environment and Natural Resources
2090 U.S. Highway 70
Swannanoa, North Carolina 28778

RE: Permit To Construct Submittal
MSW Phases 3 & 4
White Oak MSW Landfill
Haywood County, North Carolina
Permit # 44-07

Dear Mr. Gaither:

On behalf of Haywood County, McGill Associates is pleased to present to you this submittal package for a Permit To Construct a lateral expansion of the existing MSW landfill at the White Oak Landfill. MSW Phase 3 will be constructed initially and will provide the County approximately 5 years of waste disposal airspace. MSW Phase 4 will be constructed as Phase 3 reaches its capacity. Proposed MSW Phases 3 and 4 were included in the "MSWLF Facility Site Study, White Oak Landfill", submitted to the North Carolina Department of Environment and Natural Resources-Division of Waste Management on November 4, 1998, although the footprint of each has been enlarged to accommodate current waste disposal tonnages. All of the area included in this MSW Phases 3 & 4 Permit To Construct submittal was included in the area of the 1998 Site Study. Included in this Permit To Construct package is one hard copy and one digital copy of the following information:

Section 1: Project Correspondence
Section 2: Property Deeds and Plat
Section 3: Facility Plan
Section 4: Engineering Plan
Section 5: Construction Quality Assurance Plan
Section 6: Operations Plan
Section 7: Closure and Post-Closure Plan
Section 8: Technical Specifications
Section 9: Erosion Control Plan
Section 10: HELP Model Analysis
Section 11: Landfill Leachate Production Record
Section 12: 404/ Permits, Stream/Wetlands Impact

Section 13: Permit To Construct Drawings

The "Design Hydrogeologic Report, Phases 3 & 4, White Oak MSW Landfill" and "Environmental Monitoring Plan, Proposed Phases 3 & 4 MSW Cell Areas" were prepared by BLE, Inc. and will arrive at your office under separate cover. The County must abandon piezometers, borings, monitoring wells, and gas probes within the grading area for this project in order to obtain a Permit To Operate. The well abandonment work is scheduled to be included in the Contract for the construction of Phase 3. Abandonment logs will be sent to your office upon completion.

We understand that the Raleigh Central Office will be responsible for distributing a copy of this submittal to the hydrogeologic reviewer for the project; therefore, we have sent a hard copy and a digital copy to Mr. Ed Mussler. Please let us know if additional copies of the submittal are needed at this time.

The County anticipates reaching the capacity of existing MSW Phases 1 and 2 in early 2010. We understand that this creates a compressed time period for the development of Phase 3. We will work with you as necessary to promptly address your comments and concerns regarding this project.

We look forward to working with you to obtain a Permit To Construct for this project. As always, don't hesitate to contact us if you have any questions regarding this submittal or if you require additional information.

Sincerely,
McGILL ASSOCIATES, P.A.

JEFFREY R. BISHOP, P.E.
Senior Project Manager

Enclosures

cc: Ed Mussler, NCDENR Solid Waste Section, w/enc
Stephen King, Haywood County Director of Solid Waste, w/enc
David Cotton, Haywood County Manager, w/o enc

07518/letters/ag5sep08.doc

Section 2- Property Deeds -N. Plat

TRANSFER MADE ON TAX RECORD

DATE 11/7/89 BY SYC

REGISTERED

403 PAGE 1374

89 NOV -7 PM 3:58

Charles G. Howell
REGISTER OF DEEDS
HAYWOOD CO., N.C.

PD 10742

216.00

Excise Tax $216.00

Recording Time, Book and Page 10585

Tax Lot No. ..... Parcel Identifier No. .....

Verified by ..... County on the ..... day of ....., 19.....

by .....

Mail after recording to SBQ

This instrument was prepared by Michael Bonfoey, SMITH, BONFOEY & QUEEN

Brief description for the Index

NORTH CAROLINA GENERAL WARRANTY DEED

THIS DEED made this 6th day of November, 1989, by and between

GRANTOR	GRANTEE
WILLIAM V. DAVIS and wife, PAULINE DAVIS	MICHAEL D. DAVIS (a one-third undivided interest); WILLIAM ALAN DAVIS (a one-third undivided interest); and SHERRY ANN RAULERSON (a one-third undivided interst) Route 1 Clyde, NC 28721

Enter in appropriate block for each party: name, address, and, if appropriate, character of entity, e.q. corporation or partnership.

The designation Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine or neuter as required by context.

WITNESSETH, that the Grantor, for a valuable consideration paid by the Grantee, the receipt of which is hereby acknowledged, has and by these presents does grant, bargain, sell and convey unto the Grantee in fee simple, all ~~that~~ of Grantors' one-half undivided interest in and to that certain lot or parcel of land situated in the City of White Oak Township, Haywood County, North Carolina and more particularly described as follows:

SEE EXHIBIT A ATTACHED HERETO AND MADE A PART HEREOF.

N.C. Bar Assoc. Form No. 3 © 1976, Revised 1977.
Printed by Agreement with the N.C. Bar Assoc.-1981

The property hereinabove described was acquired by Grantor by instrument recorded in .....

.....

A map showing the above described property is recorded in Plat Book ..... page .....

TO HAVE AND TO HOLD the one-half undivided interest of Grantor in and to the aforesaid lot or parcel of land and all privileges and appurtenances thereto belonging to the Grantee in fee simple.

And the Grantor covenants with the Grantee, that Grantor is seized of the premises in fee simple, has the right to convey the same in fee simple, that title is marketable and free and clear of all encumbrances, and that Grantor will warrant and defend the title against the lawful claims of all persons whomsoever except for the exceptions hereinafter stated.
Title to the property hereinabove described is subject to the following exceptions:

IN WITNESS WHEREOF, the Grantor has hereunto set his hand and seal, or if corporate, has caused this instrument to be signed in its corporate name by its duly authorized officers and its seal to be hereunto affixed by authority of its Board of Directors, the day and year first above written.

..... (Corporate Name)

By: .....

..... President

ATTEST:

.....

..... Secretary (Corporate Seal)

USE BLACK INK ONLY

William V. Davis (SEAL)
William V. Davis

Pauline Davis (SEAL)
Pauline Davis

..... (SEAL)

..... (SEAL)

SEAL-STAMP

NORTH CAROLINA, HAYWOOD County.

I, a Notary Public of the County and State aforesaid, certify that WILLIAM V. DAVIS and wife, PAULINE DAVIS Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this 6 day of November, 1989.

My commission expires: 4-18-94 Margie H. Messer Notary Public

Use Black Ink

SEAL-STAMP

NORTH CAROLINA, ... County.

I, a Notary Public of the County and State aforesaid, certify that .....,

personally came before me this day and acknowledged that ..... he is ..... Secretary of

..... a North Carolina corporation, and that by authority duly

given and as the act of the corporation, the foregoing instrument was signed in its name by its .....

President, sealed with its corporate seal and attested by ..... as its ..... Secretary.

Witness my hand and official stamp or seal, this ..... day of ....., 19.....

My commission expires: ..... Notary Public

Use Black Ink

The foregoing Certificate(s) of .....

Margie H. Messer

.....

is/are certified to be correct. This instrument and this certificate are duly registered at the date and time and in the Book and Page shown on the first page hereof.

Charles Stowell REGISTER OF DEEDS FOR Haywood COUNTY

By ..... Deputy/Assistant - Register of Deeds

N.C. Bar Assn. Form No. 3 © 1976, Revised 1977 Printed by Agreement with the N.C. Bar Assn. Poole Printing Co., Inc. P.O. Box 58487, Raleigh, N.C. 27658

Exhibit "A"

TRACT I:
BEGINNING on a fence stake in Ledford's line and corner of tract conveyed to T.N. Leatherwood, June 21, 1950, and runs S. 62 deg. 30' W. 577 feet to a stake; thence N. 65 deg. 30' W. 626 feet to a white oak near a branch; thence N. 80 deg. W. 265 feet to a stake; thence S. 19 deg. 45' W. 400 feet to a stake; thence S. 20 deg. W. 119 feet to a stake; thence S. 44 deg. 30' W. 107 feet to a stake; thence S. 20 deg. 100 feet to a stake; thence S. 02 deg. 30' E. 100 feet to a stake; thence S. 12 deg. 15' W. 66 feet to a stake; thence S. 27 deg. 10' E. 59 feet to a stake; thence S. 32 deg. 30' E. 59 feet to a stake; thence S. 59 deg. E. 152 feet to a stake; thence S. 33 deg. E. 77 feet to at stake; thence S. 24 deg. 45' E. 94 feet to a stake; thence S. 17 deg. 30' E. 69 feet to a stake; thence S. 20 deg. 30' E. 74 feet to a stake; thence S. 14 deg. E. 108 feet to a stake; thence S. 21 deg. W. 82 feet to a stake; thence S. 30 deg. E. 43 feet to a white oak (control corner in survey hereinafter referred to); thence N. 85 deg. E. 742 feet to a stake; thence N. 80 deg. E. 450 feet to a stake, corner of said tract conveyed to T.N. Leatherwood; thence with line of that tract five calls as follows: N. 30 deg. E. 163 feet to a black gum; N. 37 deg. 10' E. 200 feet to a stake; N. 01 deg. 10' W. 498 feet to a black gum; N. 06 deg. 10' W. 200 feet to a white oak; N. 27 deg. 39' W. 429 feet to the BEGINNING, containing 45 acres, more or less, as per survey and plat of Watt Justice, R.L.S., made June, 1950.

TOGETHER WITH and INCLUDING right of way for road from the public road to the above described tract of land as reserved in deed of June 21, 1950 to T.N. Leatherwood for adjoining property.

TRACT II:
BEGINNING on a bunch of sarvices, corner of Sam Ledford's home tract on bank river, runs with the meander of said river to a forked sycamore tree in the mouth of large gulley; thence up said gulley to its head, then a straight line to a white pine in Weaver Bramlett's line; thence with said line four calls to Dee Clark's and Weaver Bramlett's corner; thence with Dee Clark's line to the top of Miners Nob; thence with said Ledford's line to BEGINNING, containing 25 acres more or less. Excepting out of the above tract a tract of land conveyed to B.J. Sloan from R.R. Williams.

BEING the identical two tracts conveyed to Rowe Ledford et ux, et al by deed dated August 17, 1976, recorded in Deed Book 283, page 123, Haywood County Registry.

TRACT III:
All of that certain tract or parcel of land containing thirty-three and 93/100 (33.93) acres, more or less, in White Oak Township, Haywood County, North Carolina, located on the south side of Pigeon River, about 21 miles north from the Town of Waynesville. BOUNDED on the north by Pigeon River and the Carolina Power and Light Company lands, on the east by the Dee

Clark Estate, on the south by the Dee Clark Estate, and on the west by another tract of Sam Ledford. Said tract of land being more particularly described according to a plat thereof prepared by N. Rogers, Surveyor, dated June 3, 1939, now on file with The Federal Land Bank of Columbia, as follows:
BEGINNING at a stake in the Carolina Power and Light Company right of way, said stake being located S. 25 deg. 30' E. 10 poles from a bunch of sarvices on the south bank of Pigeon River which designate the old corner of Josephine Williams, and runs thence with the line of Same Ledford's other tract S. 25 deg. 30' E. 30 poles to a white oak on ridge; thend S. 32 deg. 30' E. 26 poles to a stake; thence S. 18 deg. E. 7 poles to a pine knob, a corner of Dee Clark Estate; thence S. 81 deg. 30' E. 16 poles to a double white oak; thence S. 66 deg. 30' E. 36 poles to a large rock; thence N. 63 deg. E. 34 poles to a stake on top of ridge; thence N. 29 deg. E. 23 poles; thence N. 61 deg. 45' W. 3.61 poles; thence N. 36 deg. 15' W. 7.60 poles; thence N. 69 deg. 15' W. 4 poles; thence N. 55 deg. 45' W. 5 poles; thence N. 45 deg. W. 7.94 poles; thence N. 54 deg. 35' W. 6 poles; thence N. 60 deg. 15' W. 7.27 poles; thence N. 86 deg. 10' W. 7.02 poles; thence N. 68 deg. 50' W. 3.30 poles; thence S. 82 deg. 20' W. 3.82 poles; thence S. 89 deg. 45' W. 5.30 poles; thence S. 82 deg. 20' W. 3.82 poles; thence N. 70 deg. 20' W. 5 poles; thence N. 64 deg. 40' W. 4.64 poles; thence N. 85 deg. W. 10.15 poles; thence N. 78 deg. 30' W. 3.15 poles; thence N. 68 deg. W. 4.12 poles; thence N. 70 deg. 45' W. 4.12 poles; thence No. 89 deg. 50' W. 2.7 poles; thence S. 60 deg. W. 4.55 poles; thence S. 80 deg. W. 3.76 poles; thence N. 41 deg. W. 3.8 poles; thence N. 83 deg. 30' W. 7.5 poles; thence N. 81 deg. 30' W. 4.85 poles; thence S. 89 deg. 40' W. 7.96 poles to the point of BEGINNING. Being the same land conveyed to Sam Ledford by Dee Clark and wife, Nellie Clark, by deed dated January 7, 1922, recorded in Deed Book 57, page 615, Haywood County Registry. But being subject, nevertheless to any rights, if any, that may exist unto Carolina Power and Light Company by virtue of the following conveyances, reference to which is hereby made: Tennessee and North Carolina Railroad Company to Carolina Power and Light Company, dated September 28, 1928, recorded in Deed Book 73, pages 607 and 608, Registry of Haywood County; and Great Mountain Power Corporation to Carolina Power and Light Company, dated June 12, 1926, and recorded in Deed Book 72, page 337, Registry of Haywood County.

BEING the identical property conveyed to Rowe Ledford et ux, et al by deed dated August 16, 1976, recorded in Deed Book 283, page 125, Haywood County Registry.

TOGETHER WITH and INCLUDING that road right of way from John Bramlett et ux. to Sarah Ledford et al., dated March 4, 1988, of record in the Haywood County Registry.

2352

STATE OF NORTH CAROLINA

COUNTY OF HAYWOOD

IN THE GENERAL COURT OF JUSTICE
SUPERIOR COURT DIVISION
FILE # 91 CVS 2352

THE COUNTY OF HAYWOOD

Plaintiff,

vs.

MICHAEL D. DAVIS, and wife, DEBBIE M. DAVIS, WILLIAM ALAN DAVIS, and wife, JENEE G. DAVIS, SHERRY ANN RAULERSON and husband, THOMAS BLAKE RAULERSON, WILLIAM V. DAVIS and wife, PAULINE DAVIS, MICHAEL BONFOEY, Trustee, and CAROLINA POWER AND LIGHT COMPANY,

Defendants.

MEMORANDUM OF ACTION

91 MAR 22 PM 5:09

REGISTERED
PAGE 343

TAKE NOTICE:

1. That on the 22nd day of March, 1991, Plaintiff, the County of Haywood, pursuant to the provisions of Chapter 40A of the General Statutes, instituted the above-captioned civil action in the Superior Court of Haywood County to acquire by condemnation the real property interest hereinafter described.

2. That the above-named defendants are the persons the Plaintiff is informed and believes may have or claim to have an interest in the property.

3. The following matters are set forth in Exhibit A attached hereto and made a part hereof: Paragraph 1: a description of the area taken; and paragraph 2: a statement of the propety taken for public use.

This the 22nd day of March, 1991.

KILLIAN, KERSTEN & ELLIS, P.A.

BY: Leon M. Killian

Leon M. Killian, III
Attorney for Plaintiff
P.O. Drawer 1260
Waynesville, NC 28786

BY: _____

Stephen G. Ellis
Attorney for Plaintiff
P.O. Drawer 1260
Waynesville, NC 28786
(704) 452-5801

EXHIBIT A

X. 1, BEGINNING at a CP&L monument just south of the Pigeon River, the northeast corner of the A.L. Bramlett, et ux. property (Deed Book 204, Page 174, Haywood County Registry), and running thence with a Carolina Power and Light Company right-of-way, eleven calls as follows: N. 75 deg. 37 min. 45 sec. E. 347.50 feet to a point; thence N. 63 deg. 46 min. 50 sec. E. 220.51 feet to a point; thence N. 74 deg. 47 min. 55 sec. E. 204.53 feet to a point; thence S. 84 deg. 57 min. 18 sec. E. 244.53 feet to a point; thence S. 76 deg. 11 min. 46 sec. E. 736.61 feet to a point; thence S. 71 deg. 32 min. 38 sec. E. 220.21 feet to a point; thence S. 86 deg. 36 min. 47 sec. E. 319.05 feet to a point; thence S. 50 deg. 37 min. 50 sec. E. 539.94 feet to a point marked by a Carolina Power and Light monument; thence leaving the Carolina Power and Light Company line, and running thence with the fence line of the Faye Leatherwood property (Deed Book 151, Page 57, Haywood County Registry), the following courses and distances: S. 31 deg. 14 min. 55 sec. W. 162.95 feet to a 12" beech, S. 18 deg. 15 min. 23 sec. W. 40.01 feet to a 5" hickory, S. 59 deg. 29 min. 54 sec. W. 29.36 feet to a 5" oak, S. 63 deg. 07 min. 57 sec. W. 36.36 feet to a 10" pine, S. 37 deg. 55 min. 32 sec. W. 12.45 feet to a 3" beech, S. 42 deg. 50 min. 16 sec. W. 15.43 feet to a 3" beech, S. 22 deg. 16 min. 37 sec. W. 26.66 feet to a 12" poplar, S. 41 deg. 43 min. 12 sec. W. 21.68 feet to a 14" twin beech, S. 34 deg. 43 min. 52 sec. W. 171.81 feet to a fence corner, S. 24 deg. 35 min. E. 423.31 feet to a fence stake, S. 03 deg. 27 min. 19 sec. E. 201.59 feet to a fence stake, S. 03 deg. 05 min. 12 sec. W. 493.17 feet to a fence stake, S. 38 deg. 15 min. W. 185.09 feet to a fence stake, S. 34 deg. 50 min. 59 sec. W. 32.38 feet to a stake in the edge of a soil road, S. 32 deg. 33 min. 59 sec. W. 133.32 feet to a fence stake, S. 44 deg. 35 min. 43 sec. W. 6.85 feet to a fence stake, S. 70 deg. 38 min. 12 sec. W. 10.37 feet to a fence stake, S. 86 deg. 09 min. 19 sec. W. 170.97 feet to a 4" dogwood, S. 80 deg. 40 min. 56 sec. W. 12.38 feet to a 5" oak, S. 84 deg. 15 min. 16 sec. W. 8.07 feet to a 10" hickory, S. 86 deg. 51 min. 34 sec. W. 15.39 feet to an 18" hickory, S. 83 deg. 57 min. 42 sec. W. 14.33 feet to a 4" dogwood, S. 89 deg. 30 min. 56 sec. W. 17.62 feet to a 6" oak, S. 87 deg. 18 min. 18 sec. W. 185.00 feet to a 32" triple red oak, S. 87 deg. 51 min. 09 sec. W. 404.39 feet to a 14" walnut in a hollow, N. 77 deg. 14 min. 08 sec. W. 34.87 feet to a 21" walnut, S. 84 deg. 43 min. 27 sec. W. 269.97 feet to a 4" maple, N. 82 deg. 14 min. 56 sec. W. 10.01 feet to a 10" poplar, S. 79 deg. 21 min. 26 sec. W. 23.69 feet to a 40" black oak, N. 79 deg. 27 min. 10 sec. W. 23.58 feet to a 40" white oak, a corner between the Leatherwood property and the A.L. Bramlett and wife property (Deed Book 187, Page 482, Haywood County Registry), thence with the Bramlett fence line, the following courses and distances: N. 16 deg. 28 min. 06 sec. W. 239.12 feet to a 30" poplar, N. 18 deg. 07 min. 22 sec. W. 209.99 feet to a 3" oak gatepost, N. 27 deg. 39 min. 32 sec. W. 19.70 feet to a stake in the margin of a fifteen foot road right-of-way, N. 23 deg. 05 min. 55 sec. W. 14.75 feet to a stake, N. 28 deg. 45 min. 21 sec. W. 10.25 feet to a stake, N. 38 deg. 47 min. 17 sec. W. 92.29 feet to a 38" triple poplar, N. 42 deg. 29 min. 56

sec. W. 216.90 feet to a 30" red oak in the margin of a roadway; with the margin of the roadway, four calls as follows: N. 16 deg. 20 min. 59 sec. E. 74.21 feet to an 18" twin poplar, N. 05 deg. 14 min. 59 sec. E. 52.50 feet to a locust stump, N. 02 deg. 31 min. 37 sec. W. 45.86 feet to a 5" maple, and N. 16 deg. 18 min. 43 sec. E. 54.20 feet to a gatepost; thence crossing the road, N. 47 deg. 31 min. 24 sec. W. 9.47 feet to a gatepost, N. 09 deg. 07 min. 36 sec. W. 45.22 feet to a stake, N. 27 deg. 40 min. 36 sec. W. 49.81 feet to a 24" oak, N. 44 deg. 25 min. 37 sec. W. 79.23 feet to a fence stake, N. 53 deg. 23 min. 46 sec. W. 65.74 feet to a fence stake, N. 53 deg. 23 min. 33 sec. W. 135.76 feet to a 30" hickory, N. 79 deg. 21 min. 28 sec. W. 14.57 feet to a fence stake, N. 88 deg. 27 min. 34 sec. W. 91.41 feet to a fence stake, S. 82 deg. 24 min. 12 sec. W. 58.95 feet to a fence stake and S. 74 deg. 39 min. 37 sec. W. 35.22 feet to an iron pipe (found) at a fence corner; thence continuing with the A.L. Bramlett fence line, N. 31 deg. 16 min. 14 sec. W. 294.96 feet to an iron pipe (found); thence N. 33 deg. 41 min. 04 sec. W. 101.24 feet to an iron pipe (found); thence N. 43 deg. 59 min. 19 sec. W. 123.31 feet to an iron pipe (found); thence N. 03 deg. 21 min. 58 sec. W. 87.07 feet to an iron pipe (found); thence N. 19 deg. 24 min. 21 sec. E. 60.78 feet to an iron pipe (found); thence N. 29 deg. 50 min. 18 sec. E. 78.79 feet to an iron pipe (found); thence N. 21 deg. 07 min. 39 sec. E. 77.66 feet to an iron pipe (found); thence running a straight line down a gulley, N. 18 deg. 38 min. 23 sec. W. 355.02 feet to the BEGINNING containing 103.641 acres according to the plat of survey by Edward M. Haynes, R.L.S. entitled "Boundary of Proposed Location for Haywood County Landfill", dated February 9, 1990, revised May 1, 1990 and May 17, 1990.

TOGETHER WITH AND INCLUDING a right-of-way for road from the public road to the above described tract of land as reserved in Deed of June 21, 1950 to T.N. Leatherwood for adjoining property.

SUBJECT, nevertheless to any rights, if any, that may exist unto Carolina Power and Light Company by virtue of the following conveyances, reference to which is hereby made: Tennessee and North Carolina Railroad Company to Carolina Power and Light Company dated September 28, 1928, recorded in Deed Book 73, Pages 607 and 608, Haywood County Registry; and Great Mountain Power Corporation to Carolina Power and Light Company dated June 12, 1926 and recorded in Deed Book 72, Page 337, Haywood County Registry.

TOGETHER WITH AND INCLUDING that road right-of-way from John Bramlett, et ux. to Sara Leopard, et al. dated March 4, 1988 of record in the office of the Register of Deeds of Haywood County.

TOGETHER WITH AND INCLUDING AND SUBJECT TO the terms of that Agreement dated March 9, 1988 between William V. Davis and wife, Pauline Davis, and Michael D. Davis and wife, Debbie M. Davis, party of the first part, and John Bramlett, party of the second part, recorded in Deed Book 388, Page 1065, Haywood County Registry.

X.2. 1. As to Michael D. Davis: a one-half (1/2) undivided interest, as tenant by the entirety with his wife, Debbie M. Davis, and a one-sixth (1/6) undivided interest, individually, in fee simple. See Deed Book 388, Page 631 and Deed Book 403, Page 1374, Haywood County Registry.

2. As to Debbie Davis: a one-half (1/2) undivided interest as tenant by the entirety with her husband, Michael D. Davis, in fee simple. See Deed Book 388, Page 631, Haywood County Registry.

3. As to William Alan Davis: a one-sixth (1/6) undivided interest, in fee simple. See Deed Book 403, Page 1374, Haywood County Registry.

4. As to Sherry Ann Raulerson: a one-sixth (1/6) undivided interest, in fee simple. See Deed Book 403, Page 1374, Haywood County Registry.

5. As to Michael Bonfoey, Trustee, holder of legal title as to a one-half (1/2) undivided interest, pursuant to a Deed of Trust recorded in Deed of Trust Book 328, Page 676, Haywood County Registry.

6. As to William V. Davis and Pauline Davis, Beneficiary under Deed of Trust which encumbers a one-half (1/2) undivided interest, described in a Deed of Trust recorded in Deed of Trust Book 328, Page 676, Haywood County Registry.

7. Carolina Power and Light Co., possible rights, easements or rights of way. See Deed Book 73, Pages 607 and 608; and Deed Book 73, Page 337, Haywood County Registry.

TRANSFER MADE ON TAX RECORD

DATE 2/11/92 BY CJ

STATE OF NORTH CAROLINA

FEB 12 '92

Real Estate Excise Tax

115.00

115.00Am

REGISTERED

BOOK 424 PAGE 204

92 FEB 11 PM 12:08

Helen F. Davis

REGISTER OF DEEDS
HAYWOOD CO., N.C.

Excise Tax $115.00

Recording Time, Book and Page 1430

Tax Lot No. ..... Parcel Identifier No. .....

Verified by ..... County on the ..... day of ....., 19.....

by .....

Mail after recording to .....

This instrument was prepared by Leon M. Killian, III, KILLIAN, KERSTEN & ELLIS, P.A.

Brief description for the Index

NORTH CAROLINA GENERAL WARRANTY DEED

THIS DEED made this 27 day of January, 19 92, by and between

GRANTOR	GRANTEE
LEONE LEATHERWOOD (WIDOW), a one-half undivided interest, and MARYA LEATHERWOOD and husband, ALLEN MONSON, a one-half undivided interest	HAYWOOD COUNTY, NORTH CAROLINA, a body politic and corporate

Enter in appropriate block for each party: name, address, and, if appropriate, character of entity, e.g. corporation or partnership.

The designation Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine or neuter as required by context.

WITNESSETH, that the Grantor, for a valuable consideration paid by the Grantee, the receipt of which is hereby acknowledged, has and by these presents does grant, bargain, sell and convey unto the Grantee in fee simple, all that certain lot or parcel of land situated in the City of ....., White Oak Township, Haywood County, North Carolina and more particularly described as follows:

That 57.409 acre tract of land described as the "Leatherwood Tract" upon that plat of survey entitled "Boundary of Proposed Location for Haywood County Landfill", by Edward M. Haynes, R.L.S., Herron Land Surveying, dated February 9, 1990, as amended on May 1, 1990 and May 17, 1990, appearing of record in Plat Cabinet C, Slot 598, Haywood County Registry.

TOGETHER WITH and INCLUDING all abutters rights, if any, into the access to North Carolina State Road 1338 (White Oak Road) subject to any required approval from the North Carolina Department of Transportation, SUBJECT also to the right of way and easement of the North Carolina Department of Transportation for State Road 1338 to its full legal width.

N. C. Bar Assoc. Form No. 3A © 1977 -- James Williams & Co., Inc., Box 127, Yelkinville, N. C. 27055
Printed by Agreement with the N. C. Bar Assoc. - 1981

TRANSFER MADE ON TAX RECORD

DATE 2/11/92 BY CJ

REGISTERED

BOOK 424 PAGE 204

92 FEB 11 PM 12:08

Helen F. Davis

REGISTER OF DEEDS
HAYWOOD CO., N.C.

HAYWOOD COUNTY

STATE OF NORTH CAROLINA

FEB 12 '92

Real Estate Excise Tax

115.00

115.00 Am

Excise Tax $115.00

Recording Time, Book and Page 1430

Tax Lot No. ..... Parcel Identifier No. .....

Verified by ..... County on the ..... day of ....., 19.....

by .....

Mail after recording to .....

This instrument was prepared by Leon M. Killian, III, KILLIAN, KERSTEN & ELLIS, P.A.

Brief description for the Index

NORTH CAROLINA GENERAL WARRANTY DEED

THIS DEED made this 27 day of January, 19 92, by and between

GRANTOR	GRANTEE
LEONE LEATHERWOOD (WIDOW), a one-half undivided interest, and MARYA LEATHERWOOD and husband, ALLEN MONSON, a one-half undivided interest	HAYWOOD COUNTY, NORTH CAROLINA, a body politic and corporate

Enter in appropriate block for each party: name, address, and, if appropriate, character of entity, e.g. corporation or partnership.

The designation Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine or neuter as required by context.

WITNESSETH, that the Grantor, for a valuable consideration paid by the Grantee, the receipt of which is hereby acknowledged, has and by these presents does grant, bargain, sell and convey unto the Grantee in fee simple, all that certain lot or parcel of land situated in the City of ....., White Oak Township, Haywood County, North Carolina and more particularly described as follows:

That 57.409 acre tract of land described as the "Leatherwood Tract" upon that plat of survey entitled "Boundary of Proposed Location for Haywood County Landfill", by Edward M. Haynes, R.L.S., Herron Land Surveying, dated February 9, 1990, as amended on May 1, 1990 and May 17, 1990, appearing of record in Plat Cabinet C, Slot 598, Haywood County Registry.

TOGETHER WITH and INCLUDING all abutters rights, if any, into the access to North Carolina State Road 1338 (White Oak Road) subject to any required approval from the North Carolina Department of Transportation, SUBJECT also to the right of way and easement of the North Carolina Department of Transportation for State Road 1338 to its full legal width.

N. C. Bar Assoc. Form No. 3A © 1977 -- James Williams & Co., Inc., Box 127, Yadkinville, N. C. 27055
Printed by Agreement with the N. C. Bar Assoc. - 1981

The property hereinabove described was acquired by Grantor by instrument recorded in .....

.....

A map showing the above described property is recorded in Plat ~~Book~~ Cab. C ~~page~~ Slot 598

TO HAVE AND TO HOLD the aforesaid lot or parcel of land and all privileges and appurtenances thereto belonging to the Grantee in fee simple.

And the Grantor covenants with the Grantee, that Grantor is seized of the premises in fee simple, has the right to convey the same in fee simple, that title is marketable and free and clear of all encumbrances, and that Grantor will warrant and defend the title against the lawful claims of all persons whomsoever except for the exceptions hereinafter stated. Title to the property hereinabove described is subject to the following exceptions:

IN WITNESS WHEREOF, the Grantor has hereunto set his hand and seal, or if corporate, has caused this instrument to be signed in its corporate name by its duly authorized officers and its seal to be hereunto affixed by authority of its Board of Directors, the day and year first above written.

.....
(Corporate Name)

By: .....

.....President

ATTEST:

.....

.....Secretary (Corporate Seal)

USE BLACK INK ONLY

Leone Leatherwood .....(SEAL)
Leone Leatherwood

Marya Leatherwood .....(SEAL)
Marya Leatherwood

Allen Monson .....(SEAL)
Allen Monson

.....(SEAL)

.....(SEAL)

.....
(Corporate Name)

By: .....

.....President

ATTEST:

.....

.....Secretary (Corporate Seal)

USE BLACK INK ONLY

.....(SEAL)

.....(SEAL)

.....(SEAL)

.....(SEAL)

SEAL - STAMP

OFFICIAL SEAL
SARA E. GRAVE
NOTARY PUBLIC, STATE OF ILLINOIS
MY COMMISSION EXPIRES 1-17-92

STATE OF ILLINOIS, ~~NORTH CAROLINA~~, Sangamon County.

Use Black Ink

I, a Notary Public of the County and State aforesaid, certify that LEONE LEATHERWOOD (widow) Grantor,

personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this 27 day of January, 19 92.

My commission expires: 1-17-96 Sara E. Grave Notary Public

SEAL - STAMP

OFFICIAL SEAL
SARA E. GRAVE
NOTARY PUBLIC, STATE OF ILLINOIS
MY COMMISSION EXPIRES 1-17-92

STATE OF ILLINOIS, ~~NORTH CAROLINA~~, Sangamon County.

Use Black Ink

I, a Notary Public of the County and State aforesaid, certify that MARYA LEATHERWOOD and husband, ALLEN MONSON Grantor,

personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this 27 day of January, 19 92.

My commission expires: 1-17-96 Sara E. Grave Notary Public

SEAL - STAMP

NORTH CAROLINA, ... County.

Use Black Ink

I, a Notary Public of the County and State aforesaid, certify that ..... Grantor,

personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this ..... day of ....., 19.....

My commission expires: ..... Notary Public

SEAL - STAMP

NORTH CAROLINA, ... County.

Use Black Ink

I, a Notary Public of the County and State aforesaid, certify that ..... Grantor,

personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this ..... day of ....., 19.....

My commission expires: ..... Notary Public

SEAL - STAMP

NORTH CAROLINA, ... County.

Use Black Ink

I, a Notary Public of the County and State aforesaid, certify that .....,

personally came before me this day and acknowledged that ..... he is ..... Secretary of ..... a North Carolina corporation, and that by authority duly given and as the act of the corporation, the foregoing instrument was signed in its name by its ..... President, sealed with its corporate seal and attested by ..... as its ..... Secretary.

Witness my hand and official stamp or seal, this ..... day of ....., 19.....

My commission expires: ..... Notary Public

SEAL - STAMP

NORTH CAROLINA, ... County.

Use Black Ink

I, a Notary Public of the County and State aforesaid, certify that .....,

personally came before me this day and acknowledged that ..... he is ..... Secretary of ..... a North Carolina corporation, and that by authority duly given and as the act of the corporation, the foregoing instrument was signed in its name by its ..... President, sealed with its corporate seal and attested by ..... as its ..... Secretary.

Witness my hand and official stamp or seal, this ..... day of ....., 19.....

My commission expires: ..... Notary Public

The foregoing Certificate(s) of Sara E. Grave

is/are certified to be correct. This instrument and this certificate are duly registered at the date and time and in the Book and Page shown on the first page hereof.

Helen F. Davis REGISTER OF DEEDS FOR Haywood COUNTY

By ..... Deputy/Assistant-Register of Deeds.

206

N. C. Bar Assoc. Form No. 3A © 1977 — James Williams & Co., Inc., Box 127, Yadkinville, N. C. 27055
Printed by Agreement with the N. C. Bar Assoc. — 1981

TRANSFER MADE ON PROPERTY RECORD

Date 9/23/97

By [illegible]

HAYWOOD COUNTY NC 09/23/97

$520.00

STATE OF NORTH CAROLINA

Real Estate Excise Tax

Book 461 Page 1036

REGISTERED
HAYWOOD COUNTY NC
09/23/97 9:25 AM
AMY R. MURRAY
Register Of Deeds

Excise Tax $520.00

Recording Time, Book and Page 11434

Tax Lot No. ..... Parcel Identifier No. 8712-01-1920, 8712-00-5774, 8711-09-6705

Verified by ..... County on the ..... day of ....., 19 .....

by .....

Mail after recording to LMK

This instrument was prepared by Leon N. Killian, III, KILLIAN, KERSTEN & PATTON, P.A.

Brief description for the Index

NORTH CAROLINA GENERAL WARRANTY DEED

THIS DEED made this 22nd day of September, 19 97, by and between

GRANTOR	GRANTEE
JOHN E. BRAMLETT and wife, DOROTHEA C. BRAMLETT	HAYWOOD COUNTY, a Body Politic and Corporate and a Subdivision of the State of North Carolina

Enter in appropriate block for each party: name, address, and, if appropriate, character of entity, e.g. corporation or partnership.

The designation Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine or neuter as required by context.

WITNESSETH, that the Grantor, for a valuable consideration paid by the Grantee, the receipt of which is hereby acknowledged, has and by these presents does grant, bargain, sell and convey unto the Grantee in fee simple, all that certain lot or parcel of land situated in the City of N/A, White Oak Township, Haywood County, North Carolina and more particularly described as follows:

SEE EXHIBIT "A" ATTACHED HERETO AND INCORPORATED HEREIN BY REFERENCE.

001036

N. C. Bar Assoc. Form No. 3 © 1976, Revised © 1977 — James Williams & Co., Inc., Box 127, Yadkinville, N. C. 27055
Printed by Agreement with the N. C. Bar Assoc. – 1981

The property hereinabove described was acquired by Grantor by instrument recorded in Book 204, Page 174, Book 187, Page 482 and Book 172, Page 42

A map showing the above described property is recorded in Plat Book ..... page .....

TO HAVE AND TO HOLD the aforesaid lot or parcel of land and all privileges and appurtenances thereto belonging to the Grantee in fee simple.

And the Grantor covenants with the Grantee, that Grantor is seized of the premises in fee simple, has the right to convey the same in fee simple, that title is marketable and free and clear of all encumbrances, and that Grantor will warrant and defend the title against the lawful claims of all persons whomsoever except for the exceptions hereinafter stated. Title to the property hereinabove described is subject to the following exceptions:

IN WITNESS WHEREOF, the Grantor has hereunto set his hand and seal, or if corporate, has caused this instrument to be signed in its corporate name by its duly authorized officers and its seal to be hereunto affixed by authority of its Board of Directors, the day and year first above written.

USE BLACK INK ONLY

..... (Corporate Name)

By: .....

..... President

ATTEST:

.....

..... Secretary (Corporate Seal)

John E. Bramlett (SEAL)
John E. Bramlett

Dorothea C. Bramlett (SEAL)
Dorothea C. Bramlett

..... (SEAL)

..... (SEAL)

SEAL-STAMP

NOTARY PUBLIC

Use Black Ink

NORTH CAROLINA, Haywood County.

I, a Notary Public of the County and State aforesaid, certify that JOHN E. BRAMLETT and wife, DOROTHEA C. BRAMLETT Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this 22 day of September, 19 97.

My commission expires: July 25, 2000 Leon M. Killian Notary Public

SEAL-STAMP

Use Black Ink

NORTH CAROLINA, ... County.

I, a Notary Public of the County and State aforesaid, certify that .....,

personally came before me this day and acknowledged that ..... he is ..... Secretary of ..... a North Carolina corporation, and that by authority duly given and as the act of the corporation, the foregoing instrument was signed in its name by its ..... President, sealed with its corporate seal and attested by ..... as its ..... Secretary.

Witness my hand and official stamp or seal, this ..... day of ....., 19.....

My commission expires: .... Notary Public

The foregoing Certificate(s) of Leon M. Killian, III

.....

.....

is/are certified to be correct. This instrument and this certificate are duly registered at the date and time and in the Book and Page shown on the first page hereof.

..... Amy R. Murray ..... REGISTER OF DEEDS FOR Haywood COUNTY

By ..... Jackie F. Panic ..... (Deputy) Assistant - Register of Deeds

001037

N. C. Bar Assoc. Form No. 3 © 1976, Revised © 1977 — James Williams & Co. Inc., Box 127, Yadkinville, N. C. 27055
Printed by Agreement with the N. C. Bar Assoc. — 1981

EXHIBIT "A"

TRACT ONE: BEGINNING at an existing iron pipe, the southeast corner of the 47.65 acre tract of land originally acquired by A. L. Bramlett and wife by deed of record in Deed Book 172, page 42, Haywood County Registry, also being a corner of the Martin V. Bramlett and wife property (Deed Book 285, page 607), and a corner of the Haywood County property (Deed Book 424, page 204); and running thence with the Martin V. Bramlett line, S. 83 deg. 03 min. 01 sec. W. 736.89 feet (passing through new iron rods at 188.70 feet, 360.79 feet and 706.89 feet) to a new iron rod in the center of a ten-foot soil road leading to N.C. State Road 1346; thence leaving the center of said soil road, S. 87 deg. 40 min. 24 sec. W. 14.89 feet to a new iron rod and S. 82 deg. 29 min. 34 sec. W. 175.25 feet with the line of the property of William S. Border and wife (Deed Book 332, page 367) to a new iron rod at a chestnut stump; thence continuing with the Border line, four (4) calls as follows: S. 66 deg. 53 min. 03 sec. W. 136.92 feet to a new iron rod, S. 80 deg. 20 min. 37 sec. W. 185.35 feet to a new iron rod at a locust stump, S. 68 deg. 14 min. 42 sec. W. 284.19 feet to a stake in the eastern margin of a ten-foot soil road which leads to N.C. State Road 1346 and S. 68 deg. 14 min. 12 sec. W. 10.93 feet to a new iron rod in the center of the aforesaid 10-foot soil road, in the line of the William P. Riddle property (Deed Book 237, page 322); thence running with the center of said ten-foot soil road and the Riddle line, two (2) calls as follows: N. 23 deg. 03 min. 44 sec. W. 35.38 feet to a new iron rod and N. 33 deg. 04 min. 30 sec. W. 34.21 feet to a new iron rod, a corner of the Gloria Hessler property (Deed Book 308, page 852 and Deed Book 371, page 33); thence continuing with the center of said soil road and the Hessler line, eight (8) calls as follows: N. 33 deg. 28 min. 53 sec. W. 93.95 feet to a point, N. 28 deg. 45 min. 41 sec. W. 142.88 feet to a point, N. 21 deg. 52 min. 53 sec. W. 31.91 feet, N. 03 deg. 23 min. 44 sec. W. 38.60 feet to a point, N. 06 deg. 42 min. 38 sec. E. 100.65 feet to a point, N. 08 deg. 37 min. 57 sec. E. 48.06 feet to a point, N. 19 deg. 10 min. 10 sec. E. 44.44 feet to a point and N. 25 deg. 30 min. 15 sec. E. 61.16 feet to a point, a corner of the James R. Zook property (Deed Book 260, page 301); thence with the Zook line, two (2) calls as follows: N. 46 deg. 55 min. 33 sec. E. 83.68 feet to a point and N. 48 deg. 09 min. 16 sec. E. 32.00 feet to a 34-inch oak in the forks of the road, a corner of the Odie Fish and wife property (Deed Book 288, page 413); thence running with the Fish fence line, N. 31 deg. 47 min. 26 sec. E. 402.43 feet to a new iron rod; thence continuing with the Fish line, N. 50 deg. 01 min. 24 sec. W. 344.32 feet to a new iron rod in the center of a 10-foot soil road, a corner of the J. L. Teague and wife property (Deed Book 198, page 171); thence with the Teague line, four (4) calls as follows: N. 25 deg. 05 min. 33 sec. W. 122.81 feet to a point in the center of a 10-foot soil road, N. 11 deg. 01 min.23 sec. W. 88.01 feet to a point in said soil road, N. 19 deg. 42 min. 40 sec. W. 144.09 feet to a point in said soil road and N. 04 deg. 27 min. 43 sec. E. 83.11 feet to a point in said soil road; thence leaving the Teague line and running with the Mary F. Reeves line (Deed Book 344, page 165), eight (8) calls as follows: N. 63 deg. 13 min. 01 sec. E. 173.40 feet to a new iron rod at a locust stump, N. 38 deg. 52 min. 39 sec. E. 161.10 feet to a new iron rod, N. 03 deg. 05 min. 01 sec. E. 143.03 feet to a car jack post, N. 05 deg. 24 min. 23 sec. E. 239.36 feet to a new iron pipe, N. 05 deg. 24 min. 54 sec. E. 21.00 feet to a point in a 10-foot soil road, S. 40 deg. 54 min. 40 sec. E. 154.00 feet with the center of said road to a new iron pipe, S. 31 deg. 38 min. 59 sec. E. 105.65 feet with the center of said 10-foot soil road to a rock and S. 49 deg. 07 min. 09 sec. E. 185.00 feet to an existing iron rod, a corner of an adjacent John E. Bramlett tract (Deed Book 348, page 357); thence with said Bramlett line, eight (8) calls as follows: S. 49 deg. 07 min. 09 sec. E. 146.63 feet to an existing iron rod, N. 54 deg. 21 min. 21 sec. E. 159.69 feet to an existing iron rod in a gully, N. 39 deg. 23 min. 32 sec. W. 215.36 feet to an existing iron rod, N. 00 deg. 47 min. 40 sec. E. 178.19 feet to an existing iron rod, N. 57 deg. 46 min. 49 sec. E. 160.11 feet to an existing iron rod, N. 34 deg. 44 min. 31 sec. E. 105.82 feet to an existing iron rod, N. 59 deg. 01 min. E. 175.05 feet to an existing iron rod and N. 73 deg. 11 min. 02 sec. E. 179.90 feet to an existing iron rod, a corner of the Haywood County property (Deed Book 416, page 343); thence running with the Haywood County fence line, ten (10) calls as follows: N. 73 deg. 44 min. 57 sec. E. 34.80 feet to a new iron rod, N. 80 deg. 30 min. 38 sec. E. 54.62 feet to a new iron rod, S. 89 deg. 41 min. 19 sec. E. 95.50 feet to a new iron rod, S. 78 deg. 13 min. 27 sec. E. 15.45 feet to a 24-inch hickory, S. 54

deg. 13 min. 36 sec. E. 135.81 feet to a new iron rod, S. 54 deg. 44 min. 04 sec. E. 66.48 feet to a new iron rod, S. 47 deg. 28 min. 20 sec. E. 37.95 feet to a new iron rod, S. 42 deg. 44 min. 51 sec. E. 42.33 feet to a new iron rod, S. 28 deg. 04 min. 51 sec. E. 51.91 feet to a new iron rod and S. 07 deg. 58 min. 56 sec. E. 42.29 feet to a new iron rod in a ten-foot soil road; thence S. 56 deg. 00 min. 02 sec. E. 9.42 feet (passing through a new iron rod at 4.30 feet) to a new iron rod in the eastern margin of said 10-foot soil road; thence with the fence line running along the eastern margin of said 10-foot soil road, five (5) calls as follows: S. 16 deg. 24 min. 59 sec. W. 55.02 feet to a new iron rod, S. 03 deg. 39 min. 33 sec. E. 44.93 feet to a new iron rod, S. 03 deg. 34 min. 26 sec. W. 51.07 feet to a new iron rod, S. 14 deg. 58 min. 43 sec. W. 67.39 feet to a new iron rod and S. 14 deg. 58 min. 44 sec. W. 9.57 feet to a 20-inch maple; thence leaving the road and running with the Haywood County fence line, S. 43 deg. 34 min. 12 sec. E. 218.83 feet to a new iron rod and S. 40 deg. 06 min. 47 sec. E. 90.75 feet to a new iron rod in the northern margin of a 10-foot soil road leading to State Road 1346, said point being located S. 09 deg. 45 min. 48 sec. E. 26.77 feet from a utility pole; thence S. 24 deg. 54 min. 42 sec. E. 17.90 feet to a new iron rod in the center of said 10-foot soil road; thence continuing with the Haywood County line (Deed Book 424, page 204), nine (9) calls as follows: S. 24 deg. 54 min. 42 sec. E. 51.03 feet to a new iron rod, S. 18 deg. 39 min. 32 sec. E. 186.93 feet to a new iron rod, S. 17 deg. 42 min. 05 sec. E. 237.08 feet to a 40-inch white oak at a fence corner, S. 01 deg. 33 min. 33 sec. E. 223.44 feet to a 15-inch oak corner, S. 63 deg. 25 min. 47 sec. E. 354.07 feet to a new iron rod at a 10-inch locust, S. 52 deg. 30 min. 30 sec. W. 152.29 feet to a new iron rod, S. 09 deg. 47 min. 07 sec. W. 122.23 feet to a new iron rod, S. 57 deg. 55 min. 48 sec. W. 473.99 feet to a new iron rod and S. 20 deg. 19 min. 44 sec. W. 264.14 feet to the BEGINNING, containing 85.55 acres by DMD method, according to the plat of survey by T. Frank Davis, RLS, dated April 23, 1993 and entitled "John Ebid Bramlett."

BEING the properties conveyed to A. L. Bramlett and wife, Elsie G. Bramlett by deeds recorded in Deed Book 187, page 482 and Deed Book 172, page 42, Haywood County Registry.

SUBJECT TO the road rights-of-way in favor of property formerly owned by Sara G. Ledford and Troy Ledford described in Deed Book 283, pages 123 and 125, said road right-of-way agreement being particularly set forth in Agreement dated March 5, 1988, of record in Deed Book 388, page 626, Haywood County Registry, and road right-of-way agreement with William V. Davis and wife, Pauline Davis, and Michael D. Davis and wife, Debbie M. Davis (now the Haywood County property) dated March 9, 1988 of record in Deed Book 388, page 1065, Haywood County Registry.

TRACT TWO: BEGINNING at a 4-inch iron pipe, a Carolina Power & Light Company line and elevation marker in the line of the Carolina Power & Light Company Waterville Lake property, being the northwest corner of the Haywood County property described in Deed Book 416, page 343, Haywood County Registry, and running thence with the Haywood County line (formerly Rowe Ledford property described in Deed Book 283, page 123), nine (9) calls as follows: S. 16 deg. 39 min. 51 sec. E. 119.20 feet with a large gully to a corner and S. 21 deg. 13 min. 03 sec. E. 236.14 feet with a large gully to a stake in a fence line and continuing with the fence, S. 20 deg. 13 min. 43 sec. W. 77.74 feet to a stake, S. 28 deg. 52 min. 13 sec. W. 78.62 feet to a stake, S. 18 min. 22 min. 41 sec. W. 60.91 feet to a stake, S. 04 deg. 22 min. 59 sec. E. 87.07 feet to a stake, S. 45 deg. 02 min. 10 sec. E. 123.17 feet to a stake, S. 34 deg. 38 min. 34 sec. E. 101.38 feet to a stake and S. 32 deg. 15 min. 34 sec. E. 295.01 feet to a stake in the line of Tract One of the John Bramlett property described above; thence with the Bramlett line, six (6) calls as follows: S. 73 deg. 11 min. 02 sec. W. 179.90 feet to a stake, S. 59 deg. 01 min. 00 sec. W. 175.05 feet to a stake, S. 34 deg. 44 min. 31 sec. W. 105.82 feet to a stake, S. 57 deg. 46 min. 49 sec. W. 160.11 feet to a stake, S. 00 deg. 47 min. 40 sec. W. 178.19 feet to a stake, S. 39 min. 23 min. 32 sec. E. 215.36 feet to a stake in the gully, S. 54 deg. 21 min. 21 sec. W. 159.69 feet to a stake and N. 49 deg. 07 min. 09 sec. W. 146.63 feet to a new iron rod at a dead 10-inch locust, the southeast corner of the Mary Reeves property (Deed Book 344, page 165); thence with the Reeves line, twelve (12) calls as follows: N. 08 deg. 45 min. 56 sec. W. 102.85 feet to a stake, N. 11 deg. 05 min. 13 sec. W. 249.92 feet to a 17-

001039

inch poplar, N. 50 deg. 11 min. 49 sec. E. 222.50 feet to a stake, N. 26 deg. 03 min. 47 sec. W. 226.82 feet to a stake, N. 60 deg. 39 min. 03 sec. W. 49.44 feet to a stake, N. 84 deg. 30 min. 26 sec. W. 375.75 feet (passing through a stake at 103.00 feet) to a stake near the dam, N. 23 deg. 54 min. 58 sec. W. 11.71 feet to a stake east of the branch, N. 38 deg. 29 min. 22 sec. W. 110.98 feet to a painted rock on the east margin of the branch, N. 14 deg. 08 min. 42 sec. W. 125.85 feet to a stake on the east margin of the branch, N. 24 deg. 24 min. 55 sec. E. 83.72 feet to a painted rock on the east margin of the branch and N. 01 deg. 04 min. 00 sec. W. 98.34 feet to a painted rock on the east margin of the branch, a corner of the Teague property (Deed Book 198, page 171); thence running with the Teague line, two (2) calls as follows: N. 07 deg. 55 min. 35 sec. W. 125.30 feet to a point in the branch and N. 05 deg. 25 min. 00 sec. E. 119.43 feet to a painted rock, a corner of the Carolina Power & Light Company Waterville Lake property; thence with the CP&L property, six (6) calls as follows: N. 33 deg. 58 min. 46 sec. E. 165.23 feet to a stake, N. 73 deg. 49 min. 51 sec. E. 149.08 feet to a stake, N. 74 deg. 26 min. 31 sec. E. 152.36 feet to a stake, N. 85 deg. 47 min. 41 sec. E. 221.20 feet to a stake, N. 62 deg. 41 min. 58 sec. E. 133.84 feet to a stake and N. 78 deg. 19 min. 18 sec. E. 46.48 feet to the BEGINNING, containing 21.94 acres according to the plat of survey by T. Frank Davis, R.L.S., dated April 20, 1984, and entitled "John Ebid Bramlett property".

BEING the property conveyed to Albert L. Bramlett and wife, Elsie G. Bramlett by deed recorded in Deed Book 204, page 174, Haywood County Registry.

001040

Drawings Under Seperate Cover

Section 3 - Facility Plan

FACILITY PLAN

WHITE OAK MSW LANDFILL
PHASES 3 & 4
HAYWOOD COUNTY, NORTH CAROLINA

NORTH CAROLINA PROFESSIONAL SEAL 23574 ENGINEER JEFFREY R. BISHOP

JEFFREY R. BISHOP, P.E.

McGill ASSOCIATES

Engineering • Planning • Finance
Asheville, North Carolina

September 2008

07518

FACILITY PLAN

White Oak MSW Landfill
Phases 3 & 4

1.0 Site Development

The Phases 3 & 4 Permit to Construct drawings for the Haywood County White Oak Landfill were developed in accordance with Section .1619 of the North Carolina Solid Waste Management Rules. The overall site plan (Sheet C1), indicates the area where Haywood County intends to construct the Phases 3 & 4 Expansion.

Figure 2 in Section 2 of the Permit To Construct report shows the property boundary survey performed by Edward M. Haynes, P.L.S. of Herron Surveying, dated February 9, 1990. A copy of the landfill property deeds have been enclosed in Section 2 of the Permit to Construct Report. Figure 1 is a summary of property information for the White Oak Landfill. Sheet C1 of the Permit drawings shows the existing topography of the site and was provided by McGill Associates in an aerial survey dated March 25, 2007, with additional ground survey of the existing Phase 2 waste area on March 26, 2008. The borings that were used to produce the Design Hyrdrological Report prepared by BLE, Inc. are shown on Sheet C2 of the permit drawings.

1.1 Landfill Units

Phase 3 will consist of approximately 8.8 acres and Phase 4 will contain approximately 6.7 acres of the White Oak Landfill property. Phase 3 will be constructed initially and Phase 4 will be brought online as Phase 3 reaches its capacity. Each Phase is designed as a side-slope fill against existing Phases 1 & 2. Phase 3 will provide approximately 5 years of landfill airspace. Approximately 1,150 linear feet of proposed liner edge of Phase 3 will connect to the existing liner edge at the western margin of existing Phases 1 & 2. The various Phases of the White Oak MSW Landfill are illustrated on the Overall Site Plan, Sheet C1 of the permit drawings. Phase 3 has an estimated maximum volume capacity of 686,000 CY (which excludes the 12" temporary cap). This results in an estimated life expectancy of 5 years. Capacity calculations for Phases 3 & 4 have been enclosed in Appendix A.

Filling of Phase 3 will begin at the access point in the southeast corner of the new phase. Filling will proceed to the north margin of the phase. Waste placement will continue in a phased manner in lifts ranging from 6 to 12 feet in height. Landfill Staff will cover the entire footprint of the new phase in its second year of accepting waste. A stormwater control liner will be utilized to segregate stormwater runoff from potential leachate. Additionally, temporary stormwater control berms will be utilized to separate stormwater from potential leachate to reduce the amount of active area in the phase at any one time. As the elevations of the phase increase, stormwater will be shed to periphery ditches to the north and west of

the new phase. Refer to Sheets C13 through C17 of the permit drawings for the five-year permitting period filling sequence.

1.1.1 Future Expansion

Once Phases 3 & 4 nears their operational capacity, Haywood County intends to expand the White Oak Facility to additional Phases to the south of Phases 3 & 4. Approximately 22.3 acres will be included in future Phases 5 and 6, with an expected operational capacity of 2.8 million cubic yards of airspace and an estimated life expectancy of 22 years beyond the life expectancy of Phases 3 & 4.

In addition to the MSW Phases 3 through 6, the County has site study approval for additional areas of the landfill property to the east of the existing active MSW area available for landfill airspace beyond the lifetime of Phases 3 through 6.

Existing, proposed, and future landfill facilities are illustrated on Sheet C1 of the Permit To Construct drawings.

Haywood County contracted with Municipal Engineering in 1998 to prepare the "White Oak Landfill, MSWLF Facility Site Study". The report included the identification of potential landfill sites in the County, the selection of alternative sites based on County criteria and regulatory criteria, the evaluation of three alternate sites as well as the existing White Oak MSW Landfill, a presentation of the socioeconomic and demographic data, and a recommendation to further pursue the development of the White Oak MSW Landfill property. Based on this report, the White Oak site was selected.

Haywood County is in the process of finalizing plans for the implementation of a methane gas collection and combustion system. Methane gas collection design is included in this Phases 3 & 4 submittal.

1.2 Buffer Zones

Sheet C1 shows the buffer requirements for the proposed Phases 3 & 4 expansion. The proposed waste limits are well away from any buffer requirements.

A 300-ft buffer is shown to the Right-of-Way for SR 1338 (Fines Creek Road) to the east of the landfill. A 300-ft buffer is shown between Phases 3 & 4 and the western and southern property lines.

There are not any existing private residences or water-supply wells located within 500 feet of the proposed Phases 3 & 4. A 500-ft buffer is shown between the Phases 3 & 4 expansion and private residences and wells on the western and southern margins of the project.

A minimum buffer distance of 50 feet is maintained between the adjacent streams north and west of Phase 3 and south of Phase 4. The installation of Phase 3 will impact 0.45 acres of wetlands and approximately 185 l.f. of stream. Permits for these impacts from the United States Army Corps of Engineers and North Carolina Department of Environment and Natural Resources are pending and will be provided to the Solid Waste Section prior to the issuance of a Permit to Construct.

The nearest 100-year flood plain is approximately 1,000 feet to the north of Phase 3 along the Pigeon River. No landfill facilities will be located in the flood plain.

Refer to the Phases 3 & 4 Design Hydrogeologic Report prepared by BLE, Inc for specific discussion and data pertaining to the hydrogeological characteristics of the site. There is a minimum separation of 6.0 feet between the seasonal high water elevations and 4.95 feet between bedrock elevations and the clay liner system for Phases 3 & 4.

1.3 Landfill Facilities

Haywood County currently has and will maintain the solid waste management facilities necessary for operating and maintaining the White Oak MSW Landfill. These facilities generally consist of a scalehouse, maintenance facility, Land Clearing and Inert Debris Landfill, Construction and Demolition Landfill (in the process of being closed), and leachate storage lagoon. Future facilities planned include a methane gas collection system, power generation facility, a drop-off location for residential waste and recyclables, a grinding and mulching treatment and processing facility, a small Type 2 composting facility, and a landfill office.

2.0 Landfill Construction

The permit documents illustrate the proposed grading associated with construction and operation of Phases 3 & 4. These documents include, but are not limited to, the following:

- Limits of grading,
- Location of borrow and stockpile areas,
- Existing landfill facilities,
- Limits of Phases 3 & 4,
- Proposed base grades of Phases 3 & 4,
- Proposed drainage layer grades for Phases 3 & 4,
- Proposed final grades of Phases 3 & 4,
- Location of access roads,
- Location of leachate collection piping, leachate force main, and leachate storage lagoon,
- Location of sediment basins and drainage structures,
- Location of stormwater segregation features,

- Proposed transitional contours for each phase of development, and
- Proposed cap system
- Details of landfill development

2.1 Grading

Sheets C3 through C9 of the permit drawings show the grading limits for the proposed Phases 3 & 4 Expansion. Soil stockpile areas are shown on Sheet C1 and C11.

2.2 Phase Limits

Sheet C1 shows the limits of Phases 3 & 4. The footprint of Phase 3 is approximately 8.8 acres and is expected to provide disposal capacity until 2015. Phase 4 contains approximately 6.7 acres and will provide disposal airspace for approximately 5 years beyond the capacity of Phase 3.

2.3.2 Base Grades of Phase

Sheets C3 and C7 show the proposed top of clay grades for Phases 3 and 4, respectively. The subgrade elevations are located two (2) feet below the clay grades. The average seasonal high water table is located at a minimum distance of eight feet below the proposed top of clay grades and thus six feet below the proposed base grades. This separation ensures that the post settlement bottom elevation of the base liner system meets or exceeds the vertical separation requirements described in section .1624 (b) of the Solid Waste Management Rules. The average seasonal groundwater levels are included on Sheets C3 and C7 and are described in detail in the Design Hydrogeologic Report prepared by BLE, Inc. The proposed separation will result in a minimum distance of ten feet between the ground water table and waste placed in the phase. The minimum slope of the phase floor will be 2.75 percent. The projected settlement rates are based on the estimates developed in the Design Hydrological Report and are shown on Sheet C21 of the permit drawings.

2.4 Access Roads

Access roads for Phases 3 & 4 will be composed of a compacted subgrade overlain by six (6) inches of railroad ballast and six (6) inches of CABC. The locations of the access roads are shown on Sheets C3 through C11 of the permit drawings. The roads will have shoulders on both sides, with a drainage ditch on the landfill side. The interior ditch is sized to carry run-off for Phases 3 & 4 at the peak development.

2.5 Sediment Basins

Sheets C5 and C11 of the permit drawings show the location of the the existing sediment basins and the four proposed additional sediment basins that will be utilized in the

construction of Phases 3 & 4. Sheet C5 is the Phase 3 Erosion Control Plan and shows how stormwater runoff and sedimentation will be handled during construction of Phase 3. Sheet C11 is the Final Erosion Control Plan and shows how stormwater runoff will be dealt with when Phases 3 & 4 have reached full development. All of the sediment basins were sized for the fully-developed condition since the landfill has the greatest potential for producing runoff at the fully-developed condition when slopes are at their steepest. These basins will have the capacity to accommodate run-off from the 25-year, 24-hour storm event with excess capacity.

2.6 Leachate Force Main and Storage Lagoon

Sheets C4 and C18 of the permit drawings show the location of the existing leachate lagoon, existing leachate gravity sewers, the proposed Phase 3 leachate sump, pumping station, and force main that will be constructed during the development of Phase 3. The pump stations located at the sump areas (at the northern margin of Phase 3) will pump leachate through approximately 150 l.f. of dual-contained force main to a proposed gravity leachate sewer, then leachate will flow by gravity approximately 375 l.f. to a manhole located near the leachate storage lagoon, just north of Phase 1. The storage lagoon has an existing capacity of 642,000 gallons and will be expanded during the construction of Phase 3 to provide a total of 1,017,00 gallons of leachate storage. An additional HDPE liner will be added to the lagoon at this time.

2.7 Phase Closure

Sheet C10 of the permit drawings shows the proposed final grades for Phases 3 & 4. The ultimate cap grades for the phase will be dependent upon the design of adjacent phases. Temporary slopes within the Phases 3 & 4 area will range from five (5) to thirty-three (33) percent. Ultimate final cap grades will range from five (5) to twenty-five (25) percent. Components of the proposed closure cap, from bottom to top, will include a 12-inch thick intermediate soil cover, followed by an eighteen inch (18") thick clay layer with a permeability not greater than 1.0×10^{-5} cm/sec, a 40-mil textured HDPE geomembrane, a double-sided, eight (8)-ounce geocomposite, and an twenty-four inch (24") thick vegetative/erosion layer.

3.0 Landfill Operation

Reducing the production of leachate is a primary concern for efficient, cost-effective operation. Efficient operation of the leachate collection and stormwater segregation systems is imperative. Transitioning between active and inactive portions of a phase can also drastically increase leachate production if not handled properly.

3.1 Leachate Collection System

Sheets C4 and C8 show the proposed location of the leachate sump area and the leachate collection pipes. The minimum slope of the phase floor will be 2.5 percent in order to

maintain efficient drainage and reduce head heights on the HDPE liner. The grading of the phase floor will promote drainage to the sump areas. An eighteen (18)-inch HDPE pipe will be used for constructing each of the pump-housing side slope risers at the leachate pumping stations. There will be a leachate head test well located at each sump.

There is one sump proposed for the Phases 3 & 4 expansion, which includes two pumping stations. The sump is located at the northern margin of the Phase 3. Leachate collection piping will direct leachate to the sump and will provide complete coverage of the phase floor. The main collection lines will be constructed to a minimum slope of 2.7% and the lateral collection lines will be constructed to a minimum slope of 1.5%. The lateral leachate collectors and main headers will be placed in trenches, covered with washed stone, and surrounded with a geotextile to protect the pipes from clogging. The pipes will only be placed in trenches on the phase floor. (See details, Sheets D1-D11). The portion of the pipes where the cleanouts are located will lie on the side slopes will be covered with stone and protected with geotextile, but the pipes will lay flat against the side slopes. No trenching will be performed on the side slopes. Cleanout risers will be provided for all of the leachate piping where physically possible. The leachate that collects in the sump areas will be pumped through the dual-contained force main to the leachate storage lagoon located north of Phase 1.

3.2 Stormwater Segregation Features

Phases 3 & 4 waste area will be covered with a synthetic stormwater cover. The waste area will be divided by a temporary stormwater control berm adjacent to the working face. The berm will be constructed on top of the drainage layer and be covered by the synthetic stormwater control liner. The location of the temporary stormwater control berm is shown on the filling sequence drawings, Sheets C13 through C17 of the Permit to Construct. This berm will direct stormwater runoff away from the working face to the low point in the cell, where a stormwater pump will pump the runoff over the northern Phase 3 perimeter berm. As waste placement continues, the elevation of the active area of the phase will reach the point where stormwater runoff can be directed over the perimeter berms on the north and west sides to ditches leading to sediment basins west and north of Phases 3 & 4.

3.3 Transition Between Active and Inactive Areas of the Phase

Placement of waste at Phases 3 & 4 will generally proceed from south to north. Prior to entering an inactive portion of the phase, the stormwater control liner will be partially removed. Where necessary, a temporary berm will be utilized to assure that stormwater and leachate remain separated. As the working face moves to the north, the stormwater control liner will remain in place as long as possible. See the detail sheets D1-D11 for a detail of the temporary gravel berm.

4.0 Facility Report

4.1 Waste Stream

Haywood County currently classifies their waste stream as industrial, commercial, municipal, or residential. Regulated hazardous waste, out-of-county waste, and hazardous liquid wastes are prohibited at the White Oak Landfill. This is the classification for the waste currently being disposed of at the White Oak site. The waste stream for Phases 3 & 4 will maintain the current classification.

The service area for the White Oak Landfill will include businesses and municipalities located within Haywood County. Waste from other counties will not be accepted at the facility. The current waste stream is approximately 5,000 tons per month. The average waste stream expected for Phases 3 & 4 is estimated to be 6,600 tons per month over the life of the area. These quantities assume an annual population growth of 1.0%, but the waste stream could vary as much as 15 percent based on past occurrences of fluctuations and population changes.

The county will operate Phases 3 & 4 using basically the same equipment available to them at this time. This equipment includes a compactor, one excavator, one motor grader, and one front-end loader. This equipment should be sufficient for operating the landfill under its current waste stream. Haywood County budgets for new equipment needed for landfill operations on an annual basis.

4.2 Landfill Capacity

Phase 3 has a projected operating capacity of 686,000 cubic yards of air space to the bottom of the cap elevations shown on Sheet C13 of the permit drawings. This equates to an estimated life expectancy of approximately 5 years. This volume includes air space that is available for placing waste and operational daily cover. Phase 4 has a projected operating capacity of 631,000 cubic yards, which will provide disposal airspace for an additional 5 years after Phase 3 reaches capacity. A summary of projected MSW tonnages and required airspace is included in Appendix A.

The following nominal construction quantities for Phases 3 & 4 have been estimated:

	Phase 3	Phase 4
Cut Materials	300,000 cy	325,000 cy
Fill Materials	80,000 cy	60,000 cy
Clay Liner	35,000 cy	25,000 cy
Gravel drainage layer	35,000 cy	25,000 cy

Soil cover volumes were calculated assuming a soil to waste ratio of one (1) to five (5). Phases 3 & 4 expansion will require an average of 25,000 cubic yards of cover soils each

year, based on a one (1) to five (5) soil to waste ratio. Approximately 5,000 cubic yards of soil would be needed each year for intermediate cover. Therefore, a total of 30,000 cubic yards of soil will be needed on an annual basis. The closure soil quantities needed for constructing the final cap for Phases 3 & 4 will include 30,000 cubic yards of intermediate cover soils, 45,000 cubic yards of clay liner material, and 60,000 cubic yards of vegetation-supportive soil. Soils needed for construction and operation of Phases 3 & 4 will be taken from the borrow areas indicated on Sheets C1 and C11. Preliminary soil borings performed on the site indicate that earthen materials which meet the project specifications for the compacted clay liner are available in sufficient quantities.

4.3 Environmental Control System

The North Carolina Solid Waste Management Rules, Section .1600, entitled "Requirements For Municipal Solid Waste Landfill Facilities", were adhered to throughout the design of Phases 3 & 4.

The major component of the Environmental Control System will consist of a primary composite base liner constructed of a 24-inch, low-permeability clay layer with a permeability not greater than 1.0×10^{-7} cm/sec overlain by a 60-mil HDPE geomembrane. Once a protective 16-ounce geotextile is placed on the primary HDPE geomembrane, a two (2)-foot gravel drainage layer including leachate collection piping will be placed on top of the composite base liner system. The composite base liner will provide a redundant system for assuring that leachate is contained within the phase and does not affect local hydrogeology. The high hydraulic conductivity of the drainage layer will assure quick and efficient removal of leachate from the phase floor to the sump areas and will reduce the leak potential by reducing the driving head on the geomembrane. Once leachate reaches the sump area, it will be transported to the leachate storage lagoon through a dual-contained leachate force main and gravity sewer. Leachate pumps located in the sump will be activated by head heights of less than twelve (12) inches. Disposal of leachate from the leachate storage lagoon is discussed in detail in the Operations Plan.

Stormwater in Phase 3 that does not come into contact with waste will initially be collected on top of the proposed stormwater control liner and then pumped to a pipe that discharges into the unnamed branch north of the Phase. As the landfill increases in height, stormwater will be directed to periphery ditches that lead to permanent sediment basins prior to discharge to the nearby unnamed branch. Refer to sheet C5 of the permit drawings.

4.4 Leachate Generation

The amount of leachate that Phases 3 & 4 will generate was estimated by using the HELP Model analysis included in Section 10 of the Permit to Construct and by examining landfill records for the past six years. See Section 11 of the Permit to Construct for landfill leachate records for the past six years. The HELP model analyzed ten stages of landfill development

during the lifetime of Phases 3 & 4. Each stage of development was comprised of cross-sections of landfill construction, which included clay barrier soils, flexible membrane liners, gravel drainage layers and layers of compacted MSW wastes and cover soils. The stages of development varied from the first, which analyzed the landfill with only a small portion active with relatively thin layers of compacted waste, to the tenth, which analyzed the landfill after the final cap was installed. Stages 1 through 5 occurred during the development of MSW Phase 3 and stages 6 through 10 occurred during the development of MSW Phase 4. The HELP model estimates that average monthly leachate production will reach 596,400 gallons/month during the initial stages of Phase 4 development. Landfill records over the past six years show an average monthly leachate generation of approximately 220,000 gallons per month, and 323,500 gallons/month for F.Y. 2005, the wettest year during the past six years. The highest total leachate production for a calendar month was 486,000 gallons in September 2004, although during a 30 day period in September and October of that year, 600,000 gallons of leachate were removed. The monthly average calculated by the HELP model for 15.5 acres of lined landfill was the same as the greatest actual observed leachate production for a 21.5 acre area of lined landfill. During the six-year time period, there were only 4 months where leachate generation exceeded 400,000 gallons (for 21.5 acres). The HELP Model analysis is a conservative estimate of leachate production and will continue to be considered when designing improvements to the landfill leachate system; however, leachate production records will be utilized as well. The leachate collection system must be prepared to handle extreme events as well as function efficiently at average production levels.

4.5 Average Leachate Production Flows and Pumping

Utilizing the existing leachate production information included in Section 11 of the Permit to Construct, and pro-rating those quantities over the 15.5-acre footprint of Phases 3 and 4, it is estimated that Phases 3 and 4 will produce leachate at an average monthly rate of 250,000 gallons. Applying a 1.5 safety factor to this quantity results in an average rate of 375,000 gallons per month. To remove the leachate from the phase, assume that on average each pump will operate for 8 hours per day, which requires that the pumps remove leachate at an average flow of 13 gpm. Applying a peaking factor of 2 to the flow calculations, it is necessary for each pump to remove leachate at the rate of 26 gpm. Therefore, the each pump will be designed to pump 26 gpm at 25.5 feet total dynamic head (TDH). The pumps will utilize a 3"x 6" dual-contained force main located along the northern margin of Phase 3, which will run for approximately 150 l.f. to a point where the force main discharges into proposed leachate collection system gravity sewer manhole #2. The gravity sewer will flow approximately 375 l.f. where it will discharge to proposed leachate collection system gravity manhole #1, just upstream of the leachate storage lagoon. See Sheet C18 for proposed leachate force main and gravity sewer piping. The leachate storage lagoon located north of Phase 1 has a total storage volume of 642,000 gallons. Refer to Appendix B for force main calculations and Appendix C for correspondence between the Town of Waynesville concerning disposal of leachate.

4.6 Contingency Plan For Peak Flow Conditions And Leachate System Disruption

In the event of an extreme rainfall event, the HELP model projects a peak leachate production of 30,950 cubic feet/day, or approximately 231,000 gal/day. This peak event would be seen at Stage II of landfill development within the first two years of operation of Phase 3. Over time, the effects of an intense storm event would be greatly dampened due to the increase in the length of time that it would take stormwater to percolate through the layers of waste and daily cover. The available storage volume below the perimeter liner edge elevation of 2515 is approximately 2,200,000 gallons. During the peak event as described by the HELP model, the landfill can contain leachate for approximately 10 days of peak discharge intensity. It is unlikely that the HELP model 1-day peak intensity rate would continue for 10 days. Therefore it is highly unlikely for the landfill to produce more leachate than the pumps can transport to the leachate lagoon.

Under average operating conditions, in the event that there was a temporary failure with any of the leachate removal and storage equipment, the geometry of the landfill would allow for the landfill to contain the leachate for a period of several months. However, the system should never be out of operation for more than a few hours, and then only under extreme circumstances. Due to the conservative design of the leachate removal and storage equipment and the geometry of the landfill, the possibility of leachate buildup overflowing the perimeter berm is very low.

In conjunction with the development of Phase 3, the existing leachate lagoon will be raised and a new liner will be installed on top of the existing liner. Currently, the lagoon has a storage capacity of 642,000 gallons. The lagoon will be raised by approximately 3.25' in order to provide an additional 375,000 gallons of storage volume. During the construction of the additional storage volume, a new 60-mil textured HDPE liner will be installed over the existing liner. A double-sided geocomposite will be installed between the existing liner and the proposed liner. The final volume of the lagoon will be approximately 1,017,000 gallons. Leachate will be pumped directly to the leachate tanker truck during the period of the lagoon expansion, which will take several days. Pumping will occur from proposed leachate manhole #1, which will be located just outside the limits of the lagoon. Depending on weather conditions at the time of construction, the County must make provisions to transport leachate on a 24-hour basis. During the summer months of the drought in 2007 and 2008, the 6,000 gallon tanker truck was filled every 3 or 4 days, or longer. However, if wet weather is encountered during the time of the construction project, it will be necessary for the County to rent an additional tanker truck and make provisions for 24 hours of operation.

Section .1624 (2)(A)(ii) of the Solid Waste Management Rules states that "the geometry of the landfill shall be designed to control and contain the volume of the leachate generated by the 24-hour, 25-year storm." The input parameters of the HELP model included maintaining a minimum head of one (1) foot on the geomembrane liner, and the additional calculations have been done to assure that rule .1624 (2)(A)(ii) was met.

4.7 Soil Resources

Phase 3 is scheduled to begin construction in early 2009. It is estimated that Phase 3 will require 300,000 cubic yards of cut and 80,000 cubic yards of fill material resulting in the need to stockpile approximately 220,000 cubic yards of soil. Phase 4 is scheduled to begin construction in 2014 and will require approximately 325,000 cy of cut and 60,000 cy of fill material resulting in the need to stockpile 265,000 cy of soil.

The total soil requirements for Phase 3 & 4 construction will include 50,000 cubic yards of soil liner material. The soil stockpile area consists of materials suitable for structural fill as well as clay liner material. On-site borrow areas are located south and west of existing Phase 2 as shown on sheet C1 of the permit drawings.

The County has enough soil available to complete construction of Phases 3 & 4 and to operate the new phases prior to Phase 5 beginning operation in 2019.

APPENDIX A

Phases 3 & 4 Capacity Calculations

Haywood County
White Oak Landfill

Projected MSW Volumes and Required Airspace

Fiscal Year	Population[1]	Projected Waste[2] (tons)	Annual Air Space Required[3] (CY)	Cumulative Air Space Required (CY)	Operational Soil Requirements[4] (CY)
2008	57,530	61,793	117,432	117,432	19,611
2009	60,407	64,882	123,303	240,735	20,592
2010	63,427	68,126	129,468	370,203	21,621
2011	66,598	71,533	135,942	506,145	22,702
2012	69,928	75,109	142,739	648,884	23,837
2013	73,424	78,865	149,876	798,759	25,029
2014	77,096	82,808	157,370	956,129	26,281
2015	80,950	86,948	165,238	1,121,367	27,595
2016	84,998	91,296	173,500	1,294,867	28,974
2017	89,248	95,860	182,175	1,477,042	30,423
2018	93,710	100,653	191,284	1,668,326	31,944
2019	98,396	105,686	200,848	1,869,173	33,542
2020	103,316	110,970	210,890	2,080,064	35,219
2021	108,481	116,519	221,435	2,301,498	36,980
2022	113,905	122,345	232,507	2,534,005	38,829
2023	119,601	128,462	244,132	2,778,137	40,770
2024	125,581	134,885	256,338	3,034,475	42,809
2025	131,860	141,630	269,155	3,303,631	44,949
2026	138,453	148,711	282,613	3,586,244	47,196
2027	145,375	156,147	296,744	3,882,987	49,556
2028	152,644	163,954	311,581	4,194,568	52,034

1 Population projections use U.S. Census year 2000 population for Haywood County of 54,033 and a 1.0% yearly increse.

2 Projected waste tonnage estimates assume a 1.0% yearly increase in the waste stream. This estimate combines MSW and C&D wastes, which will all be disposed in the lined landfill. Waste totals for FY 2007 were 58,850 tons.

3 Annual air space requirements assume a capaction rate of 0.5262 tons/cy (or 1,052.4 lbs/cy).

4 Operational soil requirements are based on a 5:1 waste to soil ratio by volume.

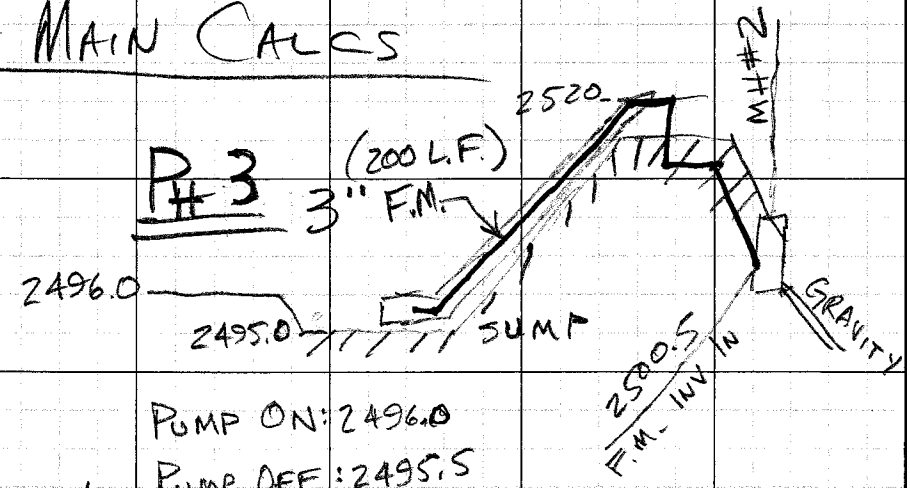
APPENDIX B

Leachate Force Main Calculations

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: W.O.L.F. – PH 3 & 4
PROJECT NO.: 07518
DESCRIPTION:
CALCULATED BY: DP CHECKED BY:
DATE: 8/25/08 SHEET NO. OF

FORCE MAIN CALCS



STATIC HEAD

2520 – 2495.5 = 24.5'

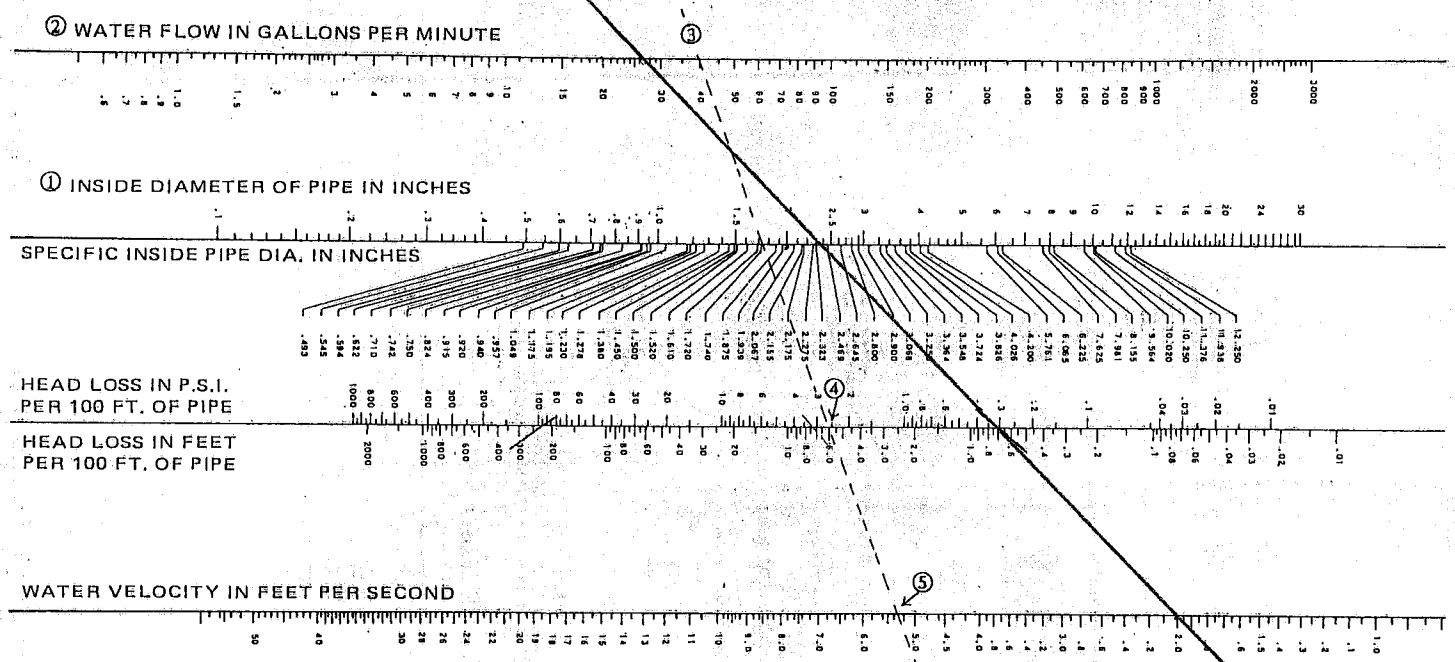
PUMP ON: 2496.0
PUMP OFF: 2495.5
BOTH PUMPS ON: 2496.5

FRICTION LOSSES

FROM FIG 26, USE 0.35 LOSS/100', OR TOTAL OF 0.70'
(C = 130) (V = 2 FT/SEC)
ASSUME FITTINGS LOSS ≈ 0.2'
TOTAL FRICTION = 1'

EACH PUMP @ 26 gpm @ 25.5' T.D.H.

FIGURE 26 – FRICTION LOSS CHARACTERISTICS OF WATER FLOW THROUGH PVC PIPE



HOW TO USE THIS GRAPH:

1. Select the desired pipe size (inside diameter).
2. Determine the amount of water to flow through the pipe.
3. Place a straight-edge on these two points.
4. The point at which the straight-edge intersects the head-loss line and the velocity line give these two values under the given conditions.

EXAMPLE:

1¼" schedule A pipe (I.D. = 1.740") ①
40 gallon per minute service ②

1. Line up these points with a straight-edge ③
2. Read 2.6 psi (or 6 ft.) from the head-loss line ④
3. Read 5.38 ft. per second from the velocity line ⑤

THE VALUES ON THIS GRAPH ARE BASED ON THE WILLIAMS AND HAZEN FORMULA:

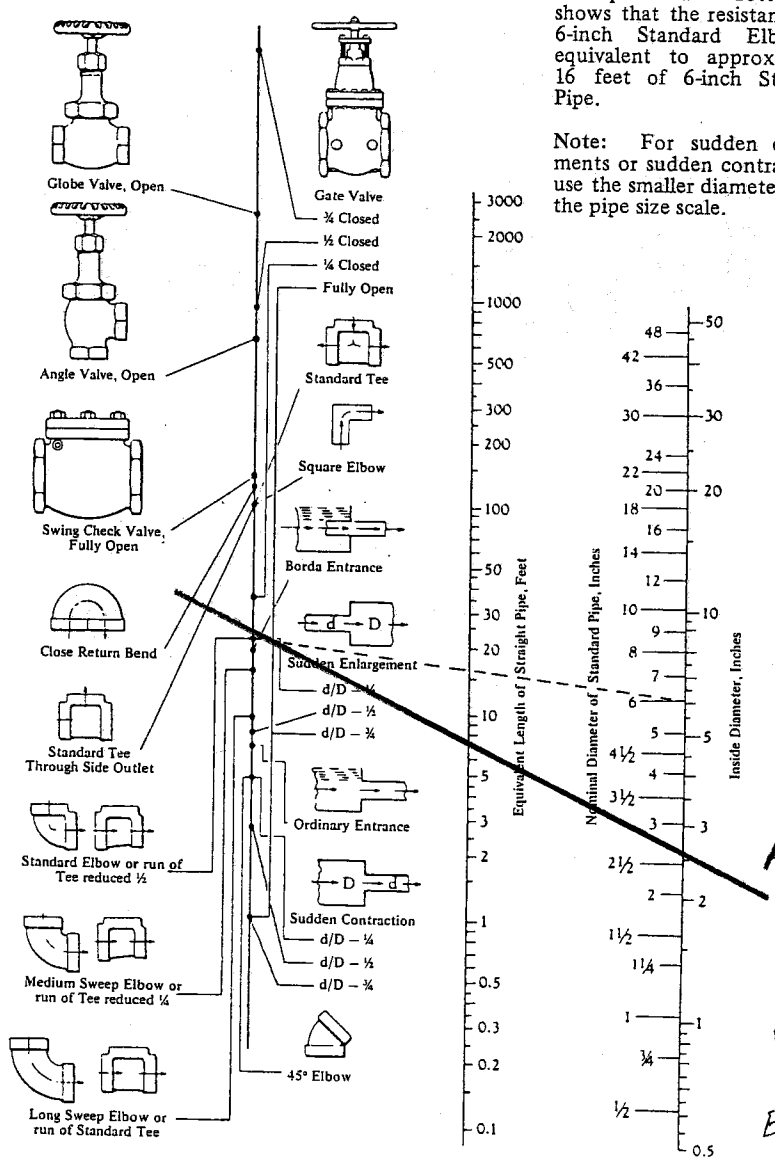
(EQUATION 80) $$f = .2083 \left(\frac{100}{C}\right)^{1.85} \times \frac{Q^{1.852}}{d_i^{4.8655}}$$

WHERE:

f = friction head in feet of water per 100 feet of pipe
d_i = Inside diameter of pipe in inches
Q = Flow in gallons per minute
C = Constant for inside roughness of pipe (150 for PVC)

FIGURE 27 – RESISTANCE OF VALVES AND FITTINGS TO FLOW OF FLUIDS

Note: Head loss through check valves varies with types manufactured. Consult manufacturer for correct values.



Example: The dotted line shows that the resistance of a 6-inch Standard Elbow is equivalent to approximately 16 feet of 6-inch Standard Pipe.

Note: For sudden enlargements or sudden contractions, use the smaller diameter, d, on the pipe size scale.

ASSUME 6 TOTAL ELBOWS OR 8'x6 EQ LENGTH = 50'

Section 4 - Engineering Plan

ENGINEERING PLAN

WHITE OAK MSW LANDFILL
PHASES 3 & 4
HAYWOOD COUNTY, NORTH CAROLINA

JEFFREY R. BISHOP, P.E.

NORTH CAROLINA PROFESSIONAL SEAL 23574 ENGINEER JEFFREY R. BISHOP

McGill ASSOCIATES

Engineering • Planning • Finance
Asheville, North Carolina

September 2008

07518

ENGINEERING PLAN

White Oak MSW Landfill
Phases 3 & 4

1.0 Introduction

The Engineering Plan incorporates the plans and specifications relative to detailed design and performance of the Phases 3 & 4 Expansion at the White Oak MSW Landfill. This plan was developed in accordance with Section .1620 of the Solid Waste management Rules (15 NCAC 13B). Sections .1624 (Construction Requirements for MSWLF Facilities) and .1627 (Closure and Post-Closure Requirements for MSWLF Facilities) were also closely referenced during the development of this plan. This Engineering Plan discusses the engineering and design of Phase 3 of the Phases 3 & 4 expansion. Phase 3 has an estimated life expectancy of five (5) years.

2.0 Engineering Report

2.1 Composite Base Liner and Leachate Collection System

The Phases 3 & 4 Expansion has the following: clay layer, HDPE liner and Leachate Collection System (LCS) design characteristics (from bottom to top):

- A minimum eight (8)-foot vertical buffer between the average seasonal high water table and the top of the composite liner,
- A minimum 6.5-foot vertical buffer between bedrock and the top of the composite liner.
- A compacted select backfill layer
- A two (2)-foot thick, compacted clay liner with a maximum permeability of 1.0×10^{-7} cm/sec.,
- A primary sixty (60)-mil, high density polyethylene (HDPE) geomembrane liner, smooth on the floor and textured on the slopes,
- A sixteen (16)-once geotextile cushion on the floor and side slopes, and
- A two (2)-foot thick leachate collection layer constructed of washed stone, and also including leachate collection and transfer piping constructed of HDPE.

2.2 Cap System

The Phases 3 & 4 Expansion will have the following cap system design characteristics (from bottom to top):

- A one (1)-foot thick layer of compacted intermediate cover directly on top of the waste,
- An eighteen (18)-inch thick compacted clay layer, with maximum permeability of 1.0×10^{-5} cm/sec
- A forty (40)-mil textured HDPE geomembrane,
- A double-sided, eight (8)-ounce geocomposite, and
- A twenty-four -inch (24") thick vegetative\erosion layer

2.3 Leachate Collection

The Phases 3 & 4 leachate collection lines consist of eight (8)-inch perforated HDPE main collector lines which run from south to north near the center of the phase, and a series of six (6)-inch, perforated, HDPE lateral collectors that connect to the main lines. The main collection lines will be constructed with a minimum slope of 2.5%. The lateral collectors are spaced approximately 110 feet apart and maintain a minimum grade of 2.8%. See Sheet C4 of the Permit Drawings for the layout of the leachate collection piping for Phase 3, and Sheet C8 for Phase 4.

Phases 3 & 4 will be constructed with two (2) leachate collection sumps and pumping stations. Both sumps are located at the lowest point in the phase along the northern margin of Phase 3. Two (2) pumping stations are designed in order to provide redundancy and to increase the safety factor against a pump failure and leachate spill. The proposed sump area will be an eight (8)-foot by sixty (60)-foot recessed area and will be double-lined with HDPE geomembrane. The pumping stations will utilize a side-slope riser with a submersible pump.

The sump area will contain a section of eighteen (18)-inch perforated HDPE pipe that will house the submersible leachate pump. The submersible pump will be lowered into the leachate collection sump through the side-slope riser by means of a steel cable and a rolling carriage. The side-slope riser rests on the 16-ounce geotextile cushion along the slope and lies between the sump and the top of the perimeter berm.

2.4 Leachate Generation

The amount of leachate that Phases 3 & 4 will generate was estimated by using the HELP Model analysis included in Section 10 of the Permit to Construct and by examining landfill records for the past six years. See Section 11 of the Permit to Construct for landfill leachate records for the past six years. The HELP model analyzed ten stages of

landfill development during the lifetime of Phases 3 & 4. Each stage of development was comprised of cross-sections of landfill construction, which included clay barrier soils, flexible membrane liners, gravel drainage layers and layers of compacted MSW wastes and cover soils. The stages of development varied from the first, which analyzed the landfill with only a small portion active with relatively thin layers of compacted waste, to the tenth, which analyzed the landfill after the final cap was installed. Stages 1 through 5 occurred during the development of MSW Phase 3 and stages 6 through 10 occurred during the development of MSW Phase 4. The HELP model estimates that average monthly leachate production will reach 596,400 gallons/month during the initial stages of Phase 4 development. Landfill records over the past six years show an average monthly leachate generation of approximately 220,000 gallons per month, and 323,500 gallons/month for F.Y. 2005, the wettest year during the past six years. The highest total leachate production for a calendar month was 486,000 gallons in September 2004, although during a 30 day period in September and October of that year, 600,000 gallons of leachate were removed. The monthly average calculated by the HELP model for 15.5 acres of lined landfill was the same as the greatest actual observed leachate production for a 21.5 acre area of lined landfill. During the six-year time period, there were only 4 months where leachate generation exceeded 400,000 gallons (for 21.5 acres). The HELP Model analysis is a conservative estimate of leachate production and will continue to be considered when designing improvements to the landfill leachate system; however, leachate production records will be utilized as well. The leachate collection system must be prepared to handle extreme events as well as function efficiently at average production levels.

2.5 Average Leachate Production Flows and Pumping

Utilizing the existing leachate production information included in Section 11 of the Permit to Construct, and pro-rating those quantities over the 15.5-acre footprint of Phases 3 and 4, it is estimated that Phases 3 and 4 will produce leachate at an average monthly rate of 250,000 gallons. Applying a 1.5 safety factor to this quantity results in an average rate of 375,000 gallons per month. To remove the leachate from the phase, assume that on average each pump will operate for 8 hours per day, which requires that the pumps remove leachate at an average flow of 13 gpm. Applying a peaking factor of 2 to the flow calculations, it is necessary for each pump to remove leachate at the rate of 26 gpm. Therefore, each pump will be designed to pump 26 gpm at a total dynamic head (TDH) of 25.5 feet. The pumps will utilize a 3" x 6" dual-contained force main located along the northern margin of Phase 3, which will run for approximately 150 l.f. to a point where the force main discharges into proposed leachate collection system gravity sewer manhole #2. The gravity sewer will flow approximately 375 l.f. where it will discharge to proposed leachate collection system gravity manhole #1, just upstream of the leachate storage lagoon. See Sheet C18 for proposed leachate force main and gravity sewer piping. The force main will accommodate a minimum flow of 26 gpm flow with a minimum velocity of 2 feet per second. The leachate storage lagoon located north of Phase 1 has a total storage volume of 642,000 gallons.

2.6 Contingency Plan For Peak Flow Conditions And Leachate System Disruption

In the event of an extreme rainfall event, the HELP model projects a peak leachate production of 30,950 cubic feet/day, or approximately 231,000 gal/day. This peak event would be seen at Stage II of landfill development within the first two years of operation of Phase 3. Over time, the effects of an intense storm event would be greatly dampened due to the increase in the length of time that it would take stormwater to percolate through the layers of waste and daily cover. The available storage volume below the perimeter liner edge elevation of 2515 is approximately 2,200,000 gallons. During the peak event as described by the HELP model, the landfill can contain leachate for 10 days of peak discharge intensity. It is unlikely that the HELP model 1-day peak intensity rate would continue for 10 days. Therefore it is highly unlikely for the landfill to produce more leachate than the pumps can transport to the leachate lagoon.

Under average operating conditions, in the event that there was a temporary failure with any of the leachate removal and storage equipment, the geometry of the landfill would allow for the landfill to contain the leachate for a period of several months. However, the system should never be out of operation for more than a few hours, and then only under extreme circumstances. Due to the conservative design of the leachate removal and storage equipment and the geometry of the landfill, the possibility of leachate buildup overflowing the perimeter berm is very low.

In conjunction with the development of Phase 3, the existing leachate lagoon will be raised and a new liner will be installed on top of the existing liner. Currently, the lagoon has a storage capacity of 642,000 gallons. The lagoon will be raised by approximately 3.25' in order to provide an additional 375,000 gallons of storage volume. During the construction of the additional storage volume, a new 60-mil textured HDPE liner will be installed over the existing liner. A double-sided geocomposite will be installed between the existing liner and the proposed liner. The final volume of the lagoon will be approximately 1,017,000 gallons. Leachate will be pumped directly to the leachate tanker truck during the period of the lagoon expansion, which will take several days. Pumping will occur from proposed leachate manhole #1, which will be located just outside the limits of the lagoon. Depending on weather conditions at the time of construction, the County must make provisions to transport leachate on a 24-hour basis. During the summer months of the drought in 2007 and 2008, the 6,000 gallon tanker truck was filled every 3 or 4 days, or longer. However, if wet weather is encountered during the time of the construction project, it will be necessary for the County to rent an additional tanker truck and make provisions for 24 hours of operation.

Section .1624 (2)(A)(ii) of the Solid Waste Management Rules states that "the geometry of the landfill shall be designed to control and contain the volume of the leachate generated by the 24-hour, 25-year storm." The input parameters of the HELP model

included maintaining a minimum head of one (1) foot on the geomembrane liner, and the additional calculations have been done to assure that rule .1624 (2)(A)(ii) was met.

2.7 Existing Dual-Contained Gravity Sewer Connection Beneath Phase 3

A portion of Phase 3 will be constructed over the existing dual-contained gravity sewer that services the sump areas of existing Phase 2 and existing Phase 1, Cell 4. The existing dual-contained gravity sewer will be replaced with new dual-contained gravity sewer to ensure that there is a minimum 4' separation between the bottom of the proposed Phase 3 clay liner and the top of the new sewer. The dual-contained gravity sewer will daylight into a new HDPE manhole located outside of the Phase 3 liner limits along the proposed access road to Phase 3. The new gravity sewer will connect to the existing leachate gravity system near the north margin of the Phase 1 cell, which flows to the existing leachate lagoon.

3.0 DESIGN SUMMARY

3.1 Analytical Methods Used for Design Evaluation

3.1.1 Liner Components.

Review of EPA literature, NCDENR regulations, and Geomembrane liner manufacturer data.

3.1.2 Leachate collection system

The leachate collection system is designed to handle leachate production flows as determined by evaluation of documented leachate generation rates. Pipe spacing is based upon HELP Model and Manning Equation analysis.

3.1.3 Leachate Production

Volumes – Documented leachate generation rates, and HELP Model
Storage Facilities - HELP Model during Phases 3 & 4

3.1.4 Gas Collection System

EPA design manual and assumption that gas well radius of influence = 100-125 feet.

3.2 Definition of Critical Conditions and Assumptions Made

Critical components

Phases 3 & 4 will connect to the existing Phases 1 and 2 liner edge and waste will piggyback over the existing Phases 1 and 2 MSW waste areas.

Base liner system separation of four (4) feet above average seasonal high water table

- Maximize use of existing property
- Existing soils may require amendment to get 1.0×10^{-7} permeability, or off-site borrow sources may have to be utilized.
- Constructed with washed stone leachate collection drainage layer to minimize potential of clogging
- Proposed base liner system and proposed final cap system in accordance with current regulations

3.3 Technical References Used

- EPA 530-R-93-017 "Solid waste disposal facility criteria, technical manual"
- NC Regulations (15A NCAC 13B)
- Federal Regulations
- HELP Model
- Geomembrane liner manufacturer literature
- "Subtitle D technical training manual"
- EPA/625/R-94/008 Seminar publication "Design, operation, and closure of municipal soil waste landfill"
- EPA/600/R-94/168a "Hydraulic evaluation of landfill performance (HELP) Model user's guide for version3"
- Bagchi, Amalendu. (1994). Design, Construction, and Monitoring of Landfills, John Wiley and Sons, Inc., New York, NY.

3.4 Location Restrictions

The Phases 3 & 4 expansion complies with all location restrictions given in Section .1622 of the Solid Waste Management Rules (15A NCAC 13B).

3.4.1 Airports

There are no Public Use Airports within the two-mile perimeter of the White Oak Landfill. The closest airport is located just over nine miles north of the Facility.

3.4.2 Water Supply

There are two public water supply wells located within a two-mile perimeter of the White Oak Landfill, at the Fines Creek Methodist Church and the Panther Creek Baptist Church. No water supply wells are located within 500' of the proposed Phases 3 & 4 landfill expansion. Private water supply wells located near the White Oak Landfill are illustrated on Sheet C1 of the Permit to Construct Plans.

3.4.3 Zoning

The area of the Phases 3 & 4 landfill expansion at the White Oak Landfill is not located within a zoned area.

3.4.4 Contamination Sources

The White Oak Landfill is the only known potential source of contamination in the area, with the exception of agricultural activities in the area.

3.4.5 Historical Sites

Six historical sites on the White Oak Landfill property were identified and examined during the preparation of the "MSWLF Facility Site Study, White Oak Landfill", prepared by Municipal Engineering and dated November 4, 1998. Four of the sites are prehistoric and two are historic. Three of the sites will be impacted during the construction of the Phases 3 & 4 expansion. None of the sites are recommended as eligible for inclusion on the National Register of Historic Places. The Site Study report concludes that no additional work is necessary at the sites. For an extensive discussion of Cultural Resources in the vicinity of the White Oak Landfill, see Section 4.7 of the "MSWLF Facility Site Study, White Oak Landfill".

3.4.6 Floodplains

Portions of the White Oak property along the Pigeon River are located in the 100-year floodplain; however, the extent of the floodplain is located over 1,000 feet horizontally and 150 feet vertically downgradient of the Phases 3 & 4 expansion. No area of the expansion is located within a 100-year floodplain.

3.4.7 Wetlands and Streams

A wetlands area and a stream are present in the area of the Phase 3 development. See Sheet C2 of the permit drawings for the location of the wetlands and stream. A jurisdictional delineation was performed by ClearWater Environmental and a representative of the U.S. Army Corps of Engineers (USCOE) conducted a field verification of the delineation. Approximately 0.45 acres of wetlands and 185 linear feet of stream will be impacted by the construction of Phase 3. An application for the wetlands and stream impact has been submitted to the USCOE and the NCDENR-Division of Water Quality for 404/401 permitting. A copy of the 404/401 permits will be submitted to the NCDENR-Solid Waste Section prior to the issuance of a Permit To Construct Phase 3. Beyond the areas of the stream/wetlands impact, the Phases 3 & 4 Expansion will not have detrimental effects on fish and wildlife. All of the following will be conformed to:

- Endangered Species Act of 1973
- Marine Protection, Research, and Sanctuaries Act of 1972
- Section 404 of the Clean Water Act

3.4.8 Seismic Design

See the Design Hydrogeologic Report prepared by Bunnell-Lammons, Inc.

3.4.9 Fault Areas

See the Design Hydrogeologic Report prepared by Bunnell-Lammons, Inc.

3.4.10 Unstable Areas

See the Design Hydrogeologic Report prepared by Bunnell-Lammons, Inc.

4.0 MATERIALS AND CONSTRUCTION PRACTICES

All materials and methods used for constructing the Phases 3 & 4 Expansion will meet the requirements set forth in Section .1624 of the Solid Waste Management Rules (15A NCAC 13B).

4.1 Subgrade

The landfill subgrade will be adequately free of organic materials and will consist of on-site soils or select fill material previously approved by the Division. The subgrade will be graded according to plans approved by the Division. The landfill operator may be required to notify the Division's hydrogeologist for inspection of the subgrade once excavation is complete. This notification would be indicated in the Permit To Construct.

Before construction of the liner system, the Project Engineer will visually inspect the subgrade. The Project Engineer will evaluate the integrity of the surface and document proper preparation and elevations according to plans approved by the Division. The subgrade will be proof-rolled using procedures specified by the technical specifications. The subgrade will be tested for moisture and density requirements at the minimum frequency given in the Division approved technical specifications and the Site Specific Construction Quality Assurance Plan.

4.2 Clay Liner

The materials used to construct the compacted clay liner will consist of native on-site materials. The on-site materials may require bentonite admixture in order to meet the requirements of the technical specifications. If a bentonite admixture is required, the material will be mixed and stockpiled according to methods approved by the technical specifications and the Project Engineer. Off-site materials may be used to acquire materials capable of meeting the project technical specifications. Any material used to construct the clay liner portion of the base liner system shall meet all of the requirements of the project technical specifications.

Construction methods used for placement of the compacted clay liner will be in accordance with the project technical specifications.

4.3 Geomembrane Liner

The geomembrane material will have a demonstrated water vapor transmission rate less than or equal to 0.03 gm/M^2-day. The geomembrane will also have physical and chemical resistance to environmental exposure, waste placement, and leachate generation. The primary liner will be high density polyethylene with a minimum thickness of 60 mils.

The installation of the geomembrane will conform to manufacturer's recommendations and the project technical specifications. The liner edge will be installed and secured into an anchor trench at the Phase limits. Refer to Appendix B for anchor trench calculations.

4.4 Leachate Collection Pipes

Leachate collection piping will have a minimum nominal diameter of six (6) inches for lateral collectors and eight (8) inches for main collectors, and be made of high density polyethylene material. The pipe will provide adequate structural strength to support static and dynamic loads produced by materials and equipment used during construction and operation of the landfill. The pipe will also provide adequate structural strength to support static loads produced by the waste fill and components of the final cap. Refer to Appendix A for pipe stability calculations.

The leachate collection pipes will be installed according to the Sheet C4 of the permit drawings for Phase 3 and Sheet C8 for Phase 4. All piping will be constructed with cleanouts where physically possible for periodic cleaning and maintenance. The bedding material for the collection lines will be #5 washed aggregate with no more than five (5) percent by weight passing the #200 sieve. This aggregate will also be chemically compatible with leachate generated in the phase and shall meet all the requirements of the project technical specifications.

4.5 Drainage Layers

The aggregate used as the drainage layer in the phase will not be adversely affected by leachate produced in the phase and will promote lateral drainage of leachate. The drainage layer material shall meet all the requirements of the project technical specifications.

The drainage layer will be placed by methods given in the project technical specifications and the Site Specific Construction Quality Assurance Plan. The drainage layer material will be stable on the 3:1 side slopes of the phase. Please refer to the Design Hydrogeologic Report prepared by Bunnell-Lammons, Inc.

.

4.6 Filter Layers

Filter layers in the leachate collection system will prevent migration of fine soil particles from entering the aggregate drainage layer, while allowing water and gases to enter the drainage medium without clogging. Geosynthetic filters shall demonstrate adequate permeability and soil particle retention, while having chemical and physical resistance from waste placement, leachate, and any overlying material. Geosynthetic materials shall meet all of the requirements of the project technical specifications.

All filter layers will be installed according to the project technical specifications, construction drawings, and the Site Specific Construction Quality Assurance Plan. Geosynthetic filters will not be wrapped directly around leachate collection piping.

4.7 Erosion Control

The erosion control structures are designed and will be maintained to manage the run-off generated by the 24-hour, 25-year storm event and will conform to the requirements of the Sedimentation Pollution Control Law (15A NCAC 4). An erosion and sedimentation control permit from NCDENR-Land Quality Section is pending. A copy of the approved erosion control plan will be forwarded to the Solid Waste Section prior to the issuance of a Permit to Construct for Phase 3. Erosion control measures for Phase 3 are shown on

Sheet C 5 of the Permit to Construct plans. Final erosion control measures are shown on Sheet C11.

5.0 DESIGN HYDROGEOLOGIC REPORT

The Design Hydrogeologic Report for Phases 3 & 4 was prepared by BLE, Inc. A copy of this report was included with the design package submitted to the Solid Waste Section under separate cover.

6.0 ENGINEERING DRAWINGS

6.1 Existing Conditions

Sheet C1 of the design drawings shows existing site topography, borings, piezometers, existing and proposed ground water monitoring wells, existing and proposed gas probes, existing roads, existing buildings, existing MSW Phases 1 and 2, existing landfill facilities, and the proposed location of the Phases 3 & 4 Expansion.

6.2 Grading Plans

The grading plans identify the proposed limits of excavation, clay liner elevations, and drainage layer elevations. Sheet C3 of the construction drawings shows the top of clay liner elevations. Sheet C4 shows the top elevation of the drainage layer.

6.3 Base liner System

The grades for the top of the Phase 3 clay liner are shown on Sheet C3. Sheet C7 shows the top of the Phase 4 clay liner elevations. As shown on the drawings, the minimum floor slope within the Phases 3 & 4 Expansion is 2.75 percent. Sheet C14 of the permit drawings shows the post-settlement contours for the top of clay. The minimum post-settlement slope of the base liner system is greater than two (2) percent. The interior 3:1 side slopes and exterior fill slopes are also shown on Sheet C3. The anchor configuration and details of the base liner system are shown on the detail Sheets, D1-D11.

6.4 Leachate Collection System

The leachate collection system for Phase 3 is shown on Sheet C4 of the permit drawings. Sheet C8 shows the Phase 4 leachate collection system. The drainage layer washed stone for the leachate collection system is placed directly on the geotextile cushion and primary geomembrane. The cleanouts and sump locations are also identified on the drawings. The top of the stone drainage layer is shown on Sheets C4 and C8 of the drawings. Details for the leachate collection system, including sump details, cleanout details, and piping details are shown on the detail Sheets, D1-D11. The proposed leachate system

force main and gravity sewer beyond the limits of the landfill cells are shown on Sheet C18.

6.5 Stormwater Segregation System

Phases 3 & 4 will be covered by a synthetic stormwater control liner that lies on top of the drainage layer. (Refer to Sheet C5). This stormwater control liner will allow stormwater runoff to collect in the lower end of the phase. Stormwater runoff will then be pumped over the perimeter embankment though a six –inch (6") and discharged into a gravity drainage pipe. The drainage pipe will discharge at a point near the unnamed stream just north of Phase 3. An energy dissipater will be installed at the discharge point. Prior to entering an inactive area of landfill, the stormwater control liner will be partially removed. The overlying synthetic cover will be pulled back in stages, therefore keeping even active areas exposed to a minimum amount of rainwater. As the active working face increases in elevation, berms will be used to direct stormwater runoff to periphery ditches. See Sheets D1-D6 for a detail of the temporary stormwater control berm.

6.6 Cap System

Sheets C6 and C10 of the permit drawings show proposed temporary and permanent cap grades of the proposed Phases 3 & 4 Expansion. Intermediate cover will be placed on the temporary cap slopes. As adjacent phases are developed, the temporary slopes will increase to the ultimate build-out of the phase. The final cap will include a one (1) foot thick compacted intermediate cover, an eighteen (18)-inch thick clay layer, a forty (40) mil textured HDPE geomembrane, a double-sided eight (8)-ounce geocomposite, and an eighteen (18)-inch thick vegetative\erosion layer. Details of the cap system are shown on Sheets D1-D11 of the permit drawings.

Although not required by Solid Waste Rules or air permitting rules, Haywood County is in the process of developing a methane gas collection and combustion system at the White Oak Landfill. A methane collection system for Phases 3 & 4 is included in this submittal. The proposed methane gas collection system for Phases 3 & 4 has been shown on Sheet C12 of the permit drawings. The proposed gas collection system will connect to the proposed gas collection system for Phases 1 and 2. The proposed expansion of the system will consist of vertical gas extraction wells, horizontal gas collection wells, intermediate gas collection piping connecting the extraction wells to 12" and 16" transmission headers located at the eastern margin of Phase 1. The transmission lines will lead to a future blower and flare located just to the east of the existing Phase 1 waste area. The methane extraction wells will be constructed prior to construction of the final cap. A typical gas collection well has a radius of influence of approximately 100 to 125 feet. This results in approximately fourteen (14) wells proposed for the Phases 3 & 4 area. The typical well penetrates the waste mass and allows a conduit for vertical migration of methane gas. The wells will be installed to a depth that is 10' above the top of stone leachate collection system layer. An HDPE boot will be placed at the area where

the extraction well penetrates the cap geomembrane to retard surface water and oxygen infiltration into the waste layers. A bentonite/soil mixture will also be placed and compacted around the vertical collection wells where the wells penetrate the clay liner.

6.7 Erosion Control

An erosion control plan submittal for Phases 3 & 4 is in the process of being finalized. In addition to the existing sediment basin located near the leachate lagoon north of the Phase 1 waste area, three additional permanent sediment basins are proposed at the north and west area of Phases 3 & 4. These basins will be utilized to control sedimentation during construction and operation of the phases. Storm water runoff will be directed to these basins prior to release to nearby streams. An additional sediment basin will be constructed to the south of the proposed soil stockpile area located to the south of Phases 3 & 4. In all cases, ditches, piping, and sediment basins were sized to accommodate the greatest flow that will be encountered throughout the lifetime of the landfill phase. Often, the greatest flow will be seen as the landfill reaches its capacity when the slopes are steepest, many years into the future. A copy of the erosion control permits associated with the development of Phases 3 & 4 will be forwarded to the Solid Waste Section upon receipt. The White Oak Landfill is being operated under a general stormwater permit that issued in November of 2007.

The erosion and sedimentation control law is performance based and although existing erosion control permits and measures are in-place, it is still the responsibility of the contractor and landfill operator to ensure that the erosion control systems are functioning properly. Existing and proposed erosion/sedimentation control structures include sediment basins, storm drains, temporary slope drains, check dams, and diversion ditches. Sediment basins will be checked after periods of significant runoff. Sediment will be removed from the basin to its original dimension when sediment accumulates to one half of the design depth. The sedimentation basins, embankments, ditches, inlets and outlets will also be inspected for erosion damage. All necessary repairs will be made immediately. Any trash or debris within the riser pipes will be removed. Storm drain outlets and diversion ditches will be inspected for damage after each runoff event. Rip rap will be placed in ditches and at pipe outlets to prevent erosion and wash outs. Provisions for a vegetative ground cover sufficient to control erosion must be accomplished within fifteen days upon completion of any phase of grading. Embankment slopes shall be periodically inspected for erosion. The embankment slopes shall be mowed at a frequency sufficient to maintain a good stand of vegetation. The slopes shall be mowed once in any one (1) year period. The embankment slopes shall be refertilized in the second year unless vegetation growth is fully adequate. Any damaged areas will be reseeded, fertilized, and mulched immediately. Seeding, fertilizing and mulching shall be in accordance with the North Carolina Erosion and Sedimentation Control Guidelines.

The erosion control plan for the construction of the Phase 3 is included on Sheet C5 of the permit drawings. The final erosion control plan is shown on Sheet C11 of the permit drawings.

6.8 Vertical Separation Requirements

Cross sections of Phases 3 & 4 are shown on Sheets C22 through C24 of the permit drawings. These drawings illustrate the base liner thickness, the depth of waste, the cap system thickness, and the existing ground elevation, the potentiometric surface, and bedrock elevations. Cross sections of the subsurface conditions, created from boring data at the site, are shown in the Phases 3 & 4 Design Hydrogeologic Report prepared by BLE, Inc. The report also contains an average seasonal high water contour map, a bedrock contour map, and a potentiometric surface map. The minimum separation between the **bottom** of the proposed clay liner and the water table in Phases 3 & 4 is 6 feet, located near the center of the Phases 3 & 4 area and at the sump area at the northern margin of Phase 3. This vertical separation increases up to 16 feet near the high point at the western edge of the new phase. Therefore, although the long-term settlement across the footprint of the landfill could be as much as 18 inches in places, the original separation between the base grades and the average high water table will allow for this magnitude of potential settlement. The estimated subgrade settlement is shown in the BLE Design Hydrogeologic Report. The projected settlement is shown on Sheet C21 of the permit drawings.

Differential settlement was looked at to ensure that if one area of the landfill subsides greater than adjacent areas, the resultant slope will still be sufficient for leachate migration to the sump areas. The worst case scenario would be if the southern margin of Phase 3 subsided the greatest amount estimated by the BLE, Inc. Design Hydrogeologic Report – 15", while the northern margin showed no subsidence. In this event, the resultant grade of the landfill floor would still be greater than 2%, which would allow for leachate to migrate to the sumps.

APPENDIX A

Pipe Stability Calculations

Appendix A

Pipe Stability Calculations

Max. landfill elevation: 2676
Clay grade elevation: 2548
Maximum overburden depth: 128'

Overburden Description (landfill fully developed)

Unit Weights:

Drainage layer stone: 130 lbs/ft^2
Compacted waste: 55 lbs/ft^2
Compacted soil material: 110 lbs/ft^2

Overburden Pressure

Drainage layer: 2 ft @ 130 lbs/ft^2 = 250 lbs/ft^2
Compacted waste: 128 ft @ 55 lbs/ft^2 = 7,040 lbs/ft^2
Compacted soil: 4 ft @ 110 lbs/ft^2 = 440 lbs/ft^2
7,740 lbs/ft^2

or $\frac{7{,}740 \text{ lbs/ft}^2}{144 \text{ in}^2/1 \text{ ft}^2} = 53.8$ psi

Check for Wall Crushing

$P_t = 53.8$ psi
SDR = 17

$S_a = \frac{(SDR - 1)}{2} P_t = 430.4$ psi

Assume compressive yield strength of HDPE pipe is approximately 1,500 psi, therefore, safety factor against wall crushing: $\frac{1{,}500 \text{ psi}}{430.4 \text{ psi}} = 3.4$

Check for Wall Buckling

$P_{cd} = 0.8 \sqrt{(E' \times P_c)}$
$P_t = 53.8$ psi
$P_c = \frac{2.32 (E')}{(SDR)^3} = 14.17$

- P_{cd} must be greater than P_t to resist against wall buckling
- Assume E' = 30,000 psi (crushed stone compacted)
- (Ref. pg. 37 of DriscoPipe design manual) Time dependent modulus of eleasticity @ 150 psi tensile stress = 30,000 psi

$P_{cd} = 0.8\sqrt{(3{,}000 \times 14.17)}$
$P_{cd} = 165$ psi

•150 psi assumption for tensile stress was based on discussion with DricoPipe engineer Bill Shultz

165 psi > 53.8 psi, therefore, there is resistance to wall buckling
Safety Factor: 165/53.8 = 3.1

Ring Deflection

Allowable ring deflection: $\Delta Y/D = (0.25)E(SDR)$
$\Delta Y = (6.625)(0.25)(0.01)(17)$
$\Delta Y = 0.28$"

$\Delta Y/D = 0.28"/6.625" = 4.23\%$

ΔY = vertical deflection (in.)
D = Pipe O.D. (in.)
E = tangential strain in surface of pipe ring due to reflection (=0.01) pg. 39 DriscoPipe manual)
SDR = Standard dimension ratio, D/t
t = pipe wall thickness
For 6" SDR 17, D = 6.625", t= 0.39"

Vertical soil strain: $E = P_t/E'$
$E = 53.8/3{,}000$
$E = 0.0179$

E' = Soil modulus, psi (3,000 psi)
E = Vertical soil strain
P_t = total vertical soil pressure = 53.8 psi

Allowable ring deflection > vertical soil strain
$\Delta Y/D = 0.0423/0.0179$

Safety Factor: 0.0423/0.0179 = 2.36 Pipe meets requirements

APPENDIX B

HDPE Liner Anchor Trench Calculations

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: Haywood County - White Oak LF
PROJECT NO.: Phases 3 & 4
DESCRIPTION: Anchor Trench
CALCULATED BY: WHS CHECKED BY:
DATE: 9/2/08 SHEET NO. 1 OF 6

Material Properties:

Washed Stone: $\gamma_s \approx 130$ pcf
$\phi_s = 40°$

Embankment Fill: $\gamma_F \approx 125$ pcf
$\phi_F = 32°$

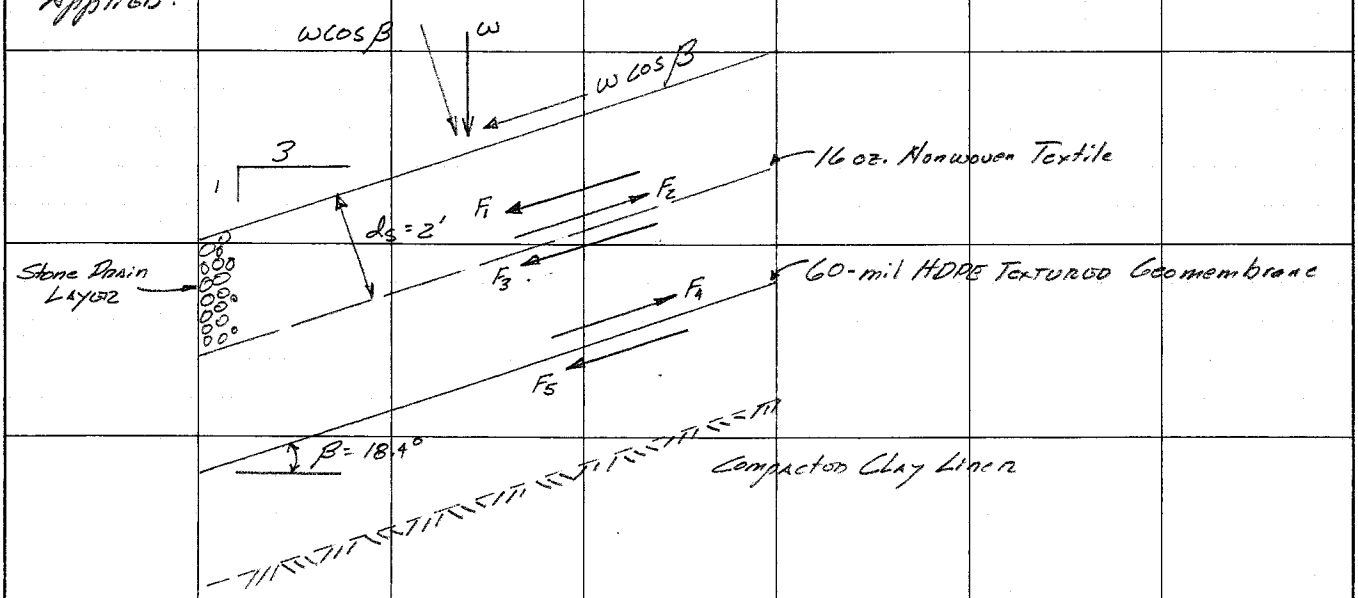
Compacted Clay: $\gamma_c \approx 120$ pcf
$\phi_c \approx 25°$

Minimum interface friction angle between Compacted Clay Liner (L) and the 60 mil HDPE Textured Geomembrane (G): $\delta_{LG} = 17°$

Minimum interface friction angle between Nonwoven Geotextile Fabric (T) and the 60-mil HDPE Textured Geomembrane (G): $\delta_{TG} = 20°$

Minimum interface friction angle between Nonwoven Geotextile Fabric (T) and the washed stone drainage layer (S): $\delta_{TS} = 24°$

Resolution of Shear Stress in Section @ Construction End with No Waste Applied:



McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: Haywood County - White Oak LF
PROJECT NO.: Phases 3 & 4
DESCRIPTION: Anchor Trench
CALCULATED BY: WHS CHECKED BY:
DATE: 9/2/08 SHEET NO. 2 OF 6

$\omega = (d_s/\cos\beta)(\gamma_s)$ $\gamma_s \approx 130$ pcf, $d_s = 2'$, $\beta = 18.4°$

$= (2'/\cos 18.4°)(130\text{ pcf})$

$\therefore \omega = 274$ psf

$N = \omega \cos\beta$ $\omega = 274$ psf, $\beta = 18.4°$

$= (274\text{ psf})(\cos 18.4°)$

$\therefore N = 260$ psf

$F_1 = (N)(\tan \delta_{TS})$ $N = 260$ psf, $\delta_{TS} = 24°$

$= (260\text{ psf})(\tan 24°)$

$\therefore F_1 = 116$ psf

$F_2 = (N)(\tan \delta_{T6})$ $N = 260$ psf, $\delta_{T6} = 20°$

$= (260\text{ psf})(\tan 20°)$

$\therefore F_1 = 95$ psf

$F_1 - F_2 =$ Tensile stress carried by 16oz nonwoven geotextile

$= 116\text{ psf} - 95\text{ psf}$

$= 21$ psf

Maximum inside slope length @ Trench to existing liner ≈ 70'
Total Tensile Stress in Fabric, T, is

$T_F = (70')(21\text{ psf})$

$= 1470$ lbs/LF of fabric

From published data, 16 oz nonwoven geotextile fabric has a tensile yield strength @ 195 to 220 #/inch (2340 lbs/ft to 2640 lbs/ft.)

$F.S._{(min)} = 2340\text{ lbs/ft} / 1470\text{ lbs/ft} = 1.59$ O.K.

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: Haywood County - White Oak LF
PROJECT NO.: Phase 3 & 4
DESCRIPTION: Anchor Trench
CALCULATED BY: WHS CHECKED BY:
DATE: 9/2/08 SHEET NO. 3 OF 6

By inspection: $F_3 = F_2$ (in opposing direction)

$\therefore F_3 = 95$ psf

$F_4 = (N)(\tan \delta_{LG})$ $N = 260$ psf ; $\delta_{LG} = 17°$
$(260 psf)(\tan 17°)$

$\therefore F_4 = 79$ psf

Tensile Strength carried by HDPE Textured Geomembrane $= F_3 - F_4$
$= 95$ psf $- 79$ psf
$= 16$ psf

Max inside slope length @ Tie-in to Existing Liner ≅ 70'

$T_G = (70')(16 psf)$
$= 1120$ lbs/LF of Geomembrane

From published data, 60-mil HDPE Textured Geomembrane Liners have an approximate yield strength in wide width tension of approximately 130 lbs/inch (1560 lbs/LF)

F.S. 1560 lbs/LF / 1120 lbs/ft = 1.39 O.K.

By inspection: $F_5 = F_4$ in opposing direction

$\therefore F_5 = 79$ psf

Internal shear in Compacted Clay:

$\tau = N(\tan \phi_c)$ $N = 260$ psf ; $\phi_c = 25°$
$= (260 psf)(\tan 25°)$

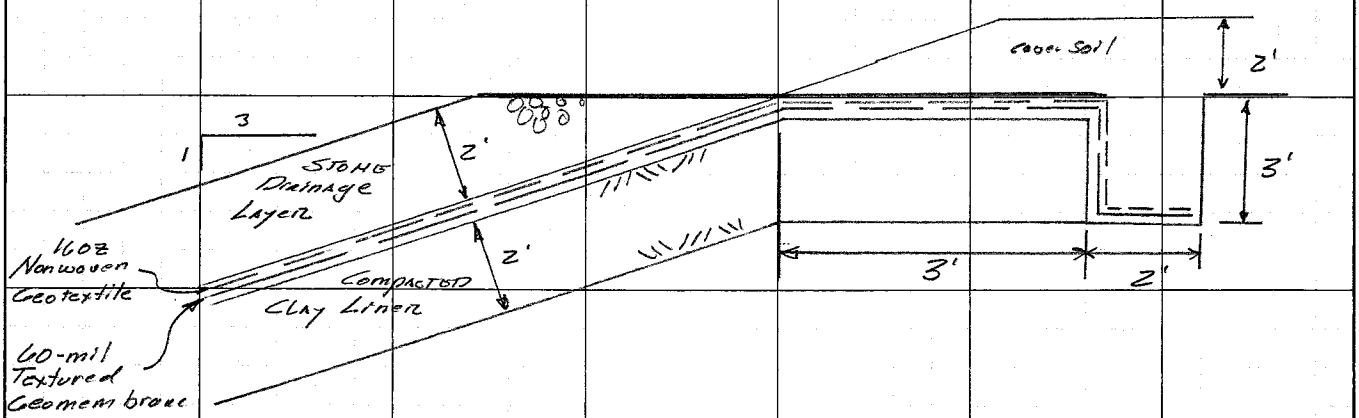
$= 121$ psf

F.S. (min) = 121 psf / 79 psf = 1.5 O.K.

By inspection, stresses w/ waste deposition should result in decreased stresses in Liner Components due to an increase in normal forces and friction developed at the edge of waste at the transition from base grades up the interior slope.

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: Haywood County - White Oak LF
PROJECT NO.: Phase 3 & 4
DESCRIPTION: Anchor Trench
CALCULATED BY: WHS CHECKED BY:
DATE: 9/2/08 SHEET NO. 4 OF 6



Cover soil Density: $\gamma_F \approx 125$ pcf
Anchor Trench Soil Density: $\gamma_F \approx 125$ pcf
Anchor Trench width: $L_{AT} = 2'$
Anchor Trench depth: $d_{AT} = 3'$
Depth of Cover Soil: $d_{CS} \approx 2'$

Rollout Trench Length: $L_{RO} = 3'$
Anchor Trench Backfill Material friction Angle: $f = 25°$
Minimum Interface Adhesion: $a = 0$

Anchor Trench Rollout Resistance (Liner to clay)

$P_{R1L} = (S_{n1} \tan \delta_{LG} + a) L_{RO}$
where $S_{n1} = (\gamma_F)(d_{CS})$
$= (125 pcf)(2')$
$S_{n1} = 250$ psf

$= ((250 psf)(\tan 17°) + 0)(3')$
$P_{R1L} = 229$ lbs/ft

Anchor Trench Bottom Resistance: (Liner)

$P_{R2L} = (S_{n2} \tan \delta_{LG} + a) L_{AT}$
where $S_{n2} = (\gamma_F d_{CS}) + (\gamma_F d_{AT})$
$= (125 pcf)(2') + (125 pcf)(3')$
$= 250 psf + 375 psf$
$S_{n2} = 625$ psf

$= ((625 psf)(\tan 17°) + 0)(2)$
$P_{R2L} = 382$ lbs/ft

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: Haywood County - White Oak LF
PROJECT NO.: Phase 3&4
DESCRIPTION: Anchor Trench
CALCULATED BY: WHS CHECKED BY:
DATE: 9/2/08 SHEET NO. 5 OF 6

Anchor Trench Sidewall Resistance (Liner)

$K_o = (1 - \sin f)$
$= 1 - \sin 25°$
$= 0.58$

Avg. normal stress through anchor Trench

$S_{AVGV} = (S_{n1} + S_{n2})/2$
$= (250\ psf + 625\ psf)/2$
$S_{AVGV} = \underline{438\ psf}$

$S_{AVGH} = (K_o)(S_{AVGV})$
$= (0.58)(438\ psf)$
$S_{AVGH} = \underline{254\ psf}$

$S_{HAVG} = S_{n3} = 254\ psf$

$P_{R3L} = (S_{n3} \tan \delta_{LP} + a)(d_{AT})$
$= ((254\ psf)(\tan 17°) + 0)(3')$
$\underline{P_{R3L} = 233\ lbs/LF}$

Geotextile to Liner:
minimum Geotextile to Liner Interface Friction Angle: $\delta_{TL} = 20°$
minimum Geotextile interface adhesion: $a = 0$

Anchor Trench Rollout

$P_{R1T} = (S_{n1} \tan \delta_{TL} + a)(L_{RO})$
where $S_{n1} = (\gamma_P)(d_{AS})$
$= (125\ pcf)(2')$
$= 250\ psf$

$P_{R1T} = ((250\ psf)(\tan 20°) + 0)(3')$
$\underline{P_{R1T} = 273\ lbs/LF}$

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: Haywood County - White Oak LF
PROJECT NO.: Phase 3:4
DESCRIPTION: Anchor Trench
CALCULATED BY: WHS CHECKED BY:
DATE: 9/2/08 SHEET NO. 6 OF 6

Anchor Trench Bottom Resistance (Geotextile)

$P_{R2T} = (S_{n2} \tan \delta_{TG} + a)(L_{AT})$

where $S_{n2} = (\gamma_F)(d_{CS}) + (\gamma_F)(d_{AT})$

$= (125 pcf)(2') + (125 pcf)(3')$

$= 250 psf + 375 psf$

$= 625 psf$

$= ((625 psf)(\tan 20°) + 0)(2')$

$P_{R2T} = 455 lbs/ft$

Anchor Trench Sidewall (Geotextile)

$K_o = (1 - \sin f)$

$= 1 - \sin 25°$

$K_o = 0.58$

Avg normal Stress Through Anchor Trench

$S_{AVGU} = (S_{n1} + S_{n2})/2$

$= (250 psf + 625 psf)/2$

$= 438 psf$

$S_{AVGH} = K_o * S_{AVGU}$

$= (0.58)(438 psf)$

$= 254 psf$

$S_{AVGH} = S_{n3}$

$P_{R3T} = (S_{n3} \tan \delta_{TG} + a)(d_{AT})$

$= ((254 psf)(\tan 20°) + a)(3')$

$P_{R3T} = 277 lbs/ft$

TOTAL Anchor Trench Rollout:

$T_{PR} = P_{R1L} + P_{R2L} + P_{R3L} + P_{R1T} + P_{R2T} + P_{R3T}$

$= 229 lbs/ft + 382 lbs/ft + 233 lbs/ft + 273 lbs/ft + 455 lbs/ft + 277 lbs/ft$

$= 1849 lbs/ft$

$F.S. = 1849 lbs/ft / 1470 lbs/ft = 1.26$ OK

Section - COA Plan

SITE SPECIFIC CONSTRUCTION QUALITY ASSURANCE PLAN

WHITE OAK MSW LANDFILL
PHASES 3 & 4
HAYWOOD COUNTY, NORTH CAROLINA

JEFFREY R. BISHOP, P.E.

McGill ASSOCIATES

Engineering • Planning • Finance
Asheville, North Carolina

NORTH CAROLINA PROFESSIONAL SEAL 23574 ENGINEER JEFFREY R. BISHOP

9/05/08

September 2008

07518

SITE SPECIFIC CONSTRUCTION QUALITY ASSURANCE PLAN

White Oak MSW Landfill
Haywood County, North Carolina
Phases 3 & 4

This Construction Quality Assurance Plan has been prepared as required under Rule .1617 and in accordance with Rule .1621.

1.0 INTRODUCTION

1.1 Project Background

The White Oak MSW Landfill Site is the current MSW landfill for Haywood County. The current project involves the construction of a 15.5-acre expansion referred to as Phases 3 & 4. Phase 3, consisting of 8.8 acres, will be constructed initially and will provide approximately 5 years of landfill airspace. Phase 4 will be constructed and brought on line as Phase 3 nears operational capacity. Phase 1 of the landfill began receiving wastes in October 1993. The current active waste area, Phase 2, began operation in November 2001. This project will include connecting to portions of the existing Phase 1 and Phase 2 liner edge. The Phases 3 & 4 Expansion will consist of structural fill to achieve the desired gradients followed by a compacted, low-permeability clay liner layer, a 60-mil high density polyethylene (HDPE) geomembrane liner, and an aggregate drainage layer. The White Oak Landfill site is located in Haywood County at 3898 Fines Creek Road (S.R. 1338).

1.2 Project Scope

The purpose of this Site Specific Construction Quality Assurance Plan (SSCQAP) is to provide guidance to McGill Associates and sub-contractor personnel on required documentation activities during the construction of the engineered Phase expansion. This guidance is intended to ensure that construction meets the requirements of Haywood County and the Project Construction Quality Assurance (CQA) Plan and project drawings and specifications.

The overall goals of the SSCQAP are to ensure that proper construction techniques and procedures are used to verify that the materials and installation techniques used meet Project CQA Plan and project drawings and specifications. Additionally, the program will identify and define problems that may occur during construction and ensure that these problems are corrected before the construction is complete. At completion of work, the program will culminate in a certification report, which documents that, the

clay liner and the geosynthetic liners have been constructed in substantial compliance with this SSCQAP and project drawings and specifications. The primary emphasis of the SSCQAP is careful documentation during the preparation and placement of the clay and the geosynthetic liner.

1.2.1 Scope of Services

The Scope of Services provided by CQA Consulting Firm for the construction of engineered base is as follows:

1. Pre-Construction materials evaluation (structural fill, clay liner, geosynthetics).
2. Structural Fill observation, testing, documentation, and verification of construction procedures.
3. Clay liner observation, testing, documentation, and verification of construction procedures.
4. Geosynthetic observation, testing, documentation, and verification of construction procedures.
5. Provide CQA Report and CQA Certification that Phases 3 & 4 was constructed in accordance with this SSCQAP.

1.2.2 Construction Schedule

Construction of Phase 3 shall be completed within 270 consecutive calendar days.

Description
Preconstruction Meeting
Underdrain Installation
Extension of Existing Leachate Gravity Sewer From Phases 1 & 2, Beneath Phase 3
Structural Fill Subgrade Installation
Primary Clay Liner Installation
Primary Geomembrane Liner Installation
Primary Geotextile Cushion Installation
Installation of Leachate Collection System
Installation of Washed Stone Drainage Layer
Submit CQA Report and CQA Certification

2.0 Parties Involved

2.1 Haywood County

Contact: Mr. Stephen King, (828) 627-8042
Title: Haywood County Solid Waste Director

Contact: Mr. Mark Shumpert, P.E. (828) 356-2114
Title: Haywood County Engineer

Contact: Mr. David Cotton (828) 452-6625
Title: Haywood County Manager

2.2 McGill Associates, P.A.

Contact: Jeffrey R. Bishop, P.E. (828) 252-0575
Title: Project Engineer

2.3 General Contractor

Contact: Unknown

Title:

2.3.1 Surveyor

Contact: Unknown

Title:

2.3.2 Geosynthetic Manufacturer

Contact: Unknown

Title:

2.3.3 Geosynthetic Installer

Contact: Unknown

2.4 Construction Quality Assurance Consulting Firm

Contact: Unknown

Title:

2.4.1 CQA Certifying Engineer

Name: Unknown

Title:

CQA Resident Engineer

Name: Unknown

Title:

Geosynthetic Testing Laboratory

Contact: Unknown

Title:

2.4.4 Soils Laboratory (permeability testing)

Contact: Unknown

Title:

3.0 Preconstruction Meeting

A Preconstruction meeting will be held prior to the beginning of construction. The following people shall be present: Owner representative, Solid Waste Director, County Engineer, Project Engineer, Design Engineer, Certifying CQA Engineer/CQA Project Manager, Resident CQA Engineer, General Contractor, Geosynthetics Installer, and all other subcontractors.

The following items will be discussed at a minimum:

Any questions about the SSCQAP will be addressed and any modifications that result will be documented. Any modifications to the approved SSCQAP must be approved by the North Carolina Department of Environment, Health, and Natural Resources, Division of Waste Management, Solid Waste Section (DEHNR Solid Waste Section).

- Special permits and state and/or federal regulations.
- Responsibilities, expectations, and roles of each party.
- Lines of authority and proper lines of communication.
- Procedures for documenting and reporting information.
- Distribution and storage of documents and reports.
- Protocol for testing and geosynthetic sample management.
- Protocol for handling construction deficiencies.
- Protocol for repairs and re-testing.
- Conduct site walk through:

  Discuss work plans
  Inspect material handling and storage locations
  Review office facilities (copy machine, mailing, etc.)

- Review detailed time schedule for all operations.
- Review work area security, check-in procedure, and safety protocol.
- Establish procedures for material processing.
- Review site health and safety requirements.

The Preconstruction Meeting will be documented by McGill Associates and a copy of the meeting minutes will be distributed to all parties who attend.

4.0 Definitions

4.1 Construction Quality Assurance

A planned and systematic application of all means and actions designed to provide adequate confidence that items or services meet design and specifications requirements and will perform satisfactorily in service. In the context of the geosynthetic liner system, construction quality assurance refers to means and actions employed by the CQA Resident Engineer, CQA Senior Lead Technician, and the CQA Monitors to

ensure conformity of the liner system installation with guidelines set forth in the SSCQAP, construction plans, and construction specifications.

4.2 Construction Quality Control

Those actions which provide a means to measure and regulate the characteristics of an item or services to design, and specifications requirements. In the context of the geosynthetic liner system installation, quality control refers to those actions taken by the Geosynthetic Contractor/Manufacturer to ensure that the product and the workmanship meets the requirements set forth in the SSCQAP, construction plans, and construction specifications.

4.3 Design Engineer

The individual or firm responsible for the preparation of this SSCQAP, construction drawings, and construction specifications.

4.4 Project Engineer

The individual or firm responsible for the implementation of this SSCQAP, construction drawings, and construction specifications.

4.5 General Contractor

The firm responsible for the complete construction of the soil and geosynthetic components of the landfill as specified in this SSCQAP and as shown on the construction drawings and construction specifications.

4.6 Construction Quality Assurance Consultant

The firm responsible for observing, testing and documenting activities related to construction quality assurance during the installation of the leak detection layer, clay liner, geomembrane liner, and the leachate collection system. The CQA Certifying Engineer is responsible for issuing a summary certification and documentation report bearing his/her Professional Engineering Seal. The CQA Resident Engineer is responsible for the management of on-site CQA personnel and providing the Project Engineer and Owner with a daily report of the construction activities.

5.0 DOCUMENTATION PROCEDURES

5.1 Standard Reporting Procedures

The CQA Technicians shall issue a daily report of construction activities. These reports shall include, as a minimum, the following information:

An identifying sheet number for cross-referencing and documentation control.

Date, project name, location and other identification.

1. Weather conditions.

2. Problems encountered and resolutions.

3. Descriptions and locations of ongoing construction.

4. Equipment and personnel in each work area, including subcontractors.

5. Descriptions and specific locations of areas or units of work being tested and/or observed and documented (identified by coordinates or seam/panel numbers).

6. Locations where samples were taken.

7. A summary of test results, failures, and re-tests.

5.2 Monitors of geosynthetic installation shall perform and/or provide the following information and services:

a. Material delivery (time, date, and physical condition of material)
b. Unloading and on-site storage and transport
c. Sampling for conformance testing
d. Deployment operations (roll #, panel #, approved QA\QC cert, thickness, overlap, defects, etc.)
e. Seam preparation (proper overlap and cleanliness)
f. Seaming operations (seaming method, seam#, welding technician, welding apparatus #, welder settings, ambient temperature, chronological order of seams welded, seam length, etc.)
g. Conditions of panel before and after placement
h. Locate and document all defects in the geosynthetic material.
i. Repairs (location, method, technician, date, etc.)
j. Trial seams (monitor preparation and testing)
k. Nondestructive testing (visual observation and documentation)
l. Sampling for destructive seam testing (locating test location)
m. Final walkovers (confirm defect repairs)

5.3 Applicable Forms

As a minimum, the CQA monitors will utilize the following forms for the project:

1. Daily Field Report
2. Weekly Progress Report
3. Nuclear Density Testing
4. Drive Cylinder Test Report
5. Soil Testing Tracking Log
6. Certificate of Acceptance of Soil Subgrade
7. Geosynthetic Materials Inventory Checklist
8. Weather Log
9. Trial Weld Form
10. Panel Deployment
11. Panel Seaming
12. Nondestructive Seam Testing
13. Destructive Sample Test Log
14. Geosynthetic Defect Log
15. Geosynthetic Repair Log
16. Construction Site Safety Form
17. Construction Photo Log
18. Certificate of Completion

5.4 Problem/Deficiency Identification and Corrective Action Report

The CQA Monitor is required to inform the General Contractor and/or the Geosynthetic Contractor, or their representatives, in a timely manner, of any difference between the interpretation of the SSCQAP, the construction plans and construction specifications by the contractor versus the CQA Monitor's interpretation. In addition, any actual or suspect work deficiencies shall be brought to the Project Engineer's and Owner's attention.

A special meeting shall be held when and if a problem or deficiency is present. At a minimum, the meeting shall be attended by the General Contractor, the Owner, the Project Engineer, the CQA Resident Engineer, and the CQA Monitor. If the problem involves a possible design modification, the Design Engineer shall be notified. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

1. Define and discuss the problem or deficiency

2. Review alternative solutions
3. Implement an action plan to resolve the problem or deficiency

The CQA Resident Engineer or his representative will document all proceedings.

Any changes and/or modifications to the SSCQAP must be approved by the Owner, Design Engineer, Project Engineer, CQA Certifying Engineer, and the DEHNR Solid Waste Section.

5.5 Plan Modifications

Design and/or specification changes shall be made only with written approval of the Owner, the Design Engineer and the Project Engineer. Substantial design changes shall also require approval from the DEHNR Solid Waste Section.

5.6 Scope Change

The CQA Resident Engineer shall notify the Project Engineer whenever additional engineering services are requested by Owner that exceed the original scope of services.

5.7 Photographic Documentation

Photographs taken to document observations, problems, and/or deficiencies, or work in progress will include identification of the date, location, direction of view, and time period. Photographs will be filed in chronological order in a permanent protective file by the CQA team. One set of prints shall be turned over to both the Owner and Project Engineer at the conclusion of the project.

The permanent file will also contain a comprehensive index of each photo, which the CQA Monitor is responsible for preparing and maintaining. This index will include the following information:

1. Date of photograph
2. Provide a location and scale where photographed, including information regarding the orientation of the photograph itself for proper viewing
3. Subject description
4. Photo file number

The following is a list of minimum photographs to be taken during cell construction:

1. Subgrade/subbase proof rolling
2. Geosynthetic conformance sampling
3. Geomembrane deployment
4. Fusion welding devices
5. Extrusion welding devices
6. Air testing
7. Vacuum box testing
8. Seaming
9. Destructive sample location and removal
10. Trial welds
11. Tensiometer testing
12. Geotextile deployment
13. On-site lab soil testing
14. Drainage Layer Construction
15. Progress photographs
16. Design modifications
17. Construction deficiencies
18. Completed construction

5.8 Final Construction Documentation Report

During placement of the drainage layer and stormwater control liner, the CQA Resident Engineer shall prepare a final certification-documentation report covering the installation and testing of the clay and geosynthetic lining system. This report shall certify that the clay and geosynthetic liner system has been constructed in substantial accordance with this SSCQAP, the construction drawings, and the construction specifications. A Draft Copy of this report shall be issued to the Project Engineer following completion of the lining system. The final report shall be issued to the Project Engineer following completion of the drainage layer. For this project, two (2) copies of the draft version, five (5) copies of the final version of the report, and a digital copy of the final version of the report, complete with all attachments shall be issued.

5.9 Format of CQA Report

As a minimum, the certification report will contain the following items for discussion in the narrative portion of the report. The proposed table of contents is:

5.9.1 Table of Contents

Section

1.0 Summary of Information

1.1 Narrative
1.2 Reference Information

2.0 Soil Preconstruction Data (embankment and clay liner)

2.1 Proctors
2.2 Soil Density/Moisture
2.3 Soil Classification

3.0 Subgrade Field Data

3.01 Moisture Content
3.02 Field Density Testing

3.1 Clay Liner Field Data

3.21 Moisture Content
3.22 Field Density Testing
3.23 Permeability Testing

4.0 Soil Laboratory Data

4.1 Construction Proctors
4.2 Soil Classification
4.3 Permeability

5.0 Geosynthetic Quality Control

5.1 Manufacturer's Q.C.
5.2 Installer Resumes
5.3 Material Conformance Testing

6.0 Geosynthetic Liner Field Data

6.1 Weather Log
6.2 Trial Welds
6.3 Panel Placement
6.4 Panel Seaming
6.5 Non-Destruct Test
6.6 Destruct Test

6.7 Repair Log
6.8 Installed Quantities
6.9 Defect Location Map

7.0 Protective/Drainage Layer Data

7.1 Preconstruction testing

7.2 Field and laboratory testing

7.2.1 Sieve analysis
7.2.2 Permeability testing

8.0 Project Meeting Minutes

9.0 Construction Photographs

10.0 Pertinent Information

5.9.2 List of Drawings

As a minimum, the certification will include in an appendix the following proposed list of drawings:

- Geomembrane Panel Layout
- Defect Location Map
- Map giving elevation of subgrade, clay liner, and drainage layer at a maximumfrequency of every fifty (50) feet and a maximum frequency of every fifty (50) feet along grade breaks.

5.10 Site Surveying Requirements

The CQA Resident Engineer shall coordinate all survey activities with the surveyor, provided by the Contractor. Survey services will be required for initial site layout, final grade verification, and primary geomembrane as-built survey. All grade surveying shall be conducted on a maximum 50-foot grid and a maximum 50-foot frequency along grade breaks. The certification surveys will be as directed by the CQA Resident Engineer and shall include the following items:

- Panel placement and seaming locations
- Location of destructive testing samples
- Location of all significant repairs
- Topographic survey of base grades
- Topographic survey of top of clay liner

- Topographic survey of top of drainage layer

6.0 LANDFILL CONSTRUCTION-EARTHWORK

6.1 Subgrade/ Structural Fill Preparation

6.1.1 Subgrade

Subgrade preparation shall be performed by the General Contractor and in accordance with the construction drawings and construction specifications.

The General Contractor shall be responsible for preparing the subgrade prior to placement of the base liner system and is responsible for constructing the subgrade in accordance with the technical specifications.

Before beginning placement of the Compacted Clay Liner:

1. The project engineer shall document that a licensed land surveyor has verified that all grades and elevations are consistent with the DEHNR Solid Waste Section approved engineering plans.

2. The Project Engineer shall document that he/she has visually inspected the subgrade surface to evaluate its suitability and that the subgrade meets the criteria specified in the project specifications.

3. The prepared subgrade shall be proof-rolled using a smooth-drum roller (minimum 20 tons) making a minimum of two (2) passes in each direction or other procedures and equipment approved by the Project Engineer.

4. The Project Engineer shall document that the subgrade has been tested for conformance to the construction specifications at the following minimum frequencies:

Construction Testing SUBGRADE TESTING FREQUENCIES		
TEST	ASTM METHOD	QUANTITY
Field Density	D6938, D1556, D2937	1/5,000 YD^3
Field Moisture	D2216, D6938, D4643	1/5,000 YD^3

6.1.2 Structural Fill

Structural fill shall be the soil placed to achieve the design subgrade contours. The subgrade will be tested for field density and field moisture content at a minimum frequency of one (1) test per 5,000 cubic yards placed. Testing will also consist of visual observation and documentation of proof-rolling with a smooth-drum roller (minimum 20 tons) with at least two (2) passes in each direction or by other procedures and equipment approved by the Project Engineer. If a nuclear gauge is used as the primary means of construction testing, the instrument shall be calibrated properly and test data shall be verified using alternate test methods such as drive cylinders. An alternate test method shall be used at least once for every hundred tests performed with the nuclear gauge. The alternate test method should be performed in the same area as an instrument reading in order to allow accurate comparison of the data resulting from the two tests.

Preconstruction Qualification Structural Fill		
Test	**ASTM Method**	**Quantity**
Natural Moisture Content	D2216	1/5,000 YD^3
Laboratory Compaction	D698	1/5,000 YD^3

Construction Testing STRUCTURAL FILL TESTING FREQUENCIES		
TEST	ASTM METHOD	QUANTITY
Field Density	D6938, D1556, D2937	1/5,000 YD^3
Field Moisture	D2216, D6938, D4643	1/5,000 YD^3

6.2 Select Backfill Placement and Testing

Select backfill will be utilized on a limited basis in berms near the liner edge and at anchor trenches. This material will have the same preconstruction and testing requirements as the subgrade, with the exception that the preconstruction and construction testing will have to be performed to show conformance with the Maximum Particle Size requirements. The testing requirements are as follows:

Preconstruction Qualification		
Test	**ASTM Method**	**Quantity**
Natural Moisture Content	D2216	1/5,000 YD^3
Laboratory Compaction	D698	1/5,000 YD^3
Grain Size Analysis	D422	1/5,000 YD^3
*** Preconstruction test samples shall be taken from the borrow source and or clay stockpiled prior to construction.**		
Construction Testing		
Test	**ASTM Method**	**Quantity**
Field Density	D6938, D1556, D2937	1/5,000 YD^3
Field Moisture	D2216, D6938, D4643	1/5,000 YD^3
Grain Size Analysis	D422	1/5,000 YD^3

6.3 Compacted Clay Liner Material

The Compacted Clay Liner shall consist of low-permeability soils placed on the prepared subgrade.

Table 1 - QA Testing Frequencies and Criteria for Compacted Clay Liner Layer

Preconstruction Qualification		
Test	**ASTM Method**	**Quantity**
Natural Moisture Content	D2216	1/1,000 YD^3 or Change in Material
Grain Size Analysis	D422 or D1140	1/5,000 YD^3 or Change in Material
Classification	D2487	1/5,000 YD^3 or Change in Material
Atterberg Limits	D4318	1/5,000 YD^3 or Change in Material
Laboratory Compaction	D698 - Standard	1/5,000 YD^3 or Change in Material
Permeability **	D5084	1/10,000 YD^3 or Change in Material Three per Moisture-Density Curve

*** Preconstruction test samples shall be taken from the borrow source and or clay stockpiled prior to construction.**

** The Moisture-Density Curve shall show the region in which the required maximum permeability is met. A minimum of three (3) permeability tests (ASTM D5084) shall be performed per curve to establish the zone of acceptable moistures and densities at which the required maximum permeability may be achieved. If the Contractor elects to run multiple curves to enlarge the zone of acceptance, all curves must be submitted.

Construction Testing		
Test	**ASTM Method**	**Quantity**
Field Density	D6938, D1556, D2937	1/10,000 FT^2/Lift
Field Moisture	D2216, D6938, D4643	1/10,000 FT^2/Lift
Classification	D2487	1 per acre per lift
Permeability	Extracted per D1587 Tested Per D5084	1/40,000 FT^2/Lift
Atterberg Limits	D4318	1/5,000 YD^3
Grain Size	D422 or D1140	1/5,000 YD^3
Soil Layer Thickness	Observation, Field Measurement	Continuous Observation, Minimum of Five (5) per Lift

If a nuclear gauge is used as the primary method for construction testing of the clay liner, the test data shall be verified by alternate test methods at least once for every 25 tests performed.

Any modifications made to these testing frequencies will require prior approval from the DEHNR Solid Waste Section.

Clay liner material generally consists of cohesive soils with low hydraulic conductivity used as barriers in lining systems. Soils used in clay liners shall consist of clean, select material free of debris, excessive coarse particles or other deleterious matter. Soils with a visibly identifiable organic content, or soils classified according to the Unified Soil Classification System as organic silt or organic clay (OL, OH) shall not be used.

6.4 Clay Liners

Prior to the construction of a clay liner, soil evaluation tests shall be performed to confirm the adequacy of clay liner materials procured from each on-site or off-site source area. All tests shall be performed in a geotechnical laboratory. The General Contractor shall submit the results of source evaluation tests to the Project Engineer. Previous testing and evaluations of the soil sources may also be used to evaluate the soil material. The material shall be accepted or rejected by the Project Engineer according to these results. The acceptance and rejection criteria for the clay liner material will be verified by the construction of a test pad in accordance with the construction specifications

6.4.1 Quality Assurance Testing

Permeability tests shall be performed at a confining pressure of 25 psi +/- 1 psi and with a gradient in accordance with ASTM method D5084. Samples taken from each location shall be compared to the approved moisture-density-permeability relation. Test frequencies for construction testing are given in Table 1 of Section 6.3. The Resident CQA Engineer shall certify that the clay liner was constructed using the same methods and acceptance criteria consistent with test pad construction and tested according to the DEHNR Solid Waste Section approved plans.

6.4.2 Test Pad Construction

The test pad shall be constructed in accordance with the technical specifications. The results of the test pad testing shall be in accordance with Table 1 in Section 6.3 and the previously approved moisture-density-permeability relationship established from preconstruction testing. Field moisture and density tests and laboratory permeability tests will be performed by the Resident CQA Engineer for each lift placed on the test pads to verify the construction method, equipment, and material to achieve the maximum required permeability for the clay liner. If the contractor chooses to construct the test pads within the cell, all lifts of the test pads must pass to enable them to remain as part of the clay liner. The Contractor shall allow sufficient time for

construction and testing of the test pad prior to placement of the Compacted Clay Liner.

6.4.3 Clay Liner Placement

The clay liner shall be placed in accordance with Section 02300 of the technical specifications.

6.4.4 Clay liner Acceptance

The Resident CQA Engineer must approve the condition of the clay liner prior to the geosynthetic installer deploying the geomembrane.

The soil components of the lining system will be approved by the Resident CQA Engineer when:

1. The installation of the soil components is finished.

2. Verification of the adequacy of the constructed components, including repairs, if any, is completed in accordance with this SSCQAP and the technical specifications.

All documentation of installation is completed.

The depth and grade of the clay liner has been verified by a licensed surveyor and has been approved by the project engineer.

3. The appropriate frequency of permeability tests have been performed and the results have been approved by the Certifying CQA Engineer.

4. The Soil QA Monitors shall certify that installation of the soil components has proceeded in accordance with this SSCQAP and the Technical Specifications.

6.5 Granular Drainage and Protective Layer

The Granular Drainage and Protective Layer will be the twenty-four (24) inch layer of material placed directly over the liner system to provide protection for the liner system as well as a drainage conduit for leachate drainage. The testing requirements are as follows:

Testing Frequencies and Criteria for Granular Drainage and Protective Layer

Preconstruction Qualification		
Test	**ASTM Method**	**Quantity**
Moisture Content	D2216	1 per source***
Grain Size	D422 or D1140	1 per source***
Classification	D2487	1 per source
Calcium Carbonate	D4373	1 per source
Permeability	D2434	1 per source
***In addition to quarry certificate		
Construction Testing		
Test	**ASTM Method**	**Quantity**
Grain Size	D422	1/1,500 YD^3
Permeability	D2434	1/6,000 YD^3

6.6.2 Placement

Placement of the granular drainage layer shall be performed by a low ground pressure dozer and/or off-road dump truck not in direct contact with the geomembrane. A minimum depth of 2 feet of drainage layer material must be maintained at all times during placement activities when vehicles other than the low ground pressure dozer are needed. High traffic areas, such as access roads constructed to transport material into the landfill, should have a minimum depth of three (3) feet.

The drainage layer shall be placed in the coolest part of the day when possible in order to reduce the potential for wrinkles forming in the geomembrane. See Sections 1.4.2 and 1.1.5 of Appendix B for information on evaluating and repairing wrinkles in the geomembrane.

The Resident CQA Engineer will observe placement activities. The General Contractor is to provide laborers ahead of drainage material placement to assist in minimizing wrinkle formation of the geomembrane. Temperature variations may impact the Contractor's ability to place this material.

6.6.3 Depth Verification

CQA Monitor(s) will randomly verify granular drainage layer depth utilizing test pits or survey means. A Surveyor licensed in the State of North Carolina will survey the top of the drainage layer to certify proper depth was achieved. The General Contractor may use depth markers (i.e., painted tubes, flags, traffic cones, etc.) during placement to provide depth control and minimize possible damage to geomembrane. Depth markers shall be removed as the drainage layer is completed. Depth markers shall not be constructed of a material that could potentially puncture the geomembrane and shall be approved by the Project Engineer.

7.0 LANDFILL CONSTRUCTION-GEOMEMBRANE

7.1 Geomembrane Liner

The geosynthetic components of the lining system will be approved by the Resident CQA Engineer when:

The installation of the geosynthetic components has been completed in accordance with this SSCQAP and the Technical Specifications.

Verification of the adequacy of all seams including associated testing and repairs, if any, is completed in accordance with this SSCQAP and the Technical Specifications.

1. All documentation of installation is completed.

2. The Geosynthetic CQA Monitor(s) are able to recommend acceptance.

7.2 Geomembrane Quality Control

The Geosynthetic Contractor/Manufacturer will provide geosynthetic quality control in accordance with Appendix A.

7.3 Geomembrane Quality Assurance

7.3.1 Conformance Sampling

Conformance testing will be done on-site as material arrives and is inventoried. Conformance sampling procedures will be in accordance with Appendix A.

7.4 Geomembrane Seaming

Field seaming will be done in accordance with Appendix B.

7.4.1. Double Tracked Fusion Welding

All seaming performed shall utilize the double-tracked fusion process when possible. Detailing and repairs do not require double tracked fusion welding.

7.4.2 Extrusion Welding

Extrusion welding shall only be used when double-tracked fusion welding is not possible. The extrusion process will be utilized for repair or detail work, attaching temporary rain flaps, capping a failed seam, or completion of other appurtenances that cannot be performed with fusion welding.

7.5 Geomembrane/Seam Repairs

All repairs to the geomembrane or seams shall be done utilizing the extrusion welding process. All repair work shall be conducted in accordance with Appendix B.

7.6 Geotextile Quality Control

The Geosynthetic Contractor/Manufacturer shall provide quality control information in accordance with Appendix C.

7.7 Geotextile Quality Assurance

Conformance sampling will be performed on-site as material arrives and is inventoried. All conformance sampling will be in accordance with Appendix C.

8.0 LEACHATE COLLECTION PIPING

8.1 Definition and Applicability

Leachate Collection Piping pertains to the High Density Polyethylene Pipe (HDPE) pipe utilized in the collection and transmission of leachate and/or other contaminated liquids generated as a byproduct of the disposal of MSW.

8.2 Quality Control Documentation

Prior to the shipment of any HDPE pipe, the Manufacturer shall provide the Resident CQA Engineer with the following information:

1. A specification for the HDPE pipe that includes all properties contained in the Project Technical Specifications measured using the appropriate test methods.

2. At a minimum, results shall be given for the following:

Property	Test Method	Frequency
Relative Density	ASTM D1505	Per Shipment
Melt Index	ASTM D1238	Per Shipment
Carbon Black Content	ASTM D3350	Per Shipment
Tensile Strength at Yield	ASTM D638, Type IV	Per Shipment
Elastic Modulus	ASTM D638	Per Shipment

The Manufacturer shall identify all HDPE pipe products with the following:

Manufacturers Name
Product Identification
Size
SDR Rating

The Resident CQA Engineer shall review these documents and shall report any discrepancies with the above requirements to the Project Engineer. The Resident CQA Engineer shall verify that:

Property values submitted by the Manufacturer meet the required Project Technical Specifications.

Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

HDPE pipe products are appropriately labeled.

Appendix A

1.0 Geomembranes

1.1 Description and Applicability

Geomembranes are low permeability geosynthetic barriers used in lining systems. This Section is applicable to smooth and textured high density polyethylene (HDPE) geomembranes. This Section may need to be modified when using other geomembranes.

1.2 Manufacturing Plant Inspection

The Owner or other appropriate representative may conduct an inspection of the Manufacturer's plant. In addition, the Project Engineer, or his designated representative, may visit the manufacturing plant for a project-specific inspection if deemed necessary. If possible, the project-specific inspection shall be prior to or during the manufacturing of the geomembrane rolls for that particular project. The purpose of the plant inspection is to review the manufacturing process and quality control procedures.

The manufacturing plant inspection shall include:

Verification that properties guaranteed by the manufacturer are met and meet all the project specifications.

Verification that the measurement of properties by the Manufacturer is properly documented and test methods used are acceptable.

Spot inspection of the rolls and verification that they are free of imperfections or any sign of contamination by foreign matter.

Review of handling, storage, and transportation procedures, and verification that these procedures will not damage the geomembrane.

Verification that roll packages have a label indicating the name of the manufacturer, type of geomembrane, thickness, roll number, and roll dimensions.

Verification that extrusion rods and/or beads are produced from the same base resin type as the geomembrane.

A report describing the inspection shall be retained by the Owner and by the Project Engineer for project-specific inspections.

1.3 Quality Control Documentation

Prior to the shipment of any geomembrane, the Manufacturer shall provide the Resident CQA Engineer with the following information:

1. The origin (supplier's name and production plant) and identification (brand name and number) of the resin used to manufacture the geomembrane.

2. Copies of dated quality control certificates issued by the resin supplier.

3. Results of tests conducted by the Manufacturer to verify that the resin used to manufacture the geomembrane meets the project specifications.

4. A statement indicating that the amount of reclaimed polymer added to the resin during manufacturing was done with appropriate cleanliness.

5. A list of the materials that comprise the geomembrane, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.

6. A specification for the geomembrane that includes all properties contained in the project specifications measured using the appropriate test methods.

7. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.

8. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for the following:

Property	Test Method	Frequency
Thickness	ASTM D-5199 (Smooth) ASTM D-5994 (Textured)	Each Roll
Relative Density	ASTM D-1505	Every 5th roll
Tensile Properties	ASTM D6693 Type IV	Every 5th roll
Tear Resistance	ASTM D1004 Die C	Every 5th roll
Puncture Resistance	ASTM D-4833	Every 5th roll
Carbon Black Content	ASTM D-1603	Every 5th Roll
Carbon Black Dispersion	ASTM D-5596	Every 5th Roll

The Manufacturer shall identify all rolls of geomembranes with the following:

Manufacturer's name
Product identification
Thickness
Roll number
Roll dimensions

The Resident CQA Engineer shall review these documents and shall report any discrepancies with the above requirements to the Project Engineer. The Resident CQA Engineer shall verify that:

Property values certified by the Manufacturer meet all of its guaranteed specifications.

Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

Rolls are appropriately labeled.

Certified minimum properties meet the project specifications.

1.4 Conformance Testing

1.4.1 Sampling Procedures

Upon delivery of the rolls of the geomembrane, the Resident CQA Engineer shall ensure that conformance test samples are obtained for the geomembrane. The geomembrane rolls to be sampled shall be selected by the Resident CQA Engineer. Samples shall be taken across the entire width of the roll judged by the Resident CQA Engineer not to be damaged. Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Resident CQA Engineer shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Certifying CQA

Engineer based on a review of all roll information including quality control documentation and manufacturing records.

If the Project Engineer desires, the Resident CQA Engineer can perform the conformance test sampling at the manufacturing plant. This may be advantageous in expediting the installation process for very large projects.

Unless otherwise specified in the project specifications, samples shall be taken at a rate of one per lot and not less than one per 100,000 ft^2 (10,000 m^2) of geomembrane. These samples shall be forwarded to the Resident CQA Engineer for testing.

1.4.2 Conformance Tests

The following conformance tests shall be conducted:

Relative Density (ASTM D-1505)
Carbon black content (ASTM D-1603)
Carbon black dispersion (ASTM D-5596)
Thickness - Smooth (ASTM D-5199)
Thickness - Textured (ASTM D-5994)
Tensile properties (ASTM D-6693, Type IV)

Other conformance tests may be required by the project specifications.

1.4.3 Test Results

All conformance test results shall be reviewed and accepted or rejected by the Certifying CQA Engineer prior to the deployment of the geomembrane. The Certifying CQA Engineer shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Engineer. The Certifying CQA Engineer shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If a test result is in nonconformance, all material from the lot represented by the failing test shall be considered out-of-specification and rejected. Alternatively, at the option of the Project Engineer, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the project specification. This procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line. To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next large roll number)

shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

1.5 Geomembrane Specifications

1.5.1 Materials

The geomembrane materials used for construction shall be in strict accordance with the technical specifications.

1.5.2 Construction

The geomembrane liner shall be installed as soon as practical after completion and approval of the compacted clay liner or portion thereof. The top of the compacted clay liner will be surveyed to ensure adequate thickness of clay material and proper grades toward the collection sump area have been achieved. The geomembrane is to cover the bottom of the secure cell and the side slopes in accordance with the Contract Drawings.

Areas to receive liner installation should be relatively smooth and even, free of ruts, voids, etc., to the extent required by the Engineer. This shall be accomplished by final dressing of the compacted liner with smooth drum rollers. No vehicles are permitted on final dressed surfaces unless authorized by the Engineer.

An anchor trench (as illustrated on the Contract Drawings) will be required to secure the geomembrane. No loose soil will be allowed to underlie the geomembrane in the anchor trenches. The time schedule for excavation and backfilling of the anchor trenches is to be approved by the Engineer so that desiccation of trench soils does not occur prior to backfilling.

Before the geomembrane installation begins, the Resident CQA Engineer shall verify that:

1) A State of North Carolina licensed Professional Land Surveyor has verified all lines and grades of the compacted clay liner.

2) A qualified and licensed Professional Engineer has verified that the clay liner surface meets the criteria specified in the project specifications.

3) The clay liner surface to be lined has been rolled, compacted, or hand-worked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.

4) The surface of the clay liner 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 clay liner surface contains desiccation cracks, which may damage the geomembrane.

7) The clay liner has sufficient thickness and that all permeability tests have not exceeded the specified maximum permeability.

8) The geomembrane to be deployed has an absolute minimum thickness of 60 mils and passing conformance samples at the frequencies specified in Section 1.4.1 of this Appendix B and be documented .

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 Resident CQA Engineer prior to commencement of geomembrane deployment in the area under consideration. The Certifying CQA Engineer shall be given a copy of this certificate by the Resident CQA Engineer.

After the underlying soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the General Contractor any change in the underlying soil condition that may require repair work. The General Contractor will consult with the Resident CQA Engineer regarding the need for repairs. If the Resident CQA Engineer concurs with the Installer, the General Contractor shall ensure that the underlying soil is repaired.

At any time before or during the geomembrane installation, the Resident CQA Engineer shall indicate to the General Contractor any locations which may not be adequately prepared for the geomembrane.

The Resident CQA Engineer shall verify that the **anchor trench** is constructed in accordance with the following:

1) The anchor trench has been constructed according to the project plans and specifications.

2) If the anchor trench is excavated in a clay material susceptible to desiccation, the amount of trench open at any time is minimized. The Resident CQA Engineer shall inform the Contractor and Project Engineer of any signs of significant desiccation associated with the anchor trench construction.

3) Rounded corners are provided in the trench so as to avoid sharp bends in the geomembrane.

4) Excessive amounts of loose soil are not allowed to underlie the geomembrane in the anchor trench.

5) The anchor trench is adequately drained to prevent ponding or softening of the adjacent soils while the trench is open.

6) The anchor trench is backfilled and compacted as outlined in the project specifications.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetic components. The Resident CQA Engineer shall observe the backfilling operation and advise the Contractor and Project Engineer of any problems. Any problems shall be documented by the Resident CQA Engineer in his daily report.

Appendix B

1.0 Field Seaming

1.1.1 Seam Layout

Before installation begins, the Installer shall provide the Resident CQA Engineer and the Project Engineer with a panel layout drawing. This drawing shall present all the proposed seams of the lining system at the facility. The Project Engineer and the Resident CQA Engineer shall review the panel layout drawing and verify that it is consistent with the technical specifications and the Division approved plans. No panels may be seamed until written approval of the panel layout drawing has been provided by the Project Engineer. In addition, panels not specifically shown on the panel layout drawing may not be used without the Project Engineer's prior approval.

In general, seams should be oriented parallel to the line of maximum slope, thus, 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 10 ft (3.0m) from the toe or crest of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

A seam numbering system compatible with the panel numbering system shall be used by the Resident CQA Engineer and the CQA monitors.

1.1.2 Accepted Seaming Methods

Approved processes for field seaming are fusion welding and extrusion welding. Proposed alternate processes shall be documented and submitted by the Installer to the Project Engineer for approval. Only apparatuses that have been specifically approved by make and model shall be used. The Contractor shall submit all documentation regarding seaming methods to be used to the Resident CQA Engineer for review.

1.1.2.1 Fusion Process

The CQA monitor shall log ambient temperature, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the Resident CQA Engineer.

The Resident CQA Engineer shall verify that:

The Installer maintains on-site the number of spare operable seaming apparatuses agreed upon at the pre-construction meeting.

Equipment used for seaming is not likely to damage the geomembrane.

The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.

1. A movable protective layer is used as required by the Installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and to prevent debris from collecting around the pressure rollers.

2. In general, the geomembrane panels are aligned to have an overlap of 4 to 6 in (100 mm to 150 mm) for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

3. No solvent or adhesive is used.

4. The geomembrane is protected from damage in heavy traffic areas.

1.1.2.2 *Extrusion Process*

The CQA monitor shall log ambient temperature, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the Resident CQA Engineer.

The Resident CQA Engineer shall verify that:

The Installer maintains on-site the number of spare operable seaming apparatuses agreed upon at the pre-construction meeting.

Equipment used for seaming is not likely to damage the geomembrane.

Prior to beginning a seam, the extruder is purged until all heat-degraded extrudate has been removed from the extruder barrel.

Clean and dry welding rods or extrudate pellets are used.

The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

Grinding is completed no more than one hour prior to seaming.

A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs.

The geomembrane is protected from damage in heavy traffic areas.

Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than 1/8 in (6 mm) from the finished seamed area.

In general, the geomembrane panels are aligned to have a nominal overlap of 3 in (75 mm) for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

No solvent or adhesive is used.

The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged

1.1.3 Seam Preparation

The CQA monitors 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 CQA monitors must ensure that the process is completed according to the Manufacturer's instruction within one hour of the seaming operation, and in a way that does not damage the geomembrane. The CQA monitors shall also verify that seams are aligned with the fewest number of wrinkles and "fishmouths".

1.1.4 Test Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Trial seams shall be performed in accordance with Section 02620 of the technical specifications.

1.1.5 General Seaming Procedures

During general seaming, the CQA monitors shall ensure the following:

Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 in (150 mm) beyond the cut in all directions.

If seaming operations are carried out at night, adequate illumination shall be provided.

Seaming shall extend to the outside edge of panels placed in the anchor trench.

All cross seam tees should be extrusion welded to a minimum distance of 4 in (100 mm) on each side of the tee.

No field seaming shall take place without the Master Seamer being present.

A firm substrate may be required to be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

The Resident CQA Engineer shall verify that the above seaming procedures or any other procedures agreed upon and indicated in the Preconstruction Meeting or construction progress meetings are followed, and shall inform the Project Engineer of any nonconformance.

1.1.6 Seaming Weather Conditions

1.1.6.1 *Cold Weather Conditions*

To ensure a quality installation, if seaming is conducted when the ambient temperature is below 40°F (5°C), the following conditions shall be met:

Geomembrane surface temperatures shall be determined by the Resident CQA Engineer at intervals of at least once per 100 feet (30 m) of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 41°F (5°C).

1. For fusion welding, preheating may be waived by the Project Engineer based on a recommendation from the Resident CQA Engineer, if the Installer demonstrates to their satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

2. If preheating is required, the CQA monitors shall observe all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been overheated.

3. 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.

4. All preheating devices shall be approved prior to use by the Resident CQA Engineer.

Additional destructive tests shall be taken at an interval between 250 feet and 500 feet 75 to 150 m) of seam length, at the discretion of the Resident CQA Engineer.

Sheet grinding may be performed before preheating, if applicable.

Test seams shall be conducted under the same ambient temperature and preheating conditions as the production seams. Under cold weather conditions, additional trial seams shall be conducted if the ambient temperature drops by more than 10°F from the initial trial seam test conditions. Such new seams shall be constructed upon completion of seams in progress during temperature drop.

1.1.6.2 *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 Resident CQA Engineer that geomembrane seam quality is not compromised. Test seams shall be conducted under the same ambient temperature conditions as the production seams. At the option of the Resident CQA Engineer, additional destructive tests may be required for any suspect areas.

1.2 Nondestructive Seam Testing

1.2.1 Concept

The Installer shall nondestructively test all field seams over their full length using an air pressure test (for double fusion seams only, a vacuum test or other approved method. Air pressure testing and vacuum testing are described elsewhere respectively. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantity 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 CQA monitors shall:

Observe nondestructive testing procedures.

Record location, data, test unit number, name of tester, and outcome of all testing.

Inform the Installer and Resident CQA Engineer of any required repairs.

Any seams that cannot be nondestructively tested shall be cap-stripped. The cap-stripping operations shall be observed by the Resident CQA Engineer and Installer for uniformity and completeness.

1.2.2 Air Pressure Testing

Air pressure testing is applicable to double fusion welding which produces a double seam with an enclosed space.

The Equipment for air pressure testing shall consist of the following:

An air pump (manual or motor driven), equipped with pressure gauge and capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa) and mounted on a cushion to protect the geomembrane.

A rubber hose with fittings and connections.

A sharp hollow needle, or other pressure feed device, approved by the Resident CQA Engineer.

The following procedures shall be followed:

Seal both ends of the seam to be tested.

Insert needle or other approved pressure feed device into the air channel created by the fusion weld.

Insert a protective cushion between the air pump and the geomembrane.

Pressurize the air channel to a pressure of approximately 30 psi (200 Kpa). Close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes. Pressure loss over the 5-minute period should not exceed 3psi.

If loss of pressure exceeds the maximum permissible pressure differential as outlined in the project specifications or does not stabilize, locate fault area and repair in accordance with Section 1.4.3.

Cut opposite end of tested seam area once testing is complete to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area.

Remove needle or other approved pressure feed device and grind and weld or patch the hole in the geomembrane.

1.2.3 Vacuum Testing

Vacuum testing is applicable to extrusion welding.

The equipment shall consist of the following:

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.

A pump assembly equipped with a pressure controller and pipe connections.

A rubber pressure/vacuum hose with fittings and connections.

A soapy solution. (CQA monitors shall ensure solution makes bubbles when air is passed through.)

A bucket and wide paint brush, or other means of applying the soapy solution.

The following procedures shall be followed:

Wet a strip of geomembrane approximately 12 in X 48 in (0.3 m X 1.2 m) with the soapy solution.

Place the box over the wetted area.

Close the bleed valve and open the vacuum valve.

Ensure that a leak-tight seal is created.

Energize the vacuum pump and reduce the applied pressure to approximately 5 psi (10 in of Hg/35kPa) gauge.

For a minimum of 10 seconds, apply vacuum with the box placed and maintaining a seal, examine the geomembrane through the viewing window for the presence of soap bubbles.

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 in (75 mm) overlap, and repeat the process.

All areas where soap bubbles appear shall be marked and repaired in accordance with Section 1.4.3.

1.2.4 Test Failure Procedures

The Installer shall complete any required repairs in accordance with Section 1.4.3. For repairs, the CQA monitor shall:

Observe the repair and testing of the repair.

Mark on the geomembrane that the repair has been made.

Document the repair procedures and test results.

1.3 Destructive Seam Testing

1.3.1 Concept

The purpose of destructive tests is to evaluate seam strength. Destructive seam tests shall be performed at selected locations. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

1.3.2 Location and Frequency

The Resident CQA Engineer shall select where seam samples will be cut out for laboratory testing. The frequency and locations shall be established as follows:

A minimum frequency of one test location per 500 feet (150 m) of seam length performed by each welding machine. This frequency is to be determined as an average taken throughout the entire facility.

Test locations shall be determined during seaming at the discretion of the Resident CQA Engineer or the Project Engineer. Special consideration shall be given to locations where the potential for imperfect welding, such as overheating, contamination, and offset welds exists.

1.3.3 Sampling Procedures

Samples shall be cut by the Installer at locations chosen by the Resident CQA Engineer as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The Resident CQA Engineer shall:

Observe sample cutting.

1. Assign a number to each sample, and mark it accordingly.

2. Record sample location on layout drawing.

3. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be repaired in accordance with repair procedures described in Section 1.4.3 immediately following receipt of successful test results. The continuity of the new seams in the repaired area shall be tested according to Section 1.2.3. All holes in the geomembrane shall be temporarily patched or repaired in accordance with Section 1.4.3 before the end of each work day in order to protect the clay liner from inclement weather.

1.3.4 Sampling Procedure

Destructive sampling shall be performed in accordance with Section 02620 of the technical specifications.

1.3.5 Field Testing

Destructive field testing shall be performed in accordance with Section 02620 of the technical specifications.

1.3.6 Destructive Test Failure

Destructive test failures shall be handled in accordance with Section 02620 of the technical specifications.

1.4 Defects and Repairs

1.4.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the CQA monitors for identification of defects, holes, blisters, undispersed raw materials, large

wrinkles and any sign of contamination by foreign matter. The geomembrane surface shall be cleaned by the Installer prior to examination if the CQA monitor determines that the amount of dust or mud inhibits examination.

1.4.2 Evaluation

Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 1.2. Each location which fails the nondestructive testing shall be marked by the CQA monitor and repaired by the Installer. Work shall not proceed with any materials that will cover locations that have been repaired until successful nondestructive and/or laboratory tests are obtained.

When seaming of the geomembrane is completed, and prior to placing overlying materials, the Resident CQA Engineer shall indicate to the General Contractor any large wrinkles that 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 period, while keeping in mind the forecasted weather to which the undercover geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over onto itself which is generally a wrinkle that extends 12 in (0.3 m) from the subgrade. Seams produced while repairing wrinkles shall be nondestructively tested.

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. 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 McGill Associates or a CQA monitor to ensure that wrinkle formation is minimized and that, in all cases, the geomembrane is not folded over on itself.

1.4.3 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. The final decision as to the appropriate repair procedure shall be determined by the Project Engineer and the Resident CQA Engineer.

1. The repair procedures available include:

    a. Patching, used to repair holes, tears, undispersed raw materials, and contamination by foreign matter.

    b. Spot welding used to repair 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 Resident CQA Engineer and shall not exceed 100 ft (30 m) in total 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 ground 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 this SSCQAP.

d. Patches or caps shall extend at least 6 in (150 mm) beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 in (75 mm).

1.4.4 Repair Verification

The CQA monitors shall observe all nondestructive testing of repairs and shall record the number of each repair, date and test outcome. Each repair shall be nondestructively tested using the method described in Section 1.2 as appropriate. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 500 ft (50 m) long require destructive test sampling. Failed tests require that the repair shall be redone and re-tested until a passing test results.

1.5 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. The quality assurance of the adjacent materials themselves are covered in separate Sections of this manual.

1.5.1 Soils

1. Placement of gravel on the geomembrane shall not proceed at an ambient temperature below 32 degrees F (0 degrees C) nor above 104 degrees F (40 degrees C) unless otherwise specified.

2. Placement of gravel 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 gravel shall not be driven directly on the geomembrane.

4. A minimum thickness of 24 inches of gravel shall be maintained between the geotextile cushion and the top of the drainage layer Off-road trucks shall have a minimum thickness of 3 feet between them and the geomembrane/geotextile cushion.

5. In any areas traversed by heavy construction, any vehicles other than low ground pressure vehicles approved by the Project Engineer, the gravel layer shall have a minimum thickness of 3 ft (09 m). This requirement may be waived if provisions are made to protect the geomembrane through an engineered design approved by the Project Engineer. Drivers shall proceed with caution when traveling on the overlying gravel and prevent spinning of tires or sharp turns.

6. Leachate collection pipes shall not be crossed with construction equipment without the full two (2) feet of stone in place. In areas where off-road trucks must repeatedly cross the leachate piping, a temporary stone road shall be build to bridge over the pipe and maintain a minimum thickness of three (3) feet.

7. Care shall be taken to avoid creating wrinkles in the geomembrane during placement of the gravel layer.

1.5.2 Sumps and Appurtenances

The sumps shall be constructed in accordance with the technical specifications and the Resident CQA Engineer shall certify the following:

1. Installation of the geomembrane, sumps, equipment, and appurtenant areas has been performed properly, and connections of geomembrane to sumps and appurtenances have been made according to project specifications.

2. Extreme care is taken while welding around appurtenances since nondestructive testing will be difficult in these areas.

3. The geomembrane has not been visibly damaged while making connections to sumps and appurtenances.

4. The Resident CQA Engineer or his representative shall be present at all times when the Installer is welding geomembrane to appurtenant structures.

The Resident CQA Engineer shall inform the Project Engineer in writing if the above conditions are not fulfilled.

Appendix C

1.0 Geotextiles

1.1 Definition and Applicability

Geotextiles are used in protection and filtering applications in lining systems. This Section does not describe procedures for other applications such as erosion control or reinforcement. This Section is applicable to nonwoven geotextiles made of polyester of polypropylene and not applicable to nonwoven geotextiles made of other materials or woven geotextiles.

1.2 Manufacturing Plant Inspection

The Owner or an appropriate representative may conduct a periodic inspection of the Manufacturer's plant. In addition, the Project Engineer or his designated representative may visit the manufacturing plant for a project-specific inspection if deemed necessary. If possible, the project-specific inspection shall be prior to or during the manufacturing of the geotextile rolls for that particular project. The purpose of the plant inspections is to review the manufacturing process and quality control procedures.

The manufacturing plant inspection shall include:

1. Verification that properties of the geotextile guaranteed by the Manufacturer are met and meet the project specifications.

2. Verification that the measurement of properties by the manufacturer is properly documented and test methods used are acceptable.

3. Inspection of the rolls and verification that they are free of imperfections or any sign of contamination by foreign matter.

4. Review of packaging, handling, storage, and transportation procedures and verification that these procedures will not damage the geotextile.

5. Verification that roll packages have a label indicating the name of the manufacturer, type of geotextile, roll number and roll dimensions.

6. Verification that the geotextiles are inspected continuously for the presence of needles using a metal detector.

A report describing the inspection will be retained by the Owner for periodic inspections and by the Project Engineer for project-specific inspections.

1.3 Quality Control Documentation

Prior to the shipment of any geotextile, the Manufacturer shall provide the Resident CQA Engineer with the following information:

1. Results of tests conducted by the Manufacturer to verify that the material used to manufacture the geotextile meets the project specifications.

2. A specification for the geotextile that includes all properties contained in the Project Technical Specifications were measured using the appropriate test methods.

3. Written certification that minimum values given in the Project Technical Specifications are guaranteed by the Manufacturer.

4. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and the results of quality control tests. At a minimum, results shall be given for the following:

Property	Test Method	Frequency
Mass per Unit Area	ASTM D-5261	Each Roll
Grab Tensile Strength	ASTM D-4632	Every 5th Roll
Grab Tensile Elongation	ASTM D-4632	Every 5th Roll
Puncture (pin) Strength	ASTM D-4833	Every 5th Roll
Apparent Opening Size (AOS)	ASTM D-4751	Every 5th Roll

The Manufacturer shall identify all rolls of geotextiles with the following:

Manufacturer's name
Product identification
Thickness
Roll number
Roll dimensions

The Resident CQA Engineer shall review these documents and shall report any discrepancies with the above requirements to the Project Engineer. The Resident CQA Engineer shall verify that:

Property values certified by the Manufacturer meet all of its guaranteed specifications.

Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

Rolls are appropriately labeled.

Certified minimum properties meet the project specifications.

1.4 Conformance Testing

1.4.1 Sampling Procedures

Upon delivery of the rolls of geotextiles, the Resident CQA Engineer shall ensure that conformance test samples are obtained for the geotextile. The rolls to be sampled shall be selected by the Resident CQA Engineer. Samples shall be taken from any portion of a roll that has not been damaged. Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Resident CQA Engineer shall mark the machine direction on the samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Certifying CQA Engineer based on a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified in the project specifications, samples shall be taken at a rate of one per lot, not to be less than one per 100,000 ft^2 of geotextile. These samples shall then be forwarded to the Geosynthetic laboratory for testing to ensure conformance with the project specifications.

1.4.2 Conformance Tests

The following conformance tests shall be conducted;

Mass per Unit Area (ASTM D5261)
Grab Tensile Strength (ASTM D4632)
Grab Tensile Elongation (ASTM D4632)
Puncture Strength (ASTM D4833)

Apparent Opening Size (ASTN D4751)

1.4.3 Test Results

All conformance test results shall be reviewed and accepted or rejected by the Certifying CQA Engineer prior to the deployment of the geotextile. The Certifying CQA Engineer shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Engineer. The Certifying CQA Engineer shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If a test result is in nonconformance, all material from the lot represented by the failing test shall be considered out-of-specification and rejected. Alternatively, at the option of the Project Engineer, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the project specification. This procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line. To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next large roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

2.0 Geocomposites

2.1 Definition and Applicability

Geocomposites are geosynthetic nets with geotextile heat bonded to the surface. The geocomposite can be single-sided or double-sided depending on the application. They are used as a drainage medium in lining systems, where the properties of the geotextile can either serve as a filter media from clogging the geonet or increase stability of the lining system. This Section is applicable to geocomposites where the geonet portion is made of high density polyethylene (HDPE), including "foamed" HDPE products but is not applicable to geocomposites where the geonet is made of other polymers.

2.2 Manufacturing Plant Inspection

The Owner or appropriate representative may conduct a periodic inspection of the Manufacturer's plant. In addition, the Project Engineer, or his designated representative may visit the manufacturing plant for a project-specific inspection if deemed necessary. If possible, the project-specific inspection shall be prior to or

during the manufacturing of the geocomposite rolls for that particular project. The purpose of the inspection is to review the manufacturing process and quality control procedures.

The manufacturing plant inspection shall include:

Verification that properties guaranteed by the Manufacturer are met and meet all project specifications.

1. Verification that properties guaranteed by the Manufacturer are met and meet all Project Technical Specifications.

2. Verification that the measurement of properties by the Manufacturer is properly documented and test methods used are acceptable.

3. Spot inspection of the rolls and verification that they are free of imperfections or any sign of contamination by foreign matter.

4. Review of packaging, handling, storage, and transportation procedures and verification that these procedures will not damage the geocomposite.

5. Verification that the geotextiles are inspected continuously for the presence of needles using a metal detector.

6. Verifications that roll packages have a label indicating the name of the manufacturer, type of geocomposite, roll number and roll dimensions.

A report describing the inspection will be retained by the Owner for periodic inspections and by the Project Engineer for project-specific inspections.

2.3 Production

The geocomposite shall be manufactured by heat bonding the geotextile to the HDPE drainage net on one or both sides. No burn through geotextiles shall be permitted. No glue or adhesive shall be permitted.

The geonet portion of the geocomposite shall be manufactured by extruding two sets of strands to form a three (3) dimensional structure to provide planar water flow.

2.4 Quality Control Documentation

Prior to the shipment of any geocomposite, the Manufacturer shall provide the Resident CQA Engineer with the following information:

1. The origin (supplier's name and production plant) and identification (brand name and number) of the resin used for geonet.

2. Copies of dated quality control certificates issued by the geonet resin supplier.

3. Results of tests conducted by the Manufacturer to verify that the resin used to manufacture the geonet meets the Project Technical Specifications.

4. A statement indicating that the amount of any reclaimed polymer added to the resin during manufacturing was done with appropriate cleanliness.

5. A list of the materials that comprise the geonet, expressed in the following categories as a percent by weight: polyethylene, carbon black, other additives.

6. Results of tests conducted by the Manufacturer to verify that the material used to manufacture the geotextile meets the Project Technical Specifications.

7. A specification for the geocomposite that includes all properties contained in the Project Technical Specifications measured using the appropriate test methods.

8. Written certification that minimum values given in the Project Technical Specification are guaranteed by the Manufacturer.

9. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. At a minimum, results shall be given for the following:

GEONET COMPONENT		
Property	**Test Method**	**Frequency**
Density	ASTM D1505 or ASTM D792, Method B	Every 5th Roll
Thickness	ASTM D5199	Each Roll
Carbon Black Content	ASTM D1603	Every 5th Roll
Peak Tensile Strength	ASTM D5035	Every 5th Roll
Transmissivity (MARV)	ASTM D4716	Every 5th Roll
GEOTEXTILE COMPONENT		
Property	**Test Method**	**Frequency**
Mass per Unit Area	ASTM D5261	Each Roll
Grab Tensile Strength	ASTM D4632	Every 5th Roll
Grab Tensile Elongation	ASTM D4632	Every 5th Roll

Puncture Strength	ASTM D4833	Every 5th Roll
Permittivity (min. avg.)	ASTM D4491	Every 5th Roll
Apparent Opening Size (AOS)	ASTM D4751	Every 5th Roll
UV Stability, % Retained (500 hr.)	ASTM D4355	Every 5th Roll
GEOCOMPOSITE		
Property	**Test Method**	**Frequency**
Ply Adhesion	ASTM D7005	Every 5th Roll
Transmissivity (MARV)	ASTM D4716	Every 5th Roll

The manufacturer shall identify all rolls of geocomposite with the following:

Manufacturers Name
Product Identification
Roll Number
Roll Dimensions

The Resident CQA Engineer shall review these documents and shall report any discrepancies with the above requirements to the Project Engineer. The Resident CQA Engineer shall verify that:

Property values certified by the Manufacturer meet all of its guaranteed specifications.

Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

Rolls are appropriately labeled.

Certified minimum properties meet the project specifications.

2.5 Conformance Testing

2.5.1 Sampling Procedures

Upon delivery of the rolls of geocomposite, the Resident CQA Engineer shall ensure that conformance test samples are obtained for the geocomposite. The rolls to be

sampled shall be selected by the Resident CQA Engineer. Samples shall be taken from any portion of a roll that has not been damaged. Unless otherwise specified, samples shall be 3 ft. (2 m) long by the roll width. The Resident CQA Engineer shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designed by the Certifying CQA Engineer based on a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified in the project specifications, samples shall be taken at a rate of one per lot, not to be less than one per 100,000 ft^2 of geocomposite. These samples shall then be forwarded to the Geosynthetic laboratory for testing to ensure conformance to the project specifications.

2.5.2 Conformance Tests

The following conformance tests shall be conducted;

Ply Adhesion (ASTM D7005)
Transmissivity (ASTM D4716)

2.5.3 Test Results

All conformance test results shall be reviewed and accepted or rejected by the Certifying CQA Engineer prior to the deployment of the geocomposite. The Certifying CQA Engineer shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Engineer. The Certifying CQA Engineer shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If a test result is in nonconformance, all material from the lot represented by the failing test shall be considered out-of-specification and rejected. Alternatively, at the option of the Project Engineer, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting the project specification. This procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line. To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next large roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

END OF SECTION

Section 6 - Operations Plan

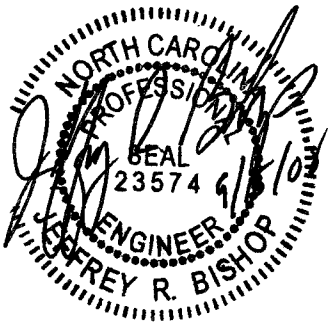
HAYWOOD COUNTY
WHITE OAK LANDFILL
OPERATION PLAN

Note: Original Operations Plan prepared By Municipal Engineering for development of Phase 2. Operational Plan has been modified to include Phase 3 and 4

OPERATIONS PLAN

WHITE OAK MSW LANDFILL
PHASES 3 & 4
HAYWOOD COUNTY, NORTH CAROLINA

JEFFREY R. BISHOP, P.E.



McGill ASSOCIATES

Engineering • Planning • Finance
Asheville, North Carolina

September 2008

07518

Operations Plan
White Oak MSW Landfill

Table of Contents

INTRODUCTION

OPERATIONAL REQUIREMENTS

1) **Waste Acceptance & Disposal Requirements**
   a) Permitted Wastes
   b) Prohibited Wastes
   c) Spoiled Foods and Animal Carcasses
   d) Asbestos Wastes
   e) Wastewater Treatment Sludges
   f) Hazardous Wastes
   g) Waste Placement

2) **Cover Materials Requirements**
   a) Daily Cover Requirements
   b) Alternate Daily Cover
   c) Intermediate Cover

3) **Disease Vector Control**
   a) Prevention of on-site populations of disease vectors
   b) Definition of disease vector

4) **Explosive Gases Control**
   a) Routine Methane Monitoring Program
   b) Methane Sampling Instrument
   c) Methane Response Plan

5) **Air Quality**
   a) Clean Air Act
   b) Open Burning
   c) Hot Loads
   d) Fire Notification Requirements

6) **Access & Safety Requirements**
   a) Gates and Fences
   b) Attendant on Duty
   c) Access Road
   d) Dust Control
   e) Site Access and Tipping Procedures Signage
   f) Hazardous or Liquid Waste Signage
   g) Traffic Procedures Signage
   h) Removal of Solid Waste is Prohibited
   i) Barrels and Drums Disposal Requirements

7) **Erosion & Sedimentation Control**
   a) Sediment Control Measures to Prevent Off-Site Migration of Sediment
   b) Sediment Control Measures to Prevent On-Site Erosion
   c) Vegetative Ground Cover

8) **Drainage Control & Water Protection**
   a) Surface Water Diversion
   b) Surface Water Shall Not Be Impounded Over Waste
   c) Solid Waste Shall Not Be Disposed of In Water
   d) Leachate Shall Be Contained
   e) MSWLF Units Shall Not Cause a Discharge of Pollutants into Waters of the United States

9) **Liquids Restrictions**
   a) Bulk or Non-containerized Liquid Waste
   b) Containers Holding Liquid Wastes
   c) Liquid Wastes
   d) Test for Free Liquids

10) **Recordkeeping Requirements**
   a) MSWLF Records Requirements
   b) All Information Must Be Furnished Upon Request to the Division of Waste Management
   c) The Owner Must Maintain a Copy of the Operation Plan

11) **Spreading and Compaction Requirements**
   a) Smallest Feasible Area
   b) Compacted as Densely as Possible Into Cells
   c) Fencing and Diking to Control Wind-Blown Waste

12) **Leachate Management Plan**
   a) Periodic Maintenance of the Leachate Collection System
   b) Leachate Generation Records
   c) Semi-Annual Leachate Sampling
   d) Leachate Disposal Approval
   e) Contingency Plan for Extreme Operation Conditions
   f) Leachate Recirculation

APPENDICES

Appendix 1- Waste Screening Procedures
Appendix 2- Haywood County Synthetic Cover Operation Plan and Demonstration Report, Revised May 2008
Appendix 3- Explosive Gas Control Plan For Haywood County White Oak Landfill
Appendix 4- Haywood County's Recirculation Plan

INTRODUCTION

The Haywood County White Oak Landfill will only accept Municipal Solid Wastes (MSW) generated in Haywood County. The White Oak MSW Landfill consists of Phases 1 and 2, which comprise 21.5 acres of lined MSW landfill area. Phase 1 began receiving wastes in October of 1993. The most recently constructed cell was Phase 2, consisting of 10.26 acres, which was granted a Permit To Operate on November 7, 2001. Existing Phases 1 and 2 will reach their waste fill capacity in early 2010. The County will implement a lateral expansion of existing MSW Phases 1 and 2 to include proposed Phases 3 and 4. MSW Phase 3 will be constructed initially and will provide the County approximately 5 years of disposal airspace. MSW Phase 4 will be brought online as Phase 3 reaches its capacity. Phases 3 and 4 will be constructed with 24 inches of cohesive soil (permeability of 1.0×10^{-7} cm/sec), a 60-mil High Density Polyethylene (HDPE) liner, a 16-ounce geocomposite, and 24 inches of washed stone leachate collection layer. A leachate collection piping system will be installed on top of the 60-mil HDPE liner and within the 24-inch washed stone layer. Leachate will flow to a sump area located near the northern margin of Phase 3. The sump will include two side slope riser pumping stations that will pump leachate over the northern periphery berm to a gravity sewer system prior to discharge to the leachate storage lagoon. In conjunction with the development of MSW Phase 3, the leachate lagoon will be expanded and an additional HDPE liner will be installed. Leachate is transported by truck from the storage lagoon to a discharge point in the Waynesville wastewater treatment system. The three existing sump areas within MSW Phases 1 and 2 will continue to operate during and after the construction of Phases 3 and 4. Leachate flows by gravity from these areas to the storage lagoon. Leachate will be pumped directly to the transport tanker truck during the time period that the storage lagoon is being expanded.

At the White Oak Landfill, the County is in the process of closing the 4.0-acre Construction & Demolition Landfill (C&DLF). The County also operates a 4.8-acre Land Clearing and Inert Debris Landfill (LCID). Haywood County is in the process of adding a 2.0-acre Mulching and Grinding Treatment and Processing Facility and a 1.5-acre Small Type 2 Composting Facility.

MSW Phases 3 and 4 will be marked off by 4-inch square concrete markers painted day-glo orange, at maximum 200-foot intervals. Solid waste will not be placed within nine (9) feet of this boundary to assure that it is being placed directly above the liner system so that no leachate can flow outside of this area. The lined area will incorporate a berm that will segregate area for solid waste and where stormwater is to be diverted as runoff.

All stormwater that comes in contact with solid waste will be handled as leachate. The leachate is collected and held in the leachate lagoon. The leachate from Phases 3 and 4 will be pumped by two pumping stations to the leachate storage lagoon. Leachate flows by gravity from existing MSW Phases 1 and 2 to the storage lagoon. Leachate is treated at the Waynesville Waste Water Treatment Plant. The leachate will have to be tested according to the pretreatment conditions outlined in the pre-treatment agreement. Tanker trucks will transport the leachate a discharge point in the Waynesville wastewater treatment system. In the future there may be a force main constructed to pump the leachate to the treatment plant.

The leachate will be pumped out of the leachate lagoon into either tanker trucks or recirculated into the working face of the landfill. The pumping of leachate will be on an as needed basis. During wet weather, the pump and hauling may have to be done 24 hours a day for several days or until the leachate lagoon

levels have been reduced. On the other hand, during dry weather, leachate may not have to be hauled for several days at a time.

Leachate will be recirculated. See Appendix 4 for Haywood County's Recirculation Plan.

The leachate lagoon will be inspected on a monthly basis and a report generated and placed in the landfill records. The report will include the date the liner was inspected, the inspector, general observations since the last inspection, visible abrasions, possible stress cracks, or obvious punctures.

Stress cracks can occur in wrinkles that are generated from heat expansion or contraction due to freezing. Also, the HDPE liner may deteriorate due to ultra violet light and this can appear as an abrasion where material can be scraped away with a hard object. If any damage or possible weak spots due to ultra violet exposure has been detected, a qualified HDPE installation company shall be notified immediately so that a repair patch can be installed. The leachate level shall not be allowed to exceed the depth of the damaged liner until it has been repaired and tested by the liner installation company. Once this has been accomplished all testing documentation shall be placed in the operating records. A second textured 60-mil HDPE liner will be installed over the existing HDPE liner at the storage lagoon during the MSW Phase 3 construction.

Daily cover will be the combination of soil, synthetic cover, and mulched material (demonstration period for mulched material is in the process of beginning). Soil cover will be placed at least once a week. See Section 2b for the requirements of the Alternate Daily Cover tarp and mulched material.

The County has implemented a program at the landfill for detecting and preventing the disposal of hazardous and liquid wastes. The program consists of random inspection of incoming loads at a minimum of 1% of the weekly traffic. Landfill personnel have been trained to recognize hazardous and liquid wastes. Records will be kept on the training and the inspections. See Appendix 1 for a description of waste screening procedures.

The County of Haywood will monitor for explosive gases at landfill structures and the perimeter of the landfill. The concentration of methane gases generated by the landfill cannot exceed 25 percent of the lower explosive limit for methane in the structures, and it cannot exceed 100 percent of the lower explosive limit for methane of the landfill property boundary. See Appendix 3 for the Explosive Gas Control Plan. If methane gas is found to exceed the acceptable limits at either the property boundary or landfill structures, it is the County's responsibility to do the following:

1. Immediately take all necessary steps to ensure protection of human health, i.e. no smoking, temporarily abandon the structure and notify the Division of Solid Waste Management.

2. Within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and

3. Within 60 days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Division of Solid Waste management that the plan has been implemented. The plan will describe the nature and extent of the problem and the proposed remedy.

Off and on site erosion will be controlled through erosion control structures and devices. Provisions for a vegetative ground cover sufficient to restrain erosion will be accomplished within **21 calendar days** upon completion of any phase of landfill development.

The County of Haywood will record and retain at the landfill an operating record of the following information:

(1) Inspection records, waste determination records, and training procedures;
(2) Amounts by weight of solid waste received at the landfill;
(3) Waste determination, Leachate sampling data, leachate levels, meteorological data;
(4) Gas monitoring results and any remediation plans;
(5) Any demonstration, certification, findings, monitoring, testing or analytical data required for surface and groundwater monitoring;
(6) Any monitoring, testing or analytical data required for closure or post-closure;
(7) Any cost estimates and financial assurance documentation.

All information contained in the operating record will be furnished upon request to the Division of Solid Waste Management or be made available at all reasonable times for inspection by the Division.

Ground and surface water will be sampled and analyzed according to Subtitle D Appendix I detection monitoring requirements. The monitoring frequency for all Appendix I detection monitoring constituents will be at least semi-annual during the life of the facility (including closure) and the post-closure period. A minimum of four independent samples from each well (background and downgradient) will be collected and analyzed for the Appendix I constituents during the first semi-annual sampling event. At least one sample from each well (background and downgradient) will be collected and analyzed during subsequent semiannual sampling events. In conjunction with the development of MSW Phase 3, the "Environmental Monitoring Plan, Proposed Phase 3 & 4 MSW Cell Areas" was prepared by BLE, Inc.

If the County of Haywood determines that there is a statistically significant increase over background for one or more of the constituents listed in Appendix I at any monitoring well at the relevant point of compliance, the County will, within 14 days of the finding, report to the Division of Solid Waste and place a notice in the operating record indicating which constituents have shown statistically significant changes from background levels. The County will establish an assessment monitoring program within 90 days. The County may demonstrate that a source other than the landfill caused the contamination or that the statistically significant increase resulted from an error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality. A report documenting these demonstrations will be certified by a Licensed Geologist or Professional Engineer and approved by the Division of Solid Waste. A copy of this report will be placed in the operating record. If a successful demonstration is made, documented, and approved by the Division, the County may continue detection monitoring. If after 90 days, a successful demonstration is not made, the County will initiate an assessment monitoring program.

OPERATIONAL REQUIREMENTS

1. Waste Acceptance and Disposal Requirements

a. The Municipal Solid Waste Landfill (MSWLF) will only accept those solid wastes which it is permitted to receive. Haywood County will notify the Division within 24 hours of attempted disposal of any waste the landfill is not permitted to receive. Signs are placed at the entrance to the Landfill stating that Hazardous and Liquid wastes are not accepted and that random waste screening is performed.

b. The following wastes are prohibited from disposal at the MSWLF:

i. Hazardous waste as defined within 15A NCAC 13A, to also include hazardous waste from conditionally exempt small quantity generators.

ii. Polychlorinated biphenyls (PCB) wastes as defined in 40 CFR 761.

iii. Bulk or non-containerized liquid waste will not be placed in the landfill unless:

(i) The waste is household waste other than septic waste and waste oil,
(ii) The waste is leachate or gas condensate derived from the landfill.

iv. White Goods, Yard Waste, Tires.

v. Containers holding liquid wastes will not be placed in the landfill unless:

(i) The container is a small container similar in size to that normally found in household waste;
(ii) The container is designed to hold liquids for use other than storage; or
(iii)The waste is household waste.

vi. For the purpose of this paragraph:

(i) Liquid waste means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), S. W. 846.

c. Spoiled foods, animal carcasses, abattoir waste, hatchery waste, and other animal waste delivered to the disposal site will be covered immediately.

d. Asbestos waste will be accepted. The waste will be put in a hole dug out of the existing waste and buried immediately. A 24 hour notice will be given to the Landfill before any asbestos arrives, records will be kept as to whom and type of asbestos buried.

e. Wastewater treatment sludges may be accepted either as a soil conditioner incorporated into or applied onto vegetative growth layer but in no case greater than six inches in depth. Or wastewater treatment sludges may be co-disposed in the lined area.

f. Haywood County will continue a program at the Landfill for detecting and preventing the disposal of hazardous and liquid wastes. (Section 5.3-Appendix I) This program will include, at a minimum:

   i. Random inspections of incoming loads or other comparable procedures;

   ii. Records of any inspections;

   iii. Training of facility personnel to recognize hazardous and liquid wastes.

   iv. Development of a contingency plan to properly manage any identified hazardous and liquid wastes. The plan must address identification, removal, storage and final deposition of the waste.

g. Waste placement will be within the area limits of the base liner system and in a manner consistent with the effective permit.

2. Cover material requirements.

a. Except as in Part (b), Haywood County must cover disposed solid waste with six inches of earthen material at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors blowing litter, and scavenging.

b. Haywood County has completed the demonstration period and is the process of finalizing the use of a synthetic tarp to be used as an Alternate Daily Cover (ADC). Also, the County is preparing to begin a demonstration period for the use of mulched material, consisting of 1.5 inches of mulched material combined with 4.5 inches of soil. At a minimum, soil cover will be used once a week.

c. Areas which will not have additional wastes placed on them for 12 months or more, but where final termination of disposal operations has not occurred, will be covered with a minimum of one foot of intermediate cover.

3. Disease vector control

a. Haywood County will prevent or control on-site populations of disease vectors using techniques appropriate for protection of human health and the environment. At the end of every day, waste will be covered by approved daily cover. At a minimum soil will be used once a week. Any waste that requires immediate cover will be covered immediately with soil.

b. "Disease vectors" means any rodents, flies, mosquitoes, or other animals, including insects, capable of transmitting disease to humans.

4. Explosive gases control

a. Haywood County must ensure that:

   i. The concentration of methane gas generated by the landfill does not exceed 25 percent of the lower explosive limit for methane in landfill structures (excluding gas control or recovery system components); and

   ii. The concentration of methane gas does not exceed 100 percent of the lower explosive limit for methane at the landfill property boundary.

b. Haywood County will implement a routine methane monitoring program to ensure that the standards of 4 (a) are met. See Appendix 3 for the Explosive Gas Control Plan for Haywood County White Oak Landfill.

   i. The type and frequency of monitoring must be determined based on the following factors:

      I. Soil conditions;

      II. The hydrogeologic conditions surrounding the facility;

      III. The hydraulic conditions surrounding the facility;

      IV. The location of facility structures and property boundaries.

   ii. The minimum frequency of monitoring will be quarterly.

c. If methane gas levels exceeding the limits specified in 4 (a) are detected, the owner or operator will:

   i. Immediately take all necessary steps to ensure protection of human health, i.e. no smoking, temporarily abandon the structure and notify the Division of Solid Waste Management.

   ii. Within seven days of detection, place in the operating record the methane gas levels detected and a description of the steps taken to protect human health; and

   iii. Within 60 days of detection, implement a remediation plan for the methane gas releases, place a copy of the plan in the operating record, and notify the Division of Solid Waste Management that the plan has been implemented. The plan will describe the nature and extent of the problem and the proposed remedy.

d. "Lower explosive limit" means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25° C and atmospheric pressure.

5. Air Criteria

a. Haywood County will ensure that the landfill does not violate any applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the US. EPA Administrator pursuant to Section 110 of the Clean Air Act, as amended.

b. Open burning of solid waste, except for the infrequent burning of land clearing debris generated on site or debris from emergency clean-up operations, is prohibited. Any such infrequent burning will be approved by the Division of Solid Waste Management.

c. Earth moving equipment will be provided to control accidental fires and leachate tank trucks used for water or leachate that would be recirculated can also be used. Arrangements have been made with the local fire department to provide actual fire protection. This fire department has access at all times to the landfill to provide fire fighting services when needed. Landfill personnel can use soil to isolate the fire so it will not spread any further but actual fighting of the fire should be the responsibility of the trained fire department.

d. Fires that occur at the landfill will be reported to the Division of Solid Waste Management within 24 hours and written notification will be submitted within 15 days.

e. Although the County does not have nor is required to operate a methane collection and combustion system, provisions for a methane extraction and collection system are included in the MSW Phases 3 and 4 Permit To Construct. Any future gas collection system will connect to a planned methane collection and combustion associated with MSW Phases 1 and 2.

6. Access and safety requirements

a. The landfill will be adequately secured by means of gates, chains, beams, fences and other security measures approved by the Division of Solid Waste Management to prevent unauthorized entry.

b. An attendant will be on duty at the site at all times while it is open for public use to ensure compliance with operational requirements.

c. The access road to the site will be of all-weather construction and maintained in good condition.

d. Dust control measures will be implemented when necessary. If dust problems should arise, the county will use any reasonable means necessary to reduce it. At a minimum the county will spray water on necessary areas.

e. Signs providing information on tipping or disposal procedures, the hours during which the site is open for pubic use, the permit number and other pertinent information will be posted at the site entrance.

f. Signs will be posted stating that no hazardous or liquid waste can be received.

g. Traffic signs or markers will be provided as necessary to promote an orderly traffic pattern to and from the discharge area and to maintain efficient operating conditions.

h. The removal of solid waste from the landfill will be prohibited unless the County approves and the removal is not performed on the working face.

i. Barrels and drums will not be disposed of unless they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained therein, except fiber drums containing asbestos.

7. Erosion and Sedimentation Control Requirements

a. Adequate sediment control measures (structures or devices), will be utilized to prevent silt from leaving the landfill.

b. Adequate sediment control measures (structures or devices), will be utilized to prevent excessive on-site erosion.

c. Provisions for a vegetative ground cover sufficient to restrain erosion will be accomplished within **21 calendar days** upon completion of any phase of landfill development.

8. Drainage Control and Water Protection Requirements

a. Surface water will be diverted from the operational area.

b. Surface water shall not be impounded over or in waste.

c. Solid waste shall not be disposed of in water.

d. Leachate shall be contained on site and properly treated prior to discharge.

e. The construction of MSW Phase 3 will impact approximately 0.45 acres of wetlands and 185 linear feet of stream, which will require the 404/401 permits from the United States Army Corps of Engineers and the North Carolina Department of Environment and Natural Resources. A submittal for these impacts has been made to the appropriate agencies. A copy of the 404/401 permits will be forwarded to the Solid Waste Section prior to an issuance of a Permit To Construct MSW Phase 3.

f. Beyond the stream and mitigation required for (e) above, the landfill will not:

(i) Cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements pursuant to Section 402.

(ii) Cause the discharge of a non-point source of pollution to waters of the United States, including wetlands, that violates any requirements of an area-wide or state-wide water

quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended.

9. Liquids Restriction

a. Bulk or non-containerized liquid waste will not be placed in the landfill unless:

(i) The waste is household waste other than septic waste and waste oil,

(ii) The waste is leachate or gas condensate derived from the landfill.

b. Containers holding liquid wastes will not be placed in the landfill unless:

(i) The container is a small container similar in size to that normally found In household waste;

(ii) The container is designed to hold liquids for use other than storage; or

(iii) The waste is household waste.

c. For the purpose of this paragraph:

(i) Liquid waste means any waste material that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), S. W. 846.

(ii) Gas Condensate means the liquid generated as a result of gas recovery processes at the MSWLF unit.

d. Test for free liquids:

Sludges or other wastes may be tested for free liquids after previous screening tests have shown that the waster is not hazardous and does not contain PCB's. The specified test to determine whether or not a material is considered to be a liquid is the Paint Filter Test method 9095. The procedure for conducting this test is as follows:

(i) Obtain standard 400-micron paint filter;

(ii) Place a properly-sized, clean, dry funnel in a ring stand or similar device;

(iii) Fold the filter and line the funnel with it;

(iv) Place a 100 ml sample of waste into the funnel;

(v) Place a clean, dry container under the funnel; and,

(vi) Check in exactly 5 minutes to see if any liquid is in the container.

(vii) If any liquid passes through the filter in 5 minutes or less, the waste is considered to be a liquid. The filtrate can be water, oil or any combination of any non-hazardous liquids.

\

10. Record keeping Requirements

a. Haywood County MSWLF will record and retain at the facility, or an alternative location near the facility approved by the Division of Solid Waste Management, in an operating record the following information as it becomes available.

(i) Inspection records, waste determination records, and training procedures;

(ii) Amounts by weight of solid waste received at the landfill to include source of generation.

(iii) Waste determination, Leachate sampling data, leachate levels, meteorological data;

(iv) Gas monitoring results and any remediation plans;

(v) Any demonstration, certification, findings, monitoring, testing or analytical data required for surface and groundwater monitoring;

(vi) Any monitoring, testing or analytical data required for closure or post-closure; and,

(vii) Any cost estimates and financial assurance documentation.

b. All information contained in the operating record will be furnished upon request to the Division of Solid Waste Management or be made available at all reasonable times for inspection by the Division.

c. Haywood County will maintain a copy of the operation plan at the landfill.

11. Spreading and Compacting Requirements

a. The landfill will restrict solid waste into the smallest area feasible, typically 60' x 75' area. Waste will be covered with six (6) inches of daily cover. This lift will absorb the rain water and allow some of it to evaporate prior to reaching the leachate collection system. When a heavy rain does occur, the impact on the leachate collection system will not be immediate. Prior to placement of solid waste over any leachate pipe, the geotextile fabric that is covering the stone will be folded back so that solid waste will be in direct contact with the stone. This method will not allow biological growth to develop on the geotextile which could eventually clog the system.

b. Solid waste will be compacted as densely as practical into cells. The compactor should run over an area of solid waste a minimum of 6 times. The initial lift of solid waste will be placed loosely at a depth of 4 feet. As this lift is being placed, a spotter should be placed in the landfill to assure that the compactor does not drive any long, sharp objects through the protective cover

into the liner system. If an object were to penetrate the liner system, the protective cover must be removed and the penetration repaired. The subsequent lifts can be placed up to final grades or until the diversion berm needs to be moved to cell 2 which will allow for more horizontal space. Heavy landfill equipment including articulating dump trucks, and compactor will only be allowed on areas that have a minimum of 4' of solid waste. Only low pressure equipment such as a D6 LGP Caterpillar will be allowed on the protective cover.

c. Appropriate methods such as fencing and diking will be provided within the area to confine solid waste subject to be blown by the wind. At the conclusion of each day of operation, all windblown material resulting from the operation will be collected and returned to the area.

12. Leachate Management Plan

a. Leachate flows by gravity from three locations within existing MSW Phases 1 and 2. For leachate generated within the MSW Phases 3 and 4 areas, two side slope riser pumping stations located within Phase 3 will pump leachate to the gravity collection system prior to discharge into the leachate storage lagoon. The leachate collection system test wells will be checked on a quarterly basis for blockages and leachate lines will be cleaned as necessary. The leachate pipes will be cleaned with a jet cleaner with access through the cleanouts and leachate test wells. The side slope riser pumps shall be pulled and inspected annually. Any worn or damaged parts will be replaced. The pump stations will be inspected for proper operation and run-time hours will be documented. Landfill personnel shall maintain records of all inspections, cleaning, and repairs made on the leachate collection system.

b. Haywood County will maintain records for the amount of leachate collected and transported to the wastewater treatment facility.

c. Haywood County will quality sample their leachate bi-annually for Appendix I (Section 5.3) constituents, pH, BOD, COD, TDS, phosphate, nitrate, and sulfate. The sample will be obtained from the lagoon and sampled the same time as the monitoring wells.

d. The leachate is being treated by the Town of Waynesville Waste Water Treatment Plant.

e. Under extreme operational conditions Haywood County has the option of shutting down the flow of leachate to the lagoon by use of a shut off valve. The leachate will be temporarily stored within the MSWLF units until such a time the flow of leachate can continue to the lagoon. If any rain or other event requires storage of leachate or storm water in the cell, the Division of Solid Waste will be notified immediately followed by written communication. During wet weather, the pump and hauling may have to be done 24 hours a day for several days until the leachate lagoon levels have been reduced.

f. Leachate will be recirculated upon approval of the NCDENR-Division of Waste Management. See Appendix 4 for Haywood County's Recirculation Plan.

Appendix 1

WASTE SCREENING PROCEDURES

A. INTRODUCTION

The municipal solid waste stream is made up of wastes from all sectors of society. The waste is often categorized by its source or its characteristics. Terms used include commercial, industrial, residential, biomedical, hazardous, household, solid, liquid. demolition/construction, sludge, etc. Regardless of how one classifies wastes, the bottom line is that wastes are delivered to the landfill and a management decision must be made to either reject or accept them. This responsibility rests with the manager of the landfill. Wastes which are not authorized to be accepted at the landfill create a number of potential problems including: (1) liability due to future releases of contaminants; (2) bad publicity if media learns of unacceptable waste entering the landfill; (3) potential for worker injury; (4) exposure to civil or criminal penalties; (5) damage to landfill environmental control systems.

B. HAZARDOUS WASTE REGULATIONS AND MANAGEMENT

In the United States, hazardous waste is regulated under RCRA, Subtitle C. A waste is hazardous if it is listed as a hazardous waste by the Administrator of the Environmental Protection Agency (EPA) in the Code of Federal Regulations, Title 40, Part 261, or if it meets one or more of the hazardous waste criteria as defined by EPA. These criteria are:

- Ignitability
- Corrosivity
- Reactivity
- Toxicity

1. Ignitability

Ignitable waste is a waste that burns readily, causes a fire by friction under normal circumstances, or is an oxidizer. Any waste having a flash point of <140F falls in this category. Flash point is that temperature at which a liquid gives off vapors that will ignite when an open flame is applied. Under Department of Transportation (DOT) definitions, a flammable liquid has a flash point of>100 F. A combustible liquid has a flash point between 100 and 200 F. Therefore, a flammable liquid is always hazardous while a combustible liquid mayor may not be hazardous depending upon its flash point.

2. Corrosivity

A corrosive waste is one having a very high or a very low pH. The pH of a liquid is a measure of how acidic or basic (alkaline) the material is. The pH scale ranges from 0 to 14. High numbers are basic and low numbers are acidic. A substance having a pH ≤ 2.0 or ≥ 12.5 is defined as hazardous under RCRA.

3. Reactivity

A waste is reactive if it is normally unstable: reacts violently with water; forms an explosive mixture with water; contains quantities of cyanide or sulfur that could be released to the air; or can easily be detonated or exploded. These wastes may fall into anyone of several DOT categories.

4. Toxicity Characteristic Leaching Procedure (TCLP)

A waste is TCLP toxic if the concentration of any constituent in Table 1 exceeds the standard assigned to that substance. The TCLP is a methodology which attempts to simulate the conditions within a landfill. An acidic solution is passed through a sample of waste and the resultant "leachate" is analyzed for contaminants. The TCLP is designed to detect heavy metals, pesticides and a few other organic and inorganic compounds. The purpose of the test is to prevent groundwater contamination by highly toxic materials. TCLP tests the mobility of 40 different elements and compounds.

Except in certain specified circumstances, regulated quantities of hazardous waste must be disposed of at a permitted hazardous waste disposal facility. In accordance with 40 CFR Part 26 1.3, **any material contaminated by a hazardous waste is also deemed to be a hazardous waste and must be managed as such.** Hazardous waste from conditionally exempt small quantity generators are to be disposed of in a Hazardous waste disposal facility. RCRA permits are also required to store, transport, and treat hazardous waste.

C. POLYCHLORINATED BIPHENYL'S (PCBs)

1. Introduction

PCBs are nonflammable and conduct heat without conducting electricity. These compounds were most frequently used as an additive to oil or other liquids in situations where heat was involved. The PCBs enhance the heat conducting properties of the liquid and thereby increase the heat dissipation or cooling effect obtained. They have also been used in lubricants and paint. In the United States one of the most common applications was in electric transformers. The only effective method for destroying PCBs is high Temperature incineration which is relatively expensive due to a shortage of PCB incineration capacity.

TABLE 1

T.C.I.P CONSITIUENTS & REGULATORY LEVELS (mg/L)			
CONSTITUENT	REG LEVEL	CONSTITUENT	REG LEVEL
Arsenic	5.0	Hexachlorobenzene	0.13
Barium	100	Hexachloro-1,3-butadiene	0.5
Benzene	0.5	Hexachloroethane	3.0
Cadmium	1.0	Lead	5.0
Carbon Tetrachloride	0.5	Lindane	0.4
Chlordane	0.03	Mercury	0.2
Chlorobenzene	100	Methoxychlor	10.
Chloroform	6.0	Methyl ethyl ketone	200
Chromium	5.0	Nitrobenzene	2.0
m-Cresol	200	Pentachlorophenol	100
o-Cresol	200	Pyridine	5.0
p-Cresol	200	Selenium	1.0
Cresol	200	Silver	5.0
1,4-Dichlorobenzene	10.0	Tetrachloroethylene	0.7
1,2-Dichloroethane	0.7	Toxaphene	0.5
1,1-Dichloroethylene	0.5	Trichloroethylene	0.5
2,4-Dichlorophenoxyacetic acid	0.7	2,4,5-Trichlorophenol	400
2,4-Dinitrotoluene	0.13	2,4,6-Trichlorophenol	2.0
Endrin	0.02	2,4,5-TP (Silvex)	1.0
Heptachlor (and its hydroxide)	0.008	Vinyl Chloride	0.2

By law PCB's are no longer used as dielectrics in transformers and capacitors manufactured after 1979. There are many millions of pounds of PCBs still in use or in storage. One example is the ballasts used in fluorescent light fixtures. It has been estimated that there are between 0.5 million and 1.5 billion ballasts currently in use in this country. Due to the long life of these units, about half of these may be of pre-1979 manufacture and contain PCBs. Since each ballast contains about one ounce of nearly pure PCB fluid, there are about **20 to 30 million pounds** of PCBs in existing lighting fixtures. These items are not subject to RCRA Subtitle D Waste Screening!

Commercial or industrial sources of PCB wastes that should be addressed by the program include:

- Mineral oil and dielectric fluids containing PCBs;
- Contaminated soil, dredged material, sewage sludge, rags, and other debris from a release of PCBs;
- Transformers and other electrical equipment containing dielectric fluids; and
- Hydraulic machines

2. PCB Regulatory Requirements

As contrasted to hazardous wastes, the Toxic Substance Control Act regulates PCBs based on the concentration of PCBs in the waste rather than the source or characteristic of the waste. The regulations concerning PCB disposal are spelled out in 40 CFR Pan 761. Subtitle D of RCRA merely requires that PCB waste not be disposed in a MSW landfill. PCB management requirements include:

Waste containing more than 500 ppm of PCBs must be incinerated. Waste containing from 50 to 500 ppm must be disposed of by incineration. approved burning, or in chemical waste landfill permitted to receive such wastes. The regulations are silent concerning wastes containing less than 50 ppm of PCBs; however, the regulations cannot be circumvented by diluting stronger wastes.

D. FUNDAMENTALS OF WASTE SCREENING

1. Know Your Generators and Haulers

Since the level of sophistication of your waste screening program will be a reflection of the likelihood of hazardous waste and PCB waste being in your incoming waste, **knowledge of the commercial industrial base of your service area is critical.** Some examples are the automotive industry, which generates solvents, paint wastes, lead acid batteries, grease and oil; the dry cleaning industry, which may generate filters containing dry cleaning solvents; metal platers which generate heavy metal wastes; and other industries which generate a variety of undesirable wastes; e.g. chemical and related products, petroleum refining, primary metals, electrical and electronic machinery, etc.

Landfill managers should also know the haulers and trucks serving the businesses in their community which are likely to carry unacceptable wastes.

Some local governments and solid waste management agencies have enacted legislation requiring haulers to provide a manifest showing the customers whose wastes make up that particular load.

Such a manifest is an extremely useful tool when a load is found to contain prohibited wastes. It is unwise to accept wastes from unknown, unlicensed, or otherwise questionable haulers.

2. Inspections

An inspection is typically a visual observation of the incoming waste loads by an individual who is trained to identify regulated hazardous or PCB wastes that would not be acceptable for disposal at the MSWLF unit. The training of landfill personnel will be conducted by a local EMS official or a SWANA certification. An inspection is considered satisfactory if the inspector knows the nature of all materials received in the load and is able to discern whether the materials are potentially regulated hazardous wastes or PCB wastes.

Ideally, all loads should be screened; however, it is generally not practical to inspect in detail all incoming loads. Random inspections, therefore, can be used to provide a reasonable means to adequately control the receipt of inappropriate wastes. Random inspections are simply inspections made on less than every load. At a minimum the inspection frequency will not be less than one percent of the waste stream.

The frequency of random inspections may be based on the type and quantity of wastes received daily, and the accuracy and confidence desired in conclusions drawn from inspection observations. Because statistical parameters are not provided in the regulation, a reasoned, knowledge-based approach may be taken. A random inspection program may take many forms such as inspecting every incoming load one day out of every month or inspecting one or more loads from transporters of wastes of unidentifiable nature each day. If these inspections indicate that unauthorized wastes are being brought to the MSWLF site, the random inspection program should be modified to increase the frequency of inspections.

Inspection priority also can be given to haulers with unknown service areas, to loads brought to the facility in vehicles not typically used for disposal of municipal solid waste, and to loads transported by previous would-be offenders. For wastes of unidentifiable nature received from sources other than households (e.g., industrial or commercial establishments), the inspector should question the transporter about the source/composition of the materials.

Loads will be inspected on the tipping floor at the baler facility prior to actual disposal of the waste at the working face of the landfill unit to provide the County the opportunity to refuse or accept the wastes.

An inspection flow chart to identify, accept, or refuse solid waste is provided as Figure 1.

Inspections of materials may be accomplished by discharging the vehicle load in an area designed to contain potentially hazardous wastes that may arrive at the facility. The waste should be carefully spread for observation using a front end loader or other piece of equipment. The Division of Solid Waste recommends that waste should be hand raked to spread the load. Personnel should be trained to identify suspicious wastes. Some indications of suspicious wastes are:

- Hazardous placards or markings;
- Liquids;
- Powders or dusts;
- Sludges;
- Bright or unusual colors;
- Drums or commercial size containers; or
- Chemical odors.

Haywood County will follow these procedures when suspicious wastes are discovered.

- Segregate the wastes;
- Question the driver;
- Review the manifest (if applicable);
- Contact possible source;
- Call the State Solid Waste Management Department;
- Use appropriate protective equipment;
- Contact laboratory support if required; and
- Notify the local Hazardous Material Response Team.

Containers with contents that are not easily identifiable, such as unmarked 55-gallon drums, should be opened only by properly trained personnel. Because these drums could contain hazardous waste, they should be refused whenever possible. Upon verifying that the solid waste is acceptable, it may then be transferred to the working face for disposal.

Testing typically would include the Toxicity Characteristic Leaching Procedure (TCLP) and other tests for characteristics of hazardous wastes including corrositivity, ignitability, and reactivity. Wastes that are suspected of being hazardous should be handled and stored as a hazardous waste until a determination is made.

If the wastes temporarily stored at the site are determined to be hazardous, Haywood County is responsible for the management of the waste. If the wastes are to be transported from the facility, the waste must be: (1) stored at the MSWLF facility in accordance with requirements of a hazardous waste generator, (2) manifested, (3) transported by a licensed Treatment, Storage, or Disposal (TSD) facility for disposal.

E. RECORD KEEPING AND NOTIFICATION REQUIREMENTS

Records must be kept pursuant to an incident where regulated hazardous waste or prohibited waste is found at the landfill. It is also recommended that records be kept of all screening activities and incidents, whether or not, regulated or prohibited wastes are found. This will help prove that the landfill owner/operator has acted in a prudent and reasonable manner.

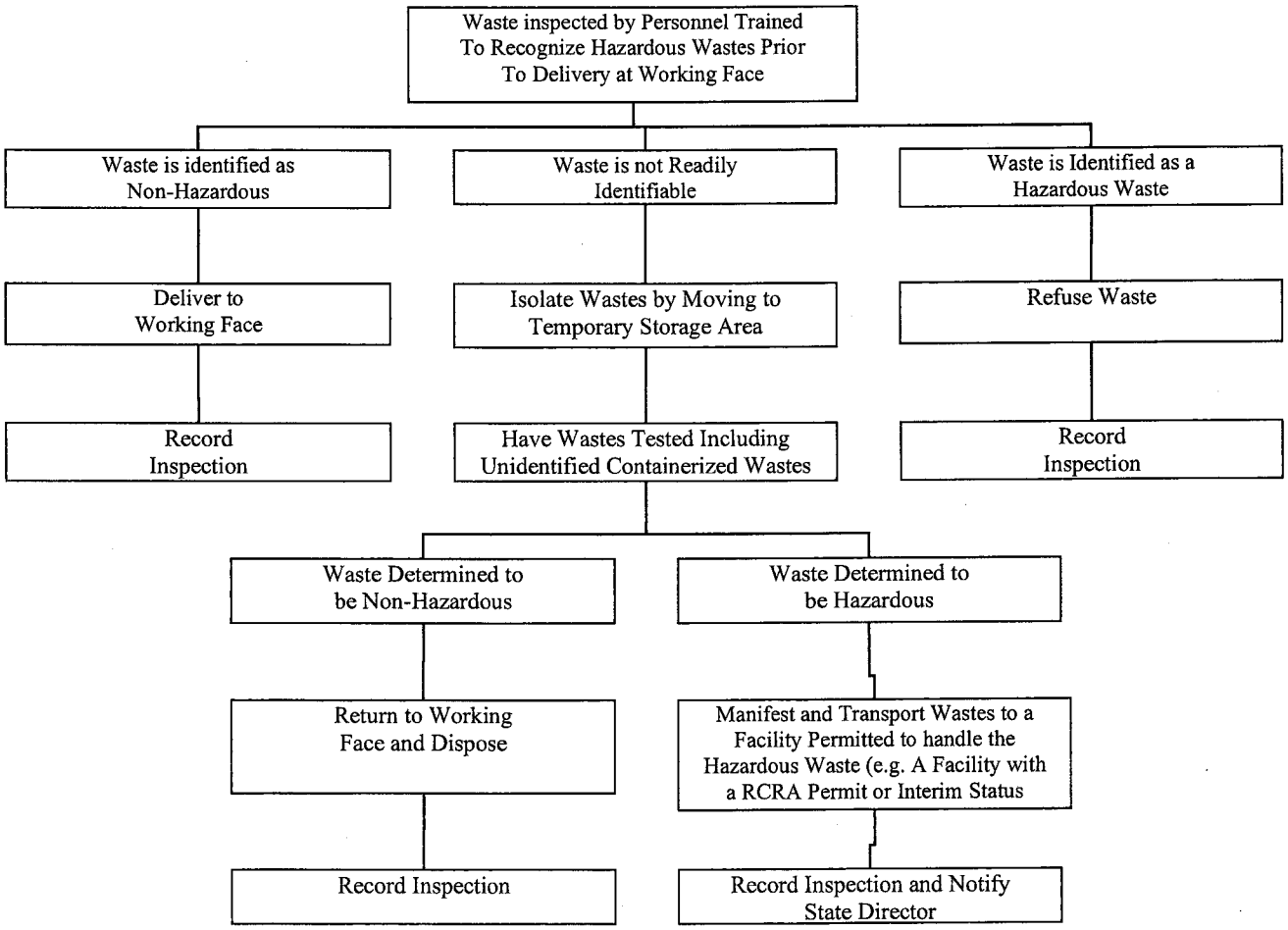
The best way to prove compliance with this requirement is to document each inspection including:

Date and time of waste detection
Hauler name (company and driver)

Waste(s) detected
Waste generator(s) if able to identity
Action(s) taken to manage or return material(s)
Efforts taken if extreme toxicity or hazard was discovered
Landfill employee in responsible charge

40 CFR Part 258 requires that records should be maintained at or near the landfill site during its active life and as long after as may be required by the appropriate state or local regulations.

FIGURE 1
Hazardous Waste Inspection Decision Tree
Inspection Prior to Working Face



WASTE SCREENING CHECK LIST

CONTAINERS	**YES**	**NO**
FULL	_____	_____
PARTIALLY FULL	_____	_____
CRUSHED	_____	_____
PUNCTURED	_____	_____
POWDERS/DUSTS		
IDENTIFIED	_____	_____
UNKNOWN	_____	_____
SATURATION	_____	_____
LABEL/HAZARDOUS	_____	_____
ODOR/FUMES		
STRONG	_____	_____
FAINT	_____	_____
HEAT	_____	_____
ITEMS FOUND		
BATTERIES	_____	_____
OIL	_____	_____
BIOMEDICAL	_____	_____
RADIOACTIVE	_____	_____
ASHES/RESIDUE	_____	_____
SOD/SOIL	_____	_____
LIQUID	_____	_____
HAZARDOUS	_____	_____
PCB'S	_____	_____

CHECK ALL THAT APPLY

DETAILED SCREENING REPORT

WASTE SOURCE _____
ADDRESS _____
_____
_____

PROBABLE [ ] SUSPECTED [ ] CONFIRMED [ ]

WASTE HAULER _____
ADDRESS _____
_____
_____

DRIVER'S NAME _____
DETAIL _____
_____
_____

NOTIFIED:

WASTE SOURCE [ ] HAULING MANAGEMENT [ ] SITE MANAGEMENT [ ]

STATE [ ] FEDERAL [ ]

_____

NAME_____
WITNESS (IF ANY) _____
DATE_____ TIME_____ AM PM

_____

ACTION REQUIRED

Appendix 2

HAYWOOD COUNTY SYNTHETIC COVER OPERATION PLAN
and
DEMONSTRATION REPORT

Demonstration Period Report

Haywood County used 3 Landfill Tarp Systems tarps during the demonstration period. The tarps were pulled over the working face at the end of the day as described in the Operations section below. The tarps were used on approximately 25% of the days during the demonstration period. Variables affecting the use of the tarps include the location within the landfill and wet weather conditions. The tarps were not used when the working face was near the permanent or temporary slopes because soil cover was used in these areas. Additionally, the tarps were not used during wet weather due to the fact that extra water weight could cause tearing of the tarps. The use of the tarps allowed for a seamless integration from one day to the next and the County will continue to use these tarps as a method of daily cover.

Operations

1. By the end of each day of operations, the horizontal or lateral expansion of the working face will be covered with at least six (6) inches of earthen material. The working face will be maintained at a minimum of a 4:1 slope and compacted to reach maximum waste density possible to minimize the size of the working face; preserve landfill space; and deter wind-blown litter. An ADC synthetic cover may be used in place of soil at the discretion of the landfill operator. At the end of the operating day, a 50' x 50', 6.5 oz/sq.ft. tarp will be pulled over the slope of the working face. The tarp will cover all exposed portions of the working face, and the corners and sides of the tarp will be weighted with dirt and/or small stones to prevent the wind from exposing any waste. At the beginning of the next operating day, the tarp will be walked off of the working face and stored in an adjacent area to the working face.

2. The proposed ADC will consist of three (3) Landfill Tarp systems. Each tarp will be approximately 50' x 50' in size, and 6.5-8.5 oz/sq.ft. The tarp is constructed of a woven polypropylene that is puncture, tear and U.V. resistant. The synthetic cover is shipped to the landfill site with panels folded accordion-type, and rolled up. Unroll the cover along the working face (depending upon operations), and attach the leading edge of the unrolled panel to existing landfill equipment with ropes (i.e., to the top of the blade).

3. Pull the sewn panels of cover across the compacted trash. The synthetic cover maybe pulled from any direction, which may vary from day to day. Keep the leading edge between the two machines (or people) as high as possible to eliminate drag.

4. Anchor the edges of synthetic cover every 20 feet with tires (with rims intact or filled with concrete) or sandbags to hold the synthetic cover in place. If it is windy, more anchoring may be required.

5. On the next day of operations, remove the tires and/or sandbags. Simply pull the synthetic cover across itself (to reduce drag) and off the refuse to an area that is inactive. Anchor the edges again to prevent wind from lifting the blanket. At the end of the day, pull the synthetic cover back across the refuse by repeating steps 3 and 4 until a new panel is needed.

The Synthetic Cover is designed to be used as landfill daily cover on a working face. For best results, it is recommended that the area to be covered be kept as close to a square shape as possible. Not only does this procedure allow for easier coverage, it allows for better management of the working face and saves time at the end of the working day.

Haywood County will continue to use the plastic panel cover that is currently approved to cover the working face of stacked bales. At the end of the working day, the plastic panel will be secured in place similar to the proposed 6.5-oz. Synthetic Cover.

The working face is operated in this manner, brought to an intermediate grade and then covered with the

required soil. The process will continue until a lift is completed. The process is then started over on the next lift until the landfill is filled to final grade and a section is closed. At a minimum six (6) inches of soil cover will be used once a week.

TIPS TO REMEMBER

1. Always pull the fabric across itself during installation and removal to make each panel last as long as possible.

2. Avoid driving on the panel(s); this may cause punctures and tears.

3. Tie the panel(s) to the top of the dozer blade and raise the blade to minimize dragging on refuse.

4. Use tires (tires must be filled with concrete or include rims) or sandbags to hold the panel(s) down overnight. Soil can be used if you plan to leave panel(s) in place and cover with refuse.

5. Minimize stress between dozer/compactors while pulling on the panel(s).

Appendix 3

EXPLOSIVE GAS CONTROL PLAN FOR - HAYWOOD COUNTY

Quarterly the Haywood County landfill will monitor the explosive gas at the landfill structures and at or near the landfill boundary. The permanent probes will consist of a plastic stand pipe similar to a piezometer used for groundwater detection. A typical permanent methane probe is detailed in the operation drawings. The permanent probe will be constructed at a depth of six (6) feet. A 6" diameter hole will contain a one (1) inch slotted PVC pipe. The bottom two (2) feet will be backfilled with non-carbonate pea gravel with a bentonite seal one (1) foot thick above it. The remaining three (3) feet will be backfilled with *in situ* soils The one (1) inch PVC pipe will be approximately three (3) feet above the existing grade. The PVC pipe will be capped with a one (I) inch PVC cap, one quarter (1/4) inch NPT hose barb, and 1" tubing, plugged or capped

The location and spacing of the methane monitoring probes is somewhat arbitrary. The locations were determined by the relationship of solid waste with property lines and landfill structures. The spacing of the monitoring probes is between 200 and 400 feet. The migration of methane gas is induced by pressure gradients. The methane will move from areas of high pressure to those of low pressure following the path of least resistance. The methane will migrate vertically until it reaches the landfill cap, where it will begin to flow horizontally. This occurs until it finds a pathway out, either by the installed methane collection trenches or migration through the permeable in situ soils. Since methane is lighter than air, it wants to escape into the atmosphere. It has been our experience that whenever gas is migrating no matter what the spacing or depth of the monitoring probes, the gas will fill the void created by the monitoring point and an explosive meter will monitor the level. The six foot depth of the monitoring probes is to ensure a stable monitoring point. The only time a shallow monitoring point has not worked is in a very heavy, impermeable clay layer that acts as a seal to the migration of the gas. If a clay layer is encountered during the construction of the monitoring points, it will either be moved beyond the clay or excavated to a depth that is in the conductive zone below the clay.

The permanent probes will surround the active waste areas. Haywood County's landfill is designed with a base liner system and cap system, there should be no migration of methane in the permeable *in situ* soils.

The gas can be detected by use of an instrument that reports the percent of lower explosive limit. The instrument being used is the Gas Tech GP 204.

Quarterly, a County employee will visit each monitoring point either the temporary or permanent. The monitoring points consist of all methane probes and leachate collection system cleanouts. Using the detection instrument, he will determine if methane gas has filled the probes. If the probe is near the property line and methane gas is detected at or beyond the lower explosive limit (100% LEL), it must then be determined if the gas is migrating across the landfill boundary. If the probe is on the boundary or methane gas has migrated beyond the boundary, a remediation plan must be completed by Haywood County.

Other points of monitoring will be the landfill structures. Each structure will be monitored, for methane using the following methods:

1. All crawl spaces will be monitored;
2. All corners in the structure will be monitored;
3. Any holes, cracks and pipes through the foundation will be monitored

If methane gas is detected beyond 25% of its lower explosive limit in any structure, check the calibration of the monitor and resample. If the reading is still above 25%, evacuate the building and try to find the source of gas. If the source is found try to remove the source. If this fails a remediation plan is stated in the operational requirements.

Appendix 4
HAYWOOD COUNTY'S RECIRCULATION PLAN

Haywood County does intend to utilize recirculation as a means of disposal of their leachate. The intention is to utilize recirculation as a method by which some relief can be given to the pumping and hauling. This relief will come in the form of evaporation and retention of water within the solid waste. The remaining leachate will be hauled to the Waynesville Waste Water Treatment Plant for disposal. Haywood County must obtain a permit from the Division of Solid Waste before leachate recirculation can begin.

No water that comes in contact with the present surface of solid waste runs off any where other than the leachate collection system.

The County will spread the leachate over the surface of the solid waste. that is at a minimum five feet (5') deep, within the landfill. The spreading will be accomplished by one of two methods. The first method is by simply backing their leachate hauling truck into the landfill. A spreader hose will then be attached to the leachate tank and Haywood County personnel will manually discharge the leachate over the solid waste. The second method will utilize the tank truck except the leachate will be used to wet down solid waste that is piled up from being dumped from a truck or trucks. Once this pile is wet. it will be spread around the working face by the trash compactor.

At a later date, a pump system may be incorporated into the system. The pump system will pump directly from the leachate lagoon and the leachate spread in a manner as it was from the tank truck.

Monthly monitoring will be performed to measure the leachate head at the leachate head detection well and analyze the leachate for BOD, COD, temperature and pH.

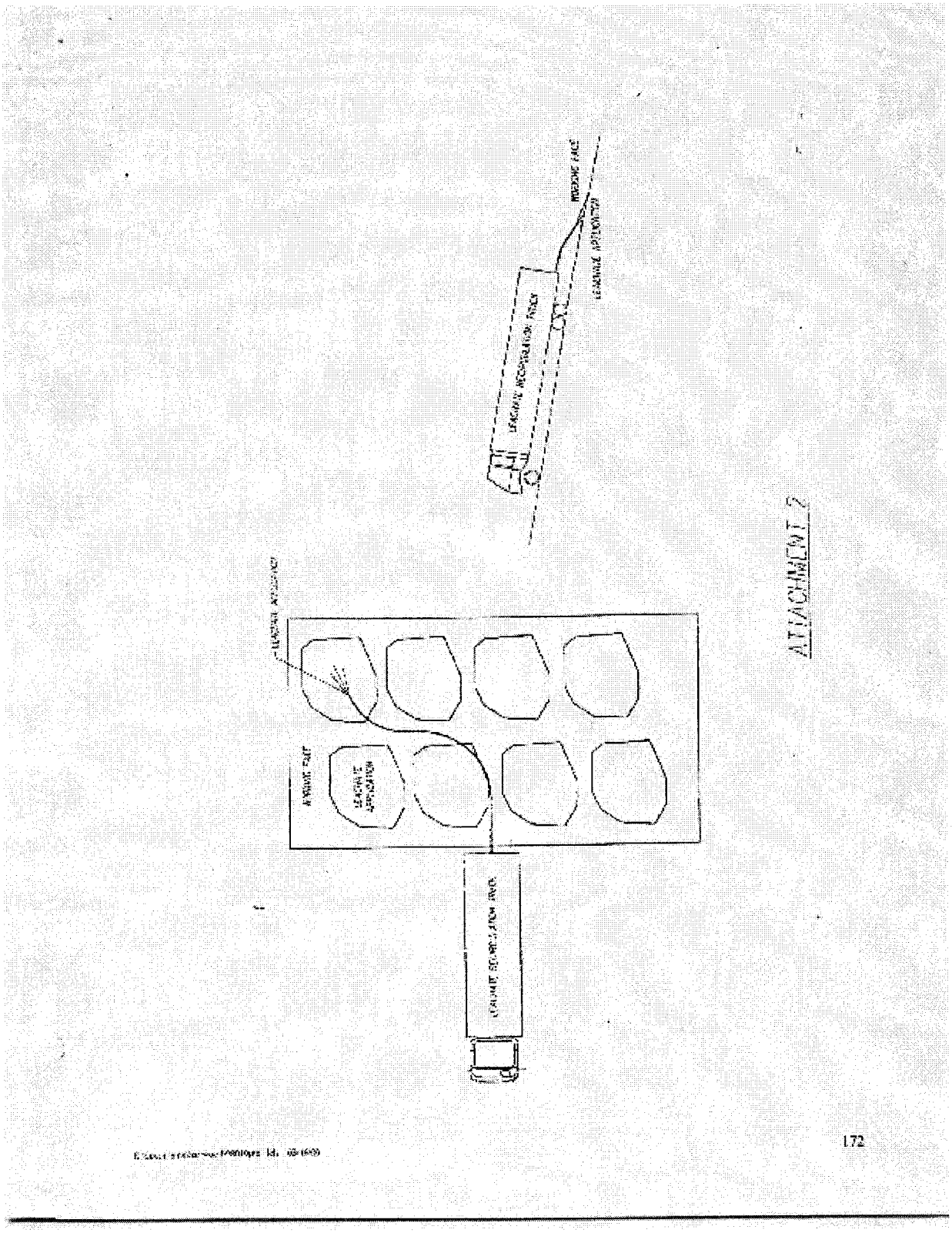
The following conditions will be met by Haywood County:

- A rain gauge and thermometer will be placed on site
- A base line sampling of leachate has been performed (See Attachment 1)
- A brief description of the equipment and its associated specifications is submitted (see Attachment 2)
- Weekly record of leachate head measurements (see Attachment 3)
- Weekly record of leachate recirculated and leachate disposed (see Attachment 4)
- Weekly record of visual monitoring log (see Attachment 5)
- Weekly record of rainfall and lagoon depth (see Attachment 6)
- Records will be kept on a weekly basis
- No leachate will be applied on less than one lifl (8 feet) of waste
- No leachate will be recirculated when it is raining, or when the waste is too wet
- No run off or side seepage will be allowed
- Odors will be controlled
- Leachate depth will be monitored in the leachate head detection well to ensure that the head on the liner does not exceed one foot for more than 24 hours.
- The application system will be properly maintained and documented
- Leachate will be tested every 30 days and a progress report will be submitted annually

ATTACHMENT 1

BASELINE DATA

TO BE ADDED IN THE FUTURE



ATTACHMENT 2

ATTACHMENT 3

HAYWOOD COUNTY LEACHATE HEAD READINGS

DATE	DEPTH AT HEAD TEST WELL

ATTACHMENT 4

HAYWOOD COUNTY LEACHATE RECIRCULATION DATA

DATE	VOLUME RECIRCULATED	RECIRCULATION AREA (Section of Landfill)	VOLUME HAULED FOR DISPOSAL

ATTACHMENT 5

HAYWOOD COUNTY VISUAL MONITORING LOG

DATE	INDIVIDUAL MONITORING	OBSERVATIONS

ATTACHMENT 6

HAYWOOD COUNTY RAINFALL AND LAGOON DEPTH LOG

DATE	RAINFALL (INCHES)	LAGOON DEPTH (FEET)

Section 7- Closure and Post-Closure Plan

CLOSURE/POST-CLOSURE PLAN

WHITE OAK MSW LANDFILL
PHASES 3 & 4
HAYWOOD COUNTY, NORTH CAROLINA

JEFFREY R. BISHOP, P.E.

McGill ASSOCIATES

Engineering • Planning • Finance
Asheville, North Carolina

NORTH CAROLINA PROFESSIONAL SEAL 23574 ENGINEER JEFFREY R. BISHOP

September 2008

07518

CLOSURE AND POST-CLOSURE PLAN

White Oak MSW Landfill

Phases 3 and 4

The final cap system for the Phases 3 and 4 Expansion at the White Oak MSW Landfill will be constructed in a progressive manner. As substantial areas of the landfill are brought to final grade, the cap system will be constructed in order to minimize infiltration of stormwater and to reduce leachate production. The Phases 3 and 4 Expansion, which covers a total area of approximately 15.5 acres, is estimated to reach capacity in 2019.

1.0 CAP DESCRIPTION AND CONSTRUCTION

A detail of the final cap is shown on Sheet D2 of the permit drawings. The cross-section will consist of a one-foot layer of compacted on-site soils (intermediate cover), a compacted clay liner with a minimum thickness of 18 inches and a maximum permeability of 1.0×10^{-5} cm/sec, a 40-mil HDPE textured geomembrane, a double-sided geocomposite drainage layer, and a vegetative supportive layer with a minimum thickness of 24 inches.

1.1 Cap Foundation (intermediate cover)

The cap foundation cover (intermediate cover) is designed to minimize infiltration of stormwater into the landfill prior to placement of the barrier cap, and to provide a sound working platform over the municipal solid waste. The compacted intermediate cover will extend over the entire waste area and consist of compacted soil with a minimum thickness of 12 inches.

1.2 Clay Liner

The composite cap system consists of an 18-inch thick compacted clay layer and an overlying textured geomembrane. The clay liner is the first portion of the composite cap system. The function of the clay liner is to minimize surface water infiltration into the underlying waste cell. The clay liner must be constructed of clay soil with a minimum thickness of 18 inches and a maximum permeability of 1.0×10^{-5} cm/sec. The clay soil may consist of on-site soils, off-site soils, or a combination of the two. The soil may require the addition of bentonite to meet the permeability requirements. The design of the landfill cap provides for a minimum number of penetrations through the low permeable barrier cap. The only anticipated penetrations will be for leachate collection piping cleanouts and methane gas system wells. Details of the proposed composite cap system are shown on Sheets D1-D11 of the permit drawings.

1.2a - Construction Requirements

Construction methods for the compacted clay liner shall be based upon the type and quality of the borrow source and shall be verified in the field by constructing test pad(s). The CQA engineer shall ensure that the compacted clay liner installation conforms to the Design Study approved by the Division of Solid Waste (Division), including the following minimum requirements:

1. A test pad shall be constructed prior to beginning installation of the compacted clay liner and at any time when there is a significant change in soil material properties. The location, equipment, liner thickness, and subgrade slope and conditions shall be representative of full-scale construction. Acceptance and rejection criteria shall be based on results from the tests as specified in Section **1.2b**. For each lift, a minimum of three (3) locations shall be established for testing moisture content and density, and collecting a composite sample for recompacted lab permeability. In addition, at least one shelby tube sample, or another in-situ test approved by the Division, shall be collected or performed for each lift of the test pad constructed. These samples will be used for performing lab permeability tests.

2. Soil conditioning, placement, and compaction shall be maintained within the range identified in the moisture-density-permeability relation developed in accordance with Section **1.2b**.

3. The final compacted thickness of each lift shall be a maximum of six inches.

4. Prior to placement of successive lifts, the surface of the lift in place shall be scarified or otherwise conditioned to eliminate lift interfaces.

5. The final lift shall be adequately protected from environmental degradation.

1.2b - Construction Quality Assurance Requirements

clay liner - The project engineer shall ensure that the clay liner installation conforms to the Division approved Site Specific Construction Quality Assurance Plan. All (CQA) requirements for the clay liner installed as part of the landfill cap system will be the same requirements that the clay liner installed as part of the composite base liner system. The only difference is as follows:

- The clay liner portion of the cap system is required to have a permeability not greater than 1.0 x 10^{-5} cm/sec and must have a minimum thickness of 18 inches. The clay liner portion of the composite base liner is required to have a permeability not greater than 1.0 x 10^{-7} cm/sec and a minimum thickness of 24 inches.

1.3 Geomembrane Liner

The geomembrane liner is the second portion of the composite cap system. The geomembrane liner shall have a demonstrated vapor transmission rate of not more than 0.03 gm/m^2-day. The liner material and any seaming materials shall have chemical and physical resistance not adversely affected by environmental exposure, waste placement and leachate generation. The type of geomembrane used for constructing the composite cap system shall be in accordance with this section and approved by the Division.

- **i.** High density polyethylene (HDPE) geomembrane liners shall have a minimum thickness of 40 mils.
- **ii.** The minimum thickness of any geomembrane approved by the Division shall be greater than 30 mils.

geonet drainage layer - A double-sided, eight (8)-ounce geocomposite will be placed on top of the 40-mil textured geomembrane. The materials used for the geonet drainage layer shall comply with the following:

- **i.** The chemical properties of the drainage layer materials shall not be adversely affected by waste placement or leachate generated by the landfill.
- **ii.** The physical and hydraulic properties of the drainage layer materials shall promote lateral drainage of leachate through a zone of relatively high permeability or transmissivity under the predicted loads imposed by overlying materials.

1.3a - Construction Requirements

The project engineer shall ensure that the geomembrane installation conforms to the requirements of the manufacturer's recommendations and the Division approved plans including the following:

- **i.** The surface of the supporting soil upon which the geomembrane will be installed shall be reasonably free of stones, organic matter, protrusions, loose soil, and any abrupt changes in grade that could damage the geomembrane;
- **ii.** Field seaming preparation and methods, general orientation criteria, and restrictive weather conditions approved by the Division;
- **iii.** Approved Anchor trench design;
- **iv.** Critical tensile forces and slope stability;
- **v.** Protection from environmental damage; and
- **vi.** Physical protection from the materials installed directly above the geomembrane.

geonet drainage layer - The construction of the geonet drainage layer shall conform to the following:

i. The drainage layer materials shall be placed according to the Division approved plans and in a manner that prevents equipment from working directly on the geomembrane.
ii. The drainage layer materials shall be stable when placed on the slopes specified on the construction plans.

1.3b - Construction Quality Assurance Requirements

geomembrane liner - The project engineer shall ensure that the geomembrane installation conforms to the requirements of the manufacturer's recommendations and the Division approved Site Specific Construction Quality Assurance Plan.

geonet drainage layer - The project engineer shall ensure that the geonet installation conforms to the requirements of the manufacturer's recommendations and the Division approved Site Specific Construction Quality Assurance Plan.

1.4 Methane Gas Removal System

The proposed methane gas collection system for Phases 3 and 4 has been shown on Sheet C12 of the permit drawings. The proposed system will be connected to the proposed gas collection system proposed for the Phases 1 and 2. Haywood County is currently in the process of permitting a methane gas collection and combustion system at the White Oak Landfill. The proposed expansion of the system for Phases 3 and 4 will consist of vertical gas extraction wells, 8", 6" and 4" intermediate gas collection piping connecting the extraction wells, and 12" and 16" transmission headers located around the margin of Phase 1 where the transmission headers will connect to Phase 1 and 2 methane header pipes.

The methane extraction wells will be constructed prior to construction of the final cap, although well heads and collection lines will be raised as necessary during the final cap construction. A typical gas collection well has a radius of influence of approximately 100 to 125 feet. This results in approximately 14 wells for the Phases 3 and 4 area. The typical well penetrates the waste mass and allows a conduit for vertical migration of methane gas. The wells will be installed to a depth that is 10' above the top of stone leachate collection system layer. An HDPE boot will be placed at the area where the extraction well penetrates the geomembrane to retard surface water infiltration into the waste layers. A bentonite/soil mixture will also be placed and compacted around the vertical collection wells where the wells penetrate the clay liner.

1.4a - Materials Required

i. The gas collection laterals shall have a minimum nominal diameter of four inches and shall be constructed of SDR 17, HDPE pipe.
ii. The gas collection header shall have a minimum nominal diameter of 12 inches and shall be constructed of SDR 17, HDPE pipe.
iii. The gas extraction wells shall be constructed as shown on Sheet C12 and detail Sheets D1 through D11 of the permit Drawings.

1.4b - Construction Requirements

i. Gas collection piping shall be installed according to the Division approved plan.
ii. The location and grade of the piping network shall provide access for periodic cleaning.
iii. The minimum grade of gas system piping that is installed under or within the final cap system shall be three percent (3%).
iv. The gas system piping shall be constructed in such a manner to provide for gas condensate collection. This condensate shall be transported to the leachate storage tanks by pneumatic or electric and explosion-proof pumps.

1.4c - Construction Quality Assurance Requirements

The development of the gas collection system at the White Oak Landfill will be constructed in phases as sections of the landfill reach final approved grades. Haywood County is planning to install and methane gas collection and combustion system and will use the landfill gas from Phases 3 and 4. Haywood County plans to expend significant capital for developing the methane collection and combustion facility at the White Oak Landfill. Therefore, developing and maintaining a productive gas collection system is of utmost importance to Haywood County. Haywood County will make every effort to ensure that the gas collection materials and construction requirements described above are followed for the future construction of the gas collection system.

1.5 Final Cover

The final cover will be a total of 24-inches thick. The soil cover will be suitable to provide support for a vegetative cover and protect the low-permeability barrier.

1.5a - Materials Required

A grass cover is proposed for the Landfill to provide the required cover while minimizing cap maintenance. The surface will be prepared by fertilizing and placing seed in accordance with the North Carolina Erosion and Sediment Control Standards. The lower 12 inches of the final cover will be constructed of native soils. Although the material will not be required to have a specific classification or permeability, it should be a cohesive soil. The upper 6 inches of the final cover should be suitable for supporting vegetative growth. The materials used for the top portion of the final cover shall meet the following criteria:

i. **Uppermost soil**

Natural, friable, loamy soil, typical of local soil which produces heavy vegetative growth; free from subsoil, weeds, sods, stiff clay, stones larger than 1 inch, toxic substances, litter, or other foreign material harmful to plant growth; having a pH between 6.0 and 7.0.

GRADING ANALYSIS

Sieve	Minimum Percent Passing
2 inch	100
No. 4	90
No. 10	80

Topsoil shall contain sand, silt, and clay as required by AASHTO M146.

	Minimum Percent	Maximum Percent
Sand	20	75
Silt	10	60
Clay	5	30

ii. Fertilizer and/or Compost:

The uppermost soil material shall be tested prior to spreading to determine the amount of fertilizer and/or compost material that should be added to achieve optimum growth potential of the required vegetative cover.

The quality of fertilizer and/or compost and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Fertilizer Law and regulations adopted by the North Carolina Board of Agriculture.

Fertilizer and/or compost shall be 10-10-10 grade. Upon written approval of the Engineer a different grade of fertilizer may be used, provided the rate of application is adjusted to provide the same amounts of plant food.

During handling and storing, the fertilizer shall be cared for in such a manner that it will be protected against hardening, caking, or loss of plant food values. Any hardened or caked fertilizer shall be pulverized to its original conditions before being used.

iv. Lime:

The uppermost soil material shall be tested prior to spreading to determine the amount of lime that should be added to achieve optimum growth potential of the required vegetative cover.

The quality of lime and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Lime Law and regulations adopted by the North Carolina Board of Agriculture.

During the handling and storing, the lime shall be cared for in such a manner that it will be protected against hardening and caking. Any hardened or caked lime shall be pulverized to its original condition before being used.

Lime shall be agriculture grade ground dolumitic limestone. It shall contain not less than 85% of the calcium and magnesium carbonates and shall be of such fineness that at least 90% will pass a No. 10 sieve and at least 50% will pass a No. 100 sieve.

iv. Seed:

The quality of seed and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Seed Law and regulations adopted by the North Carolina Board of Agriculture.

Seed shall have been approved by the North Carolina Department of Agriculture or any agency approved by the Engineer before being sown, and no seed will be accepted with a date of test more than nine (9) months prior to the date of sowing. Such testing however, will not relieve the Contractor from responsibility for furnishing and sowing seed that meets these specifications at the time of sowing. When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the Contractor may elect, subject to the approval of the Engineer, to increase the rate of seeding sufficiently to obtain the minimum pure live seed contents specified, provided that such an increase in seeding does not cause the quantity of noxious weed seed per square yard to exceed the quantity that would be allowable at the regular rate of seed.

During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents, or other causes.

Seed shall be entirely free from bulblets or seed of Johnson Grass, Nutgrass, Sandbur, Wild Onion, Wild Garlic, and Bermuda Grass. The specifications for restricted noxious weed seed refers to the number per pound, singly or collectively, of Blessed Thistle, Wild Radish, Canada Thistle, Corncockle, Field Bindwee, Quackgrass, Dodders, Dock, Horsenettle, Bracted Plantain, Buckhorn or Wild Mustard; but in no case shall the number of Blessed Thistle or Wild Radish exceed 27 seeds of each per pound. No tolerance on weed seed will be allowed.

v. Mulch:

Straw mulch shall be threshed straw of oats, rye or wheat free from matured seed of obnoxious weeds or other species which would grow and be detrimental to the specified grass.

1.5b - Construction Requirements

Uppermost soil shall be placed according to the following requirements:

i. Use equipment and methods to prevent damage to other components of the final cap system such as the clay liner, 40-mil textured geomembrane, and gas collection piping.

ii. The uppermost soil shall be spread by utilizing small equipment with a relatively low ground pressure. This will reduce the potential of the underlying layers of the final cap being damaged. Prior to placing topsoil, shape the underlying soil layer to graded lines and cross sections to provide for 6 inches of compacted topsoil. Clear the underlying soil layer of materials larger than 2" in diameter.

iii. After alignment of the underlying soil, loosen and till to a depth of 6 inches by disking, harrowing, rototilling, or other approved methods to assure that the topsoil layer properly adheres to the underlying soil layer.

iv. After the condition of the underlying soil layer has been approved by the on-site CQA personnel, place and spread topsoil to achieve required depth after compaction; rake and remove materials larger than 2 inches. Compact with approved roller equipment, grade to finished tolerances, and prepare the seedbed in accordance with the approved Phases 3 and 4 Technical Specifications

Seed, fertilizer and lime shall be applied according to the following:

Seed shall be applied by means of a hydro-seeder or other approved methods. The rates of application of seed, fertilizer and limestone shall be as stated below, unless pre-construction testing is contrary to these rates and can be documented.

All rates are in pounds per acre:

Fertilizer and/or compost - 1000 lbs. per acre
Lime - 4,000 lbs. per acre
KY-31 Fescue - 100 lbs. per acre
Straw mulch – 60 to 80 bales

For summer seeding the following shall be added:

- German Millet - 10 lbs. per acre
- Sudangrass – 15 lbs. per acre

For winter seeding the following shall be added:

- Rye grain – 15 lbs. per acre

For steep slopes the following shall be added:

- Sericea Lespedeza – 40 lbs. per acre

Equipment to be used for the application, covering or compaction of limestone, fertilizer, compost, and seed shall have been approved by the Engineer before being used on the project. Approval may be revoked at any time if equipment is not maintained in satisfactory working condition, or if the equipment operation damages the seed. Limestone, fertilizer, compost, and seed shall be applied within 24 hours after completion of seedbed preparation unless otherwise permitted by the Engineer, but no limestone, fertilizer, or compost shall be distributed and no seed shall be sown when the Engineer determines that weather and soil conditions are unfavorable for such operations.

Limestone may be applied as a part of the seedbed preparation, provided it is immediately worked into the soil. If not so applied, limestone and fertilizer shall be distributed uniformly over the prepared seedbed at the specific rate of application and then harrowed, raked, or otherwise thoroughly worked or mixed into the seedbed.

Seed shall be distributed uniformly over the seedbed at the required rate of application, and immediately harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil. The depth of covering shall be as directed by the Engineer. If two kinds of seed are to be used which require different depths of covering, they shall be sown separately.

When a hydraulic seeder is used for application of seed and fertilizer, the seed shall not remain in water containing fertilizer for more than 30 minutes prior to application unless otherwise permitted by the Engineer.

Immediately after seed has been properly covered the seedbed shall be compacted in the manner and degree approved by the Engineer.

Mulch shall be applied according to the following:

It shall be spread uniformly at the rate give above and in a continuous blanket over the areas specified.

Before mulch is applied on cut or fill slopes which are 3:1 or flatter, and ditch slopes, the Contractor shall remove and dispose of all exposed stones in excess of 2 inches in diameter and all roots or other debris which will prevent proper contact of the mulch with the soil.

Mulch shall be applied within 24 hours after the completion of the seeding unless otherwise permitted by the Engineer. Care shall be exercised to prevent displacement of soil or seed or other damage to the seeded area during the mulching operations.

Mulch shall be uniformly spread by hand or by approved mechanical spreaders or blowers that will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.

Mulch shall be held in place by applying a sufficient amount of approved binding material to assure that the mulch is properly held in place. The rate and method of application of binding material shall meet the approval of the Engineer. Where the binding material is not applied directly with the mulch, it shall be applied immediately following the mulch operation.

The Contractor shall take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water, or other causes and shall promptly remove any blockage to drainage facilities that may occur.

1.4c - Construction Quality Assurance Requirements

Haywood County will ensure that the materials described above are utilized for the final cover and that their placement is done in accordance with the above detailed Construction Requirements. The project engineer will ensure that the materials and methods described above are utilized to construct the final cover system, and that all requirements of the Site Specific Construction Quality Assurance Plan are met.

2.0 ON-SITE WASTE INVENTORY

At closure, the amount of waste on site is estimated to be:

Existing Phases 1 & 2	- 775,000 tons
Proposed Phases 3 & 4	- 660,000 tons
Total	1,435,000 tons

3.0 CLOSURE SCHEDULE

3.1 Notification of Division of Solid Waste

Prior to beginning closure of the White Oak MSW Landfill, the Haywood County will notify the Division of Solid Waste of the intent to close the landfill.

Probable Date of Closure: Summer 2020

3.2 Begin Closure

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

Probable Date: Fall 2020

3.3 Completion of Closure

Haywood County will complete closure activities of the White Oak MSW Landfill in accordance with the closure plan within 180 days following the beginning of closure. Extensions of the closure period may be granted by the Division if the owner or operator demonstrates that closure will, of necessity, take longer than 180 days and they have taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed MSWLF unit.

Probable Date: Summer 2021

3.4 Recording of Closure

Following closure of the White Oak MSW Landfill, Haywood County will record a notation on the deed to the White Oak MSW landfill facility property, or some other instrument that is normally examined during a title search, and notify the Division that the notation has been recorded.

The notation on the deed must in perpetuity notify any potential purchaser of the property that:

1. The land has been previously used as a landfill facility; and
2. Its use is restricted under the Division of Solid Waste approved Closure Plan

Probable Date: Fall 2021

3.5 Engineer's Certification

Following closure, Haywood County shall notify the Division of Solid Waste that a certification, signed by the project engineer verifying that closure has been completed in accordance with the closure plan, has been placed in the operating record.

4.0 POST CLOSURE PLAN

4.1 Inspections

Inspections of the final cover will be performed according to the table below and the condition of the facility will be recorded with notes, maps, and photographs. Since Haywood County intends to operate the White Oak Landfill after Phases 3 and 4 have reached capacity, landfill personnel will be on-site to perform inspections on a frequent basis.

The inspection will take notice of:

1. Eroded banks
2. Patches of dead vegetation
3. Animal burrows

4. Subsidence (settlement)
5. Cracks along the cover.

The inspector will note the condition of:

1. Concrete catch basins and stormwater control facilities
2. Leachate collection and removal pipes
3. Gas monitoring wells
4. Water monitoring wells

Areas showing subsidence, cracking, signs of erosion, or damage are to be repaired.

Schedule of Inspections

Years (following closure)	Minimum Yearly Inspections
0-2	4
2-30	2

4.2 Maintenance

The vegetative cover will be trimmed at least two times a year. In the early stages of development, fertilization and/or compost will be applied annually as needed.

The leachate collection and removal pipes will be flushed and pressure-cleaned annually.

The Gas Removal System will be flushed and pressure-cleaned annually.

Vegetative growth around gas collection wells will be cleaned away and all wells will be clearly marked to prevent accidental damage.

4.3 Monitoring

Explosive gas monitoring will take place on a quarterly basis according to the procedural outline contained in the Operation Plan.

Surface and ground water testing will take place semiannually or as directed by the Division of Solid Waste.

The leachate will also be sampled semi-annually to determine the quality and constituents present. Leachate will be analyzed for Appendix 1 constituents as well as BOD, COD, phosphate, nitrate, sulfate, and pH.

4.4 Leachate collection and treatment

Until it can be demonstrated that leachate concentrations become low enough so as not to pose a threat to human health or the environment, leachate collection and treatment shall continue. Such a demonstration should address direct exposures of leachate releases to ground water, surface

water or seeps. Indirect effects, such as accumulated leachate adversely affecting the chemical, physical, and structural containment systems that prevent leachate release, also should be addressed in the demonstration.

4.5 Planned use and personal contact

Preliminary proposals for the planned use of the facility, following Closure includes developing exercise and bike trails along the periphery of the landfill property and a light industry associated with the combustion of methane gas. Any alternate use of the landfill after closure has been completed will be approved by the Division of Solid Waste prior to implementation. The person to contact regarding the facility during the Post-Closure period is:

Haywood County Solid Waste Department
Mr. Stephen King, Solid Waste Director
278 Recycle Road
Clyde, North Carolina 28786
Telephone (828) 627-8042

4.6 Water Quality Monitoring Plan

A Design Hydrogeologic Report and Environmental Monitoring Plan for Phases 3 and 4 of the White Oak MSW Landfill was prepared by BLE, Inc. This includes discussion of the existing monitoring system, proposed monitoring system, additional well construction, water level monitoring, aquifer testing, and groundwater sampling and analysis.

4.7 Engineer's Certification

Following completion of the post-closure care period, Haywood County shall notify the Division of Solid Waste that a certification, signed by the project engineer verifying that post-closure care has been completed in accordance with this post-closure plan, has been placed in the operating record.

5.0 LEACHATE STORAGE CLOSURE PLAN

Haywood County shall complete the closure activities outlined in this plan within 180 days after liquid collection has ceased.

A. At closure, the liner and all solid waste shall be removed from the lagoon and connecting lines. The lagoon liner and all solid waste removed shall be properly handled and disposed of according to Federal and State requirements. All connecting lines shall be disconnected and securely capped or plugged.

B. The lagoon site will be modified to act as a stormwater management feature.

6.0 CLOSURE AND POST CLOSURE COST ANALYSIS AND SUMMARY

6.1 Closure Costs

Phases 3 & 4 (15.5 ACRES) - Closure

				Unit Cost	Total
Item 1	Earthwork				
	a.	40,000 C.Y.	18" Clay	$20.00 /C.Y.	$800,000.00
	b.	40,000 C.Y.	24" Vegetative Cover	$8.00 /C.Y.	$320,000.00
	c.	30,000 C.Y.	12" Intermediate Cover	$5.00 /C.Y.	$150,000.00
Item 2	Geomembrane				
	a.	700,000 S.F.	40 mil HDPE	$0.80 /S.F.	$560,000.00
	b.	700,000 S.F.	8 oz. Double Sided Geone	$0.60 /S.F.	$420,000.00
Item 3	Sedimentation and Erosion Control				
a.		18 AC.	Grassing	$5,000.00 /AC.	$90,000.00
b.		200 Tons	Rip Rap	$75.00 /Tons	$15,000.00
c.		5,000 L.F.	Synthetic Lined Channels	$20.00 /L.F.	$100,000.00
Item 4	Engineering				
a.	Design & Permitting				$200,000.00
b.	Construction Quality Assurance				$225,000.00
Item 5	Contingency (10%)				$288,000.00
				Total	$3,168,000.00

6.2 Post-Closure Care Cost

b.	1 Each	Repair of Cap (1acre @ 1 foot depth)	$10,000.00 /Each	$10,000.00
c.	5 AC.	Reseeding	$1,200.00 /AC	$6,000.00
d.	1 Each	Leachate System Cleanin	$5,000.00 /Each	$5,000.00
Item 4	Miscellaneous			
a.	Electricity			$30,000.00
b.	Administration			$2,000.00
c.	Inspection			$2,500.00
Item 5	Contingency(10%)			$8,235.00
		Total Annual Post-Closure Care		$90,585.00
		Total Post-Closure Care Period (30 years)		$2,717,550.00

m:\99308\99-00closcost.xls

7.0 FINANCIAL ASSURANCE

The Financial Assurance provision of Subtitle D provides that owner and operators of Municipal Solid Waste Landfills (MSWLF) must provide for certain minimum measures to insure that the funds to meet the requirements of the regulations governing closure, post-closure and corrective action activities are available in the event that these actions are not taken by the owner or operator. The regulations addressing financial assurance are embodied in North Carolina Rule .1628.

7.1 NORTH CAROLINA RULE .1628

In general, Rule .1628 provides that the owner and/or operator must:

1. Provide accurate cost estimates for the closure and post-closure care.
2. Select a mechanism for demonstrating financial assurance.
3. Maintain the selected mechanism in compliance with the provisions of Rule .1628 throughout the period for which the owner/operator is subject to the provisions of Subtitle D and Rule .1628.

The Rule provides for the following alternative mechanisms for demonstrating financial assurance:

1. Trust Fund.
2. Surety bond Guaranteeing Payment or Performance.
3. Letter of Credit.
4. Insurance.
5. Capital Reserve Fund.
6. Local Government Financial Test.
7. Multiple Mechanisms.

Haywood County has reviewed the requirements associated with each of these mechanisms and assessed the costs related to their use as the County's financial assurance mechanism. Although the relative cost of these mechanisms does not appear to vary significantly, there are various factors associated with their availability and practicality, which make certain of the mechanisms less attractive than others.

7.2 LOCAL GOVERNMENT FINANCIAL TEST

Therefore, Haywood County has elected to adopt the LOCAL GOVERNMENT FINANCIAL TEST. The Local Government Financial Test is attractive because the County's excellent financial conditions makes passing the test quite feasible. Haywood County has not had any difficulties passing the LOCAL GOVERNMENT FINANCIAL TEST in recent years and there are not any circumstances that would indicate that this would change.

CLOSURE AND POST-CLOSURE PLAN

White Oak MSW Landfill

Phases 3 and 4

The final cap system for the Phases 3 and 4 Expansion at the White Oak MSW Landfill will be constructed in a progressive manner. As substantial areas of the landfill are brought to final grade, the cap system will be constructed in order to minimize infiltration of stormwater and to reduce leachate production. The Phases 3 and 4 Expansion, which covers a total area of approximately 15.5 acres, is estimated to reach capacity in 2019.

1.0 CAP DESCRIPTION AND CONSTRUCTION

A detail of the final cap is shown on Sheet D2 of the permit drawings. The cross-section will consist of a one-foot layer of compacted on-site soils (intermediate cover), a compacted clay liner with a minimum thickness of 18 inches and a maximum permeability of 1.0×10^{-5} cm/sec, a 40-mil HDPE textured geomembrane, a double-sided geocomposite drainage layer, and a vegetative supportive layer with a minimum thickness of 24 inches.

1.1 Cap Foundation (intermediate cover)

The cap foundation cover (intermediate cover) is designed to minimize infiltration of stormwater into the landfill prior to placement of the barrier cap, and to provide a sound working platform over the municipal solid waste. The compacted intermediate cover will extend over the entire waste area and consist of compacted soil with a minimum thickness of 12 inches.

1.2 Clay Liner

The composite cap system consists of an 18-inch thick compacted clay layer and an overlying textured geomembrane. The clay liner is the first portion of the composite cap system. The function of the clay liner is to minimize surface water infiltration into the underlying waste cell. The clay liner must be constructed of clay soil with a minimum thickness of 18 inches and a maximum permeability of 1.0×10^{-5} cm/sec. The clay soil may consist of on-site soils, off-site soils, or a combination of the two. The soil may require the addition of bentonite to meet the permeability requirements. The design of the landfill cap provides for a minimum number of penetrations through the low permeable barrier cap. The only anticipated penetrations will be for leachate collection piping cleanouts and methane gas system wells. Details of the proposed composite cap system are shown on Sheets D1-D11 of the permit drawings.

1.2a - Construction Requirements

Construction methods for the compacted clay liner shall be based upon the type and quality of the borrow source and shall be verified in the field by constructing test pad(s). The CQA engineer shall ensure that the compacted clay liner installation conforms to the Design Study approved by the Division of Solid Waste (Division), including the following minimum requirements:

1. A test pad shall be constructed prior to beginning installation of the compacted clay liner and at any time when there is a significant change in soil material properties. The location, equipment, liner thickness, and subgrade slope and conditions shall be representative of full-scale construction. Acceptance and rejection criteria shall be based on results from the tests as specified in Section **1.2b**. For each lift, a minimum of three (3) locations shall be established for testing moisture content and density, and collecting a composite sample for recompacted lab permeability. In addition, at least one shelby tube sample, or another in-situ test approved by the Division, shall be collected or performed for each lift of the test pad constructed. These samples will be used for performing lab permeability tests.

2. Soil conditioning, placement, and compaction shall be maintained within the range identified in the moisture-density-permeability relation developed in accordance with Section **1.2b**.

3. The final compacted thickness of each lift shall be a maximum of six inches.

4. Prior to placement of successive lifts, the surface of the lift in place shall be scarified or otherwise conditioned to eliminate lift interfaces.

5. The final lift shall be adequately protected from environmental degradation.

1.2b - Construction Quality Assurance Requirements

clay liner - The project engineer shall ensure that the clay liner installation conforms to the Division approved Site Specific Construction Quality Assurance Plan. All (CQA) requirements for the clay liner installed as part of the landfill cap system will be the same requirements that the clay liner installed as part of the composite base liner system. The only difference is as follows:

- The clay liner portion of the cap system is required to have a permeability not greater than 1.0 x 10^{-5} cm/sec and must have a minimum thickness of 18 inches. The clay liner portion of the composite base liner is required to have a permeability not greater than 1.0 x 10^{-7} cm/sec and a minimum thickness of 24 inches.

1.3 Geomembrane Liner

The geomembrane liner is the second portion of the composite cap system. The geomembrane liner shall have a demonstrated vapor transmission rate of not more than 0.03 gm/m^2-day. The liner material and any seaming materials shall have chemical and physical resistance not adversely affected by environmental exposure, waste placement and leachate generation. The type of geomembrane used for constructing the composite cap system shall be in accordance with this section and approved by the Division.

- **i.** High density polyethylene (HDPE) geomembrane liners shall have a minimum thickness of 40 mils.
- **ii.** The minimum thickness of any geomembrane approved by the Division shall be greater than 30 mils.

geonet drainage layer - A double-sided, eight (8)-ounce geocomposite will be placed on top of the 40-mil textured geomembrane. The materials used for the geonet drainage layer shall comply with the following:

- **i.** The chemical properties of the drainage layer materials shall not be adversely affected by waste placement or leachate generated by the landfill.
- **ii.** The physical and hydraulic properties of the drainage layer materials shall promote lateral drainage of leachate through a zone of relatively high permeability or transmissivity under the predicted loads imposed by overlying materials.

1.3a - Construction Requirements

The project engineer shall ensure that the geomembrane installation conforms to the requirements of the manufacturer's recommendations and the Division approved plans including the following:

- **i.** The surface of the supporting soil upon which the geomembrane will be installed shall be reasonably free of stones, organic matter, protrusions, loose soil, and any abrupt changes in grade that could damage the geomembrane;
- **ii.** Field seaming preparation and methods, general orientation criteria, and restrictive weather conditions approved by the Division;
- **iii.** Approved Anchor trench design;
- **iv.** Critical tensile forces and slope stability;
- **v.** Protection from environmental damage; and
- **vi.** Physical protection from the materials installed directly above the geomembrane.

geonet drainage layer - The construction of the geonet drainage layer shall conform to the following:

i. The drainage layer materials shall be placed according to the Division approved plans and in a manner that prevents equipment from working directly on the geomembrane.
ii. The drainage layer materials shall be stable when placed on the slopes specified on the construction plans.

1.3b - Construction Quality Assurance Requirements

geomembrane liner - The project engineer shall ensure that the geomembrane installation conforms to the requirements of the manufacturer's recommendations and the Division approved Site Specific Construction Quality Assurance Plan.

geonet drainage layer - The project engineer shall ensure that the geonet installation conforms to the requirements of the manufacturer's recommendations and the Division approved Site Specific Construction Quality Assurance Plan.

1.4 Methane Gas Removal System

The proposed methane gas collection system for Phases 3 and 4 has been shown on Sheet C12 of the permit drawings. The proposed system will be connected to the proposed gas collection system proposed for the Phases 1 and 2. Haywood County is currently in the process of permitting a methane gas collection and combustion system at the White Oak Landfill. The proposed expansion of the system for Phases 3 and 4 will consist of vertical gas extraction wells, 8", 6" and 4" intermediate gas collection piping connecting the extraction wells, and 12" and 16" transmission headers located around the margin of Phase 1 where the transmission headers will connect to Phase 1 and 2 methane header pipes.

The methane extraction wells will be constructed prior to construction of the final cap, although well heads and collection lines will be raised as necessary during the final cap construction. A typical gas collection well has a radius of influence of approximately 100 to 125 feet. This results in approximately 14 wells for the Phases 3 and 4 area. The typical well penetrates the waste mass and allows a conduit for vertical migration of methane gas. The wells will be installed to a depth that is 10' above the top of stone leachate collection system layer. An HDPE boot will be placed at the area where the extraction well penetrates the geomembrane to retard surface water infiltration into the waste layers. A bentonite/soil mixture will also be placed and compacted around the vertical collection wells where the wells penetrate the clay liner.

1.4a - Materials Required

i. The gas collection laterals shall have a minimum nominal diameter of four inches and shall be constructed of SDR 17, HDPE pipe.
ii. The gas collection header shall have a minimum nominal diameter of 12 inches and shall be constructed of SDR 17, HDPE pipe.
iii. The gas extraction wells shall be constructed as shown on Sheet C12 and detail Sheets D1 through D11 of the permit Drawings.

1.4b - Construction Requirements

i. Gas collection piping shall be installed according to the Division approved plan.
ii. The location and grade of the piping network shall provide access for periodic cleaning.
iii. The minimum grade of gas system piping that is installed under or within the final cap system shall be three percent (3%).
iv. The gas system piping shall be constructed in such a manner to provide for gas condensate collection. This condensate shall be transported to the leachate storage tanks by pneumatic or electric and explosion-proof pumps.

1.4c - Construction Quality Assurance Requirements

The development of the gas collection system at the White Oak Landfill will be constructed in phases as sections of the landfill reach final approved grades. Haywood County is planning to install and methane gas collection and combustion system and will use the landfill gas from Phases 3 and 4. Haywood County plans to expend significant capital for developing the methane collection and combustion facility at the White Oak Landfill. Therefore, developing and maintaining a productive gas collection system is of utmost importance to Haywood County. Haywood County will make every effort to ensure that the gas collection materials and construction requirements described above are followed for the future construction of the gas collection system.

1.5 Final Cover

The final cover will be a total of 24-inches thick. The soil cover will be suitable to provide support for a vegetative cover and protect the low-permeability barrier.

1.5a - Materials Required

A grass cover is proposed for the Landfill to provide the required cover while minimizing cap maintenance. The surface will be prepared by fertilizing and placing seed in accordance with the North Carolina Erosion and Sediment Control Standards. The lower 12 inches of the final cover will be constructed of native soils. Although the material will not be required to have a specific classification or permeability, it should be a cohesive soil. The upper 6 inches of the final cover should be suitable for supporting vegetative growth. The materials used for the top portion of the final cover shall meet the following criteria:

i. **Uppermost soil**

Natural, friable, loamy soil, typical of local soil which produces heavy vegetative growth; free from subsoil, weeds, sods, stiff clay, stones larger than 1 inch, toxic substances, litter, or other foreign material harmful to plant growth; having a pH between 6.0 and 7.0.

GRADING ANALYSIS

Sieve	Minimum Percent Passing
2 inch	100
No. 4	90
No. 10	80

Topsoil shall contain sand, silt, and clay as required by AASHTO M146.

	Minimum Percent	Maximum Percent
Sand	20	75
Silt	10	60
Clay	5	30

ii. Fertilizer and/or Compost:

The uppermost soil material shall be tested prior to spreading to determine the amount of fertilizer and/or compost material that should be added to achieve optimum growth potential of the required vegetative cover.

The quality of fertilizer and/or compost and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Fertilizer Law and regulations adopted by the North Carolina Board of Agriculture.

Fertilizer and/or compost shall be 10-10-10 grade. Upon written approval of the Engineer a different grade of fertilizer may be used, provided the rate of application is adjusted to provide the same amounts of plant food.

During handling and storing, the fertilizer shall be cared for in such a manner that it will be protected against hardening, caking, or loss of plant food values. Any hardened or caked fertilizer shall be pulverized to its original conditions before being used.

iv. Lime:

The uppermost soil material shall be tested prior to spreading to determine the amount of lime that should be added to achieve optimum growth potential of the required vegetative cover.

The quality of lime and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Lime Law and regulations adopted by the North Carolina Board of Agriculture.

During the handling and storing, the lime shall be cared for in such a manner that it will be protected against hardening and caking. Any hardened or caked lime shall be pulverized to its original condition before being used.

Lime shall be agriculture grade ground dolumitic limestone. It shall contain not less than 85% of the calcium and magnesium carbonates and shall be of such fineness that at least 90% will pass a No. 10 sieve and at least 50% will pass a No. 100 sieve.

iv. Seed:

The quality of seed and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Seed Law and regulations adopted by the North Carolina Board of Agriculture.

Seed shall have been approved by the North Carolina Department of Agriculture or any agency approved by the Engineer before being sown, and no seed will be accepted with a date of test more than nine (9) months prior to the date of sowing. Such testing however, will not relieve the Contractor from responsibility for furnishing and sowing seed that meets these specifications at the time of sowing. When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the Contractor may elect, subject to the approval of the Engineer, to increase the rate of seeding sufficiently to obtain the minimum pure live seed contents specified, provided that such an increase in seeding does not cause the quantity of noxious weed seed per square yard to exceed the quantity that would be allowable at the regular rate of seed.

During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents, or other causes.

Seed shall be entirely free from bulblets or seed of Johnson Grass, Nutgrass, Sandbur, Wild Onion, Wild Garlic, and Bermuda Grass. The specifications for restricted noxious weed seed refers to the number per pound, singly or collectively, of Blessed Thistle, Wild Radish, Canada Thistle, Corncockle, Field Bindwee, Quackgrass, Dodders, Dock, Horsenettle, Bracted Plantain, Buckhorn or Wild Mustard; but in no case shall the number of Blessed Thistle or Wild Radish exceed 27 seeds of each per pound. No tolerance on weed seed will be allowed.

v. Mulch:

Straw mulch shall be threshed straw of oats, rye or wheat free from matured seed of obnoxious weeds or other species which would grow and be detrimental to the specified grass.

1.5b - Construction Requirements

Uppermost soil shall be placed according to the following requirements:

i. Use equipment and methods to prevent damage to other components of the final cap system such as the clay liner, 40-mil textured geomembrane, and gas collection piping.

ii. The uppermost soil shall be spread by utilizing small equipment with a relatively low ground pressure. This will reduce the potential of the underlying layers of the final cap being damaged. Prior to placing topsoil, shape the underlying soil layer to graded lines and cross sections to provide for 6 inches of compacted topsoil. Clear the underlying soil layer of materials larger than 2" in diameter.

iii. After alignment of the underlying soil, loosen and till to a depth of 6 inches by disking, harrowing, rototilling, or other approved methods to assure that the topsoil layer properly adheres to the underlying soil layer.

iv. After the condition of the underlying soil layer has been approved by the on-site CQA personnel, place and spread topsoil to achieve required depth after compaction; rake and remove materials larger than 2 inches. Compact with approved roller equipment, grade to finished tolerances, and prepare the seedbed in accordance with the approved Phases 3 and 4 Technical Specifications

Seed, fertilizer and lime shall be applied according to the following:

Seed shall be applied by means of a hydro-seeder or other approved methods. The rates of application of seed, fertilizer and limestone shall be as stated below, unless pre-construction testing is contrary to these rates and can be documented.

All rates are in pounds per acre:

Fertilizer and/or compost - 1000 lbs. per acre
Lime - 4,000 lbs. per acre
KY-31 Fescue - 100 lbs. per acre
Straw mulch – 60 to 80 bales

For summer seeding the following shall be added:

- German Millet - 10 lbs. per acre
- Sudangrass – 15 lbs. per acre

For winter seeding the following shall be added:

- Rye grain – 15 lbs. per acre

For steep slopes the following shall be added:

- Sericea Lespedeza – 40 lbs. per acre

Equipment to be used for the application, covering or compaction of limestone, fertilizer, compost, and seed shall have been approved by the Engineer before being used on the project. Approval may be revoked at any time if equipment is not maintained in satisfactory working condition, or if the equipment operation damages the seed. Limestone, fertilizer, compost, and seed shall be applied within 24 hours after completion of seedbed preparation unless otherwise permitted by the Engineer, but no limestone, fertilizer, or compost shall be distributed and no seed shall be sown when the Engineer determines that weather and soil conditions are unfavorable for such operations.

Limestone may be applied as a part of the seedbed preparation, provided it is immediately worked into the soil. If not so applied, limestone and fertilizer shall be distributed uniformly over the prepared seedbed at the specific rate of application and then harrowed, raked, or otherwise thoroughly worked or mixed into the seedbed.

Seed shall be distributed uniformly over the seedbed at the required rate of application, and immediately harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil. The depth of covering shall be as directed by the Engineer. If two kinds of seed are to be used which require different depths of covering, they shall be sown separately.

When a hydraulic seeder is used for application of seed and fertilizer, the seed shall not remain in water containing fertilizer for more than 30 minutes prior to application unless otherwise permitted by the Engineer.

Immediately after seed has been properly covered the seedbed shall be compacted in the manner and degree approved by the Engineer.

Mulch shall be applied according to the following:

It shall be spread uniformly at the rate give above and in a continuous blanket over the areas specified.

Before mulch is applied on cut or fill slopes which are 3:1 or flatter, and ditch slopes, the Contractor shall remove and dispose of all exposed stones in excess of 2 inches in diameter and all roots or other debris which will prevent proper contact of the mulch with the soil.

Mulch shall be applied within 24 hours after the completion of the seeding unless otherwise permitted by the Engineer. Care shall be exercised to prevent displacement of soil or seed or other damage to the seeded area during the mulching operations.

Mulch shall be uniformly spread by hand or by approved mechanical spreaders or blowers that will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.

Mulch shall be held in place by applying a sufficient amount of approved binding material to assure that the mulch is properly held in place. The rate and method of application of binding material shall meet the approval of the Engineer. Where the binding material is not applied directly with the mulch, it shall be applied immediately following the mulch operation.

The Contractor shall take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water, or other causes and shall promptly remove any blockage to drainage facilities that may occur.

1.4c - Construction Quality Assurance Requirements

Haywood County will ensure that the materials described above are utilized for the final cover and that their placement is done in accordance with the above detailed Construction Requirements. The project engineer will ensure that the materials and methods described above are utilized to construct the final cover system, and that all requirements of the Site Specific Construction Quality Assurance Plan are met.

2.0 ON-SITE WASTE INVENTORY

At closure, the amount of waste on site is estimated to be:

Existing Phases 1 & 2	- 775,000 tons
Proposed Phases 3 & 4	- 660,000 tons
Total	1,435,000 tons

3.0 CLOSURE SCHEDULE

3.1 Notification of Division of Solid Waste

Prior to beginning closure of the White Oak MSW Landfill, the Haywood County will notify the Division of Solid Waste of the intent to close the landfill.

Probable Date of Closure: Summer 2020

3.2 Begin Closure

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

Probable Date: Fall 2020

3.3 Completion of Closure

Haywood County will complete closure activities of the White Oak MSW Landfill in accordance with the closure plan within 180 days following the beginning of closure. Extensions of the closure period may be granted by the Division if the owner or operator demonstrates that closure will, of necessity, take longer than 180 days and they have taken and will continue to take all steps to prevent threats to human health and the environment from the unclosed MSWLF unit.

Probable Date: Summer 2021

3.4 Recording of Closure

Following closure of the White Oak MSW Landfill, Haywood County will record a notation on the deed to the White Oak MSW landfill facility property, or some other instrument that is normally examined during a title search, and notify the Division that the notation has been recorded.

The notation on the deed must in perpetuity notify any potential purchaser of the property that:

1. The land has been previously used as a landfill facility; and
2. Its use is restricted under the Division of Solid Waste approved Closure Plan

Probable Date: Fall 2021

3.5 Engineer's Certification

Following closure, Haywood County shall notify the Division of Solid Waste that a certification, signed by the project engineer verifying that closure has been completed in accordance with the closure plan, has been placed in the operating record.

4.0 POST CLOSURE PLAN

4.1 Inspections

Inspections of the final cover will be performed according to the table below and the condition of the facility will be recorded with notes, maps, and photographs. Since Haywood County intends to operate the White Oak Landfill after Phases 3 and 4 have reached capacity, landfill personnel will be on-site to perform inspections on a frequent basis.

The inspection will take notice of:

1. Eroded banks
2. Patches of dead vegetation
3. Animal burrows

4. Subsidence (settlement)
5. Cracks along the cover.

The inspector will note the condition of:

1. Concrete catch basins and stormwater control facilities
2. Leachate collection and removal pipes
3. Gas monitoring wells
4. Water monitoring wells

Areas showing subsidence, cracking, signs of erosion, or damage are to be repaired.

Schedule of Inspections

Years (following closure)	Minimum Yearly Inspections
0-2	4
2-30	2

4.2 Maintenance

The vegetative cover will be trimmed at least two times a year. In the early stages of development, fertilization and/or compost will be applied annually as needed.

The leachate collection and removal pipes will be flushed and pressure-cleaned annually.

The Gas Removal System will be flushed and pressure-cleaned annually.

Vegetative growth around gas collection wells will be cleaned away and all wells will be clearly marked to prevent accidental damage.

4.3 Monitoring

Explosive gas monitoring will take place on a quarterly basis according to the procedural outline contained in the Operation Plan.

Surface and ground water testing will take place semiannually or as directed by the Division of Solid Waste.

The leachate will also be sampled semi-annually to determine the quality and constituents present. Leachate will be analyzed for Appendix 1 constituents as well as BOD, COD, phosphate, nitrate, sulfate, and pH.

4.4 Leachate collection and treatment

Until it can be demonstrated that leachate concentrations become low enough so as not to pose a threat to human health or the environment, leachate collection and treatment shall continue. Such a demonstration should address direct exposures of leachate releases to ground water, surface

water or seeps. Indirect effects, such as accumulated leachate adversely affecting the chemical, physical, and structural containment systems that prevent leachate release, also should be addressed in the demonstration.

4.5 Planned use and personal contact

Preliminary proposals for the planned use of the facility, following Closure includes developing exercise and bike trails along the periphery of the landfill property and a light industry associated with the combustion of methane gas. Any alternate use of the landfill after closure has been completed will be approved by the Division of Solid Waste prior to implementation. The person to contact regarding the facility during the Post-Closure period is:

Haywood County Solid Waste Department
Mr. Stephen King, Solid Waste Director
278 Recycle Road
Clyde, North Carolina 28786
Telephone (828) 627-8042

4.6 Water Quality Monitoring Plan

A Design Hydrogeologic Report and Environmental Monitoring Plan for Phases 3 and 4 of the White Oak MSW Landfill was prepared by BLE, Inc. This includes discussion of the existing monitoring system, proposed monitoring system, additional well construction, water level monitoring, aquifer testing, and groundwater sampling and analysis.

4.7 Engineer's Certification

Following completion of the post-closure care period, Haywood County shall notify the Division of Solid Waste that a certification, signed by the project engineer verifying that post-closure care has been completed in accordance with this post-closure plan, has been placed in the operating record.

5.0 LEACHATE STORAGE CLOSURE PLAN

Haywood County shall complete the closure activities outlined in this plan within 180 days after liquid collection has ceased.

A. At closure, the liner and all solid waste shall be removed from the lagoon and connecting lines. The lagoon liner and all solid waste removed shall be properly handled and disposed of according to Federal and State requirements. All connecting lines shall be disconnected and securely capped or plugged.

B. The lagoon site will be modified to act as a stormwater management feature.

6.0 CLOSURE AND POST CLOSURE COST ANALYSIS AND SUMMARY

6.1 Closure Costs

Phases 3 & 4 (15.5 ACRES) - Closure

				Unit Cost	Total
Item 1	Earthwork				
	a.	40,000 C.Y.	18" Clay	$20.00 /C.Y.	$800,000.00
	b.	40,000 C.Y.	24" Vegetative Cover	$8.00 /C.Y.	$320,000.00
	c.	30,000 C.Y.	12" Intermediate Cover	$5.00 /C.Y.	$150,000.00
Item 2	Geomembrane				
	a.	700,000 S.F.	40 mil HDPE	$0.80 /S.F.	$560,000.00
	b.	700,000 S.F.	8 oz. Double Sided Geone	$0.60 /S.F.	$420,000.00
Item 3	Sedimentation and Erosion Control				
a.		18 AC.	Grassing	$5,000.00 /AC.	$90,000.00
b.		200 Tons	Rip Rap	$75.00 /Tons	$15,000.00
c.		5,000 L.F.	Synthetic Lined Channels	$20.00 /L.F.	$100,000.00
Item 4	Engineering				
a.	Design & Permitting				$200,000.00
b.	Construction Quality Assurance				$225,000.00
Item 5	Contingency (10%)				$288,000.00
				Total	$3,168,000.00

6.2 Post-Closure Care Cost

b.		1 Each	Repair of Cap (1acre @ 1 foot depth)	$10,000.00 /Each	$10,000.00
c.		5 AC.	Reseeding	$1,200.00 /AC	$6,000.00
d.		1 Each	Leachate System Cleanin	$5,000.00 /Each	$5,000.00
Item 4	Miscellaneous				
a.	Electricity				$30,000.00
b.	Administration				$2,000.00
c.	Inspection				$2,500.00
Item 5	Contingency(10%)				$8,235.00
			Total Annual Post-Closure Care		$90,585.00
			Total Post-Closure Care Period (30 years)		$2,717,550.00

m:\99308\99-00closcost.xls

7.0 FINANCIAL ASSURANCE

The Financial Assurance provision of Subtitle D provides that owner and operators of Municipal Solid Waste Landfills (MSWLF) must provide for certain minimum measures to insure that the funds to meet the requirements of the regulations governing closure, post-closure and corrective action activities are available in the event that these actions are not taken by the owner or operator. The regulations addressing financial assurance are embodied in North Carolina Rule .1628.

7.1 NORTH CAROLINA RULE .1628

In general, Rule .1628 provides that the owner and/or operator must:

1. Provide accurate cost estimates for the closure and post-closure care.
2. Select a mechanism for demonstrating financial assurance.
3. Maintain the selected mechanism in compliance with the provisions of Rule .1628 throughout the period for which the owner/operator is subject to the provisions of Subtitle D and Rule .1628.

The Rule provides for the following alternative mechanisms for demonstrating financial assurance:

1. Trust Fund.
2. Surety bond Guaranteeing Payment or Performance.
3. Letter of Credit.
4. Insurance.
5. Capital Reserve Fund.
6. Local Government Financial Test.
7. Multiple Mechanisms.

Haywood County has reviewed the requirements associated with each of these mechanisms and assessed the costs related to their use as the County's financial assurance mechanism. Although the relative cost of these mechanisms does not appear to vary significantly, there are various factors associated with their availability and practicality, which make certain of the mechanisms less attractive than others.

7.2 LOCAL GOVERNMENT FINANCIAL TEST

Therefore, Haywood County has elected to adopt the LOCAL GOVERNMENT FINANCIAL TEST. The Local Government Financial Test is attractive because the County's excellent financial conditions makes passing the test quite feasible. Haywood County has not had any difficulties passing the LOCAL GOVERNMENT FINANCIAL TEST in recent years and there are not any circumstances that would indicate that this would change.

Section 8 - Technical Specifications

TECHNICAL SPECIFICATIONS

PERMIT TO CONSTRUCT
WHITE OAK MSW LANDFILL
PHASES 3 & 4

HAYWOOD COUNTY, NORTH CAROLINA

Jeffrey R. Bishop, P.E.

McGill ASSOCIATES

Engineering • Planning • Finance
Post Office Box 2259
Asheville, North Carolina 28802

NORTH CAROLINA PROFESSIONAL SEAL 23571 CIVIL ENGINEER JEFFREY R. BISHOP 9/15/08

September 2008

07518

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

DIVISION 2 - SITE WORK AND UTILITY PIPING

02200	EARTHWORK
02201	SELECT BACKFILL
02300	COMPACTED CLAY LINER
02400	LEACHATE COLLECTION REMOVAL SYSTEM (LCR)
02620	HDPE GEOMEMBRANE LINER
02621	GEOCOMPOSITE DRAINAGE LAYER
02630	STORMWATER CONTROL LINER
02750	LEACHATE COLLECTION SYSTEM FORCE MAIN & NON-PERFORATED GRAVITY PIPING INSTALLATION
02760	LEACHATE COLLECTION SYSTEM FORCE MAIN & NON-PERFORATED GRAVITY PIPING INSPECTION & TESTING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. General: The work included in this section consists of the grading of the project area. The work includes:

1. Site clearing and on-site disposal of all debris and unsuitable material.

2. Removal of all topsoil, organically contaminated soil and existing unsuitable fill. Topsoil shall be stockpiled on site in a location supplied by the owner.

3. Proofrolling and grading of the property to the prescribed elevations.

4. Stockpiling or wasting on site of any excess cut material for providing acceptable material as required to obtain the desired grades.

5. Construction of earthen embankments.

6. Placement of Fill Material in order to bring the site to subgrade elevations, prior to placement of landfill components.

1.02 SITE CONDITIONS

A. Site Information: The boring logs and related information depict approximate subsurface conditions only at these specific locations and at the particular time designated on the logs. Subsurface conditions at other locations may differ from those reported at the boring locations. It is expressly understood that neither the Owner nor the Engineer will be responsible for interpretations or conclusions drawn from the boring data by the Contractor. The data are made available for the convenience of the Contractor. Test borings and other exploratory operations may be undertaken by the Contractor at his own expense, provided such operations are acceptable to the Owner.

PART 2: PRODUCTS

2.01 MATERIALS

A. Unstable Material:

5. Structural Fill material shall meet the following minimum requirements and/or be tested for the following criteria in accordance with the Site Specific Construction Quality Assurance Plan:

Test	Test Method	Frequency	Acceptable Values
Minimum Laboratory Dry Weight	ASTM D-698	1/5,000 YD^3	> 100 lbs. / FT^3
Natural Moisture Content	ASTM D-2216	1/5,000 YD^3	Reference Only
Laboratory Compaction	ASTM D-698	1/5,000 YD^3	95% Maximum Dry Density

PART 3: EXECUTION

3.01 PREPARATION

A. Subgrade Preparation:

1. After removal of all existing topsoil, debris, and other undesirable material, the areas which are to receive fill, which have been cut to the desired grade, or which are at the approximate required subgrade elevation without additional earthwork, should be proofrolled to locate any soft or yielding area. Proofrolling shall be done with a smooth-drum roller (minimum 20 tons) making a minimum of two passes in each direction or other procedures and equipment approved by the Project Engineer. In addition, the following tests shall be performed at the frequencies indicated:

Test	Test Method	Frequency	Acceptable Values
Field Density	ASTM D-6938, ASTM D-1556, ASTM D-2937	1/5,000 YD^3	95% Maximum Dry Density
Field Moisture	ASTM D-2216, ASTM D-6938, ASTM D-4643	1/5,000 YD^3	+/- 2% Optimum

2. Any soft, or excessively yielding material revealed by the proofrolling shall be removed and replaced with inert controlled fill. The Engineer shall be the sole judge of what constitutes soft or excessively yielding material.

3. Drainage from existing watercourses, springs or other sources should be rerouted out of the earthwork area. The Contractor shall take special care to remove all organically contaminated sediment, saturated soil, and other undesirable material from existing watercourses.

B. Blasting and Damages: Where blasting is done, it shall be done by qualified personnel and in accordance with all federal, state or local requirements and procedures. The Contractor shall be responsible for any damage done to adjoining properties, or to persons, by reason of the blasting or other earthwork operations. The Contractor shall also be responsible for damage to embankments and cut areas, and sewer, water, gas or other underground lines which may result from blasting or earthwork operations. All such damage shall be repaired and made good by the Contractor in a timely manner.

3.02 INSTALLATION

A. Filling and Compaction:

1. After a stable non-yielding surface has been established, the surface of the area to be filled shall be scarified with a disc or harrow to a depth of four inches (4") to six inches (6"). An initial three inch (3") layer of fill material shall then be spread over the scarified surface and the entire area compacted as specified below.

2. No fill shall be placed on any area until that area has been inspected and approved by the Engineer. Fill shall not be placed on a snow covered or frozen surface. Fill materials shall be spread in uniform horizontal layers not exceeding 8" in uncompacted thickness. Alternating layers of cohesive and granular fill soils shall not be permitted. Spreading and compacting of fill material should be started at the lowest portion of the site. All fill must be placed in horizontal layers. Sloping fill planes will not be permitted. Fill material shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form.

3. Keyways shall be provided at the toe of each fill slope as shown on the drawings. As each layer of fill meets the natural grade of a slope, a bench, approximately 7 to 8 feet wide, shall be cut into the existing grade with each layer of newly placed fill. If rock is encountered at the face of the natural grade, the original ground shall be cut in vertical steps of 4 to 5 feet and a horizontal bench cut into the rock at the top of each vertical increment. A horizontal plateau, approximately 15 to 20 feet wide, should be provided in the existing slope at vertical intervals of roughly 25 feet. Subsurface

drains shall be installed at the toe of the slope and wherever springs or excessive seepage are encountered. Drains should be led to the outside face of the embankment and the water picked up and carried away in such a manner as to avoid softening the embankment or its toe, or producing erosion gullies.

4. Before compaction begins, the fill shall be brought to a water content that will permit proper compaction. This may require aerating the material if it is too wet, or the addition of water if it is too dry. If additional water is required, it should be uniformly distributed and shall be thoroughly incorporated into the material by means of discs or other suitable mixing equipment. Care shall be taken to avoid trapping water within the fill.

5. The standard Proctor method of moisture-density relationship test, ASTM D 698, shall be used to determine the maximum laboratory dry density and the optimum moisture content of the material which is to be used for fill.

6. The fill material shall be compacted and tested in accordance with the following requirements:

Test	Test Method	Frequency	Acceptable Values
Field Density	ASTM D-6938, ASTM D-1556, ASTM D-2937	1/5,000 YD^3	95% Maximum Dry Density
Field Moisture	ASTM D-2216, ASTM D-6938, ASTM D-4643	1/5,000 YD^3	+/- 2% Optimum

7. The above compaction requirements are to be satisfied for all soil and weathered or soft rock fills. Weathered or soft rocks are those that can be broken down and disintegrated under normal compaction procedures and equipment.

8. At the close of each day's work, or where work is to be interrupted for a period of time, the surface of the site shall be shaped to drain freely, and sealed. If after a prolonged rainfall, the surface of the area to be filled or cut is too wet to work properly, the unsuitable material shall be removed to expose workable soil. The wet material removed may be dried and reused. Construction traffic shall be controlled so as to prevent rutting of graded areas and to avoid overrolling of any section.

9. All cut areas shall be rolled and compacted to produce a compaction equal to that of the filled area. If soft or yielding material is encountered in cuts, or fills as a result of trapping water, overrolling or improper control of construction traffic, and cannot be satisfactorily stabilized by moisture control, compaction or other means approved by the Engineer, the unstable material shall be excavated to the depth required by the Engineer. The excavation shall then be filled with suitable compacted material in accordance with the requirements outlined above.

B. Grading:

1. Elevations shown on the plans are finished ground unless otherwise noted. Grading shall be maintained in such a manner as to provide free surface drainage of the site at all times without any ponding of water.

2. Provide ditches and swales to the cross-sections and grades shown on the drawings. Cut ditch subgrades four inches (4") below the grades shown and provide four inches (4") of topsoil where the plans call for seeding or sodding of the ditch. Keep ditches and swales free of accumulations of debris or washed in material until final acceptance of work by the Engineer.

3. Shape all surfaces to within not more than 0.10 feet above or below the required subgrade elevations and free from irregular surface changes.

C. Control and Testing:

1. The services of qualified soils testing personnel will be employed by the Owner for the making of tests to determine the moisture-density relationships, relative densities, plastic and liquid limits and suitability of materials for compaction and for inspection and control of the site preparation, selection, placing and compaction of the fill. A copy of the testing personnel's daily field report including results of in-place density and moisture content tests should be forwarded to the Owner and the Engineer at the end of each working day. If an independent testing firm is hired by the Contractor for the purpose of testing soil used in the construction of the landfill, the testing firm shall submit a field report to the Owner and Engineer at least once per week.

2. The Contractor shall cooperate with the testing personnel so as to permit proper inspection and control of the work without unnecessary delays.

D. Maintenance:

1. The Contractor shall be responsible during construction and until final acceptance for the maintenance of all embankments made under the Contract.

2. During construction and until final acceptance; the Contractor shall construct temporary or permanent earth berms along the outer edges of the top surface of the embankment, construct temporary ditches, shape the embankment surface to provide for the drainage of surface runoff along and throughout the length of the embankments, and use any other methods necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion. The Contractor shall construct brush dikes, or install temporary or permanent slope drains or other drainage features to assist in controlling erosion.

3. The Contractor shall replace, at no cost to the Owner, any portion of embankment which have become displaced or damaged due to carelessness or neglect on the part of the Contractor. Where the work has been properly constructed, completely drained and properly maintained, and damage occurs due to natural causes, the Contractor will be paid at the Contract unit price for the excavated material required to make necessary repairs to such damage.

4. All embankments shall be brought to the grade and cross section shown on the plans or established by the Engineer, prior to final inspection and acceptance by the Engineer.

END OF SECTION

02201.1 SCOPE

The work of this section consists of locating, hauling, and processing the soil material used to construct the select backfill layers of soil as shown on the Construction Drawings. The purpose of the select backfill layer is to cushion the geomembrane component of the leak detection layer and protect it from damage. Borrow soils shall meet the requirements of Section 02201.2 and placement of the select backfill shall be in strict accordance with Section 02200 and the construction drawings.

02201.2 SOIL MATERIALS

Select backfill will be the soil placed between the subgrade and the leak detection layer to protect the geomembrane component of the leak detection layer from puncture. This material will have the same preconstruction and testing requirements as the subgrade, with the exception that preconstruction and construction testing will have to be performed to show conformance with the Maximum Particle Size requirements. The testing requirements are as follows.

Preconstruction Qualification			
Test	**ASTM Method**	**Frequency**	**Acceptable Values**
Natural Moisture Content	D2216	1/5,000 YD^3	Reference Only
Laboratory Compaction	D698	1/5,000 YD^3	95% maximum dry density
Grain Size	D422	1/5,000 YD^3	3-inch diameter (lower 6 inches) 1/4-inch diameter (top 6 inches
*** Preconstruction test samples shall be taken from the borrow source and or stockpile prior to construction.**			

2201.3 EXECUTION

The contractor is required to provide soil material for constructing the select backfill portion of the leak detection system in accordance with the material requirements described in 2201.2. The select backfill shall be placed in accordance with Section 02200. The following testing requirements shall apply to the placement of the Select Backfill material:

SELECT BACKFILL CONSTRUCTION TESTING FREQUENCIES			
TEST	ASTM METHOD	QUANTITY	ACCEPTABLE VALUES
Field Density	D6938, D1556, D2937	1/5,000 YD^3	95% maximum dry density
Field Moisture	D2216, D6938, D4643	1/5,000 YD^3	+/- 4% optimum
Grain Size	D422	1/5,000 YD^3	3-inch diameter (lower 6 inches) 1/4-inch diameter (top 6 inches

2201.4 **OTHER TESTING REQUIREMENTS**

The friction angle between the select backfill and the geomembrane shall be a minimum of 20 degrees. The Contractor shall verify and submit to the Project Engineer documentation of such verification prior to beginning construction. The test method used to verify the interface friction angle between the 60-mil geomembrane and the select backfill shall be ASTM D5321 *Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear Method*. Test parameters are to provide 3 points to range over minimum and maximum expected normal loads. Minimum will be a construction load of 260 psf. Maximum will be at the landfill's final filled condition or approximately 1,423 psf. The normal loadings used shall be 250, 750 and 1,500 psf.

The friction angle between the select backfill and the geotextile shall be a minimum of 18 degrees. The Contractor shall verify and submit to the Engineer documentation of such verification prior to beginning construction. The test method used to verify the interface friction angle between the 16-ounce geotextile and the select backfill shall be ASTM D5321 *Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear Method.* Test parameters are to provide 3 points to range over minimum and maximum expected normal loads. Minimum will be a construction load of 260 psf. Maximum will be at the landfill's final filled condition or approximately 1,423 psf. The normal loadings used shall be 250, 750 and 1,500 psf.

02201.5 MEASUREMENT AND PAYMENT

See Section 01700

END OF SECTION

02300.1 Scope of Work

The landfill cell shall include a 24-inch compacted clay liner. The Contractor shall furnish all labor, material, supervision, and equipment to complete the Compacted Clay Liner for the cell, including hauling, sieving, raking, discing, compacting, drying, wetting, removal of rainwater and removal of all previously placed material rendered unsuitable due to weather conditions or construction operations, final grading and sealing and all necessary and incidental items as detailed or required to complete the compacted liner, all in accordance with the Contract Documents, and the Site Specific Construction Quality Assurance Plan.

02300.2 Materials

Soil that meets the following requirements of clay liner fill shall be used for construction of the Compacted Clay Liner:

Preconstruction Qualification			
Test	**ASTM Method**	**Frequency**	**Acceptable Values**
Natural Moisture Content	D2216	1/1,000 YD^3 or Change in Material	Reference
Grain Size Analysis	D422 or D1140	1/5,000 YD^3 or Change in Material	< 3" in the lower 18", < ¼" in the upper 6", < 5% greater than No. 4 sieve
Classification	D2487	1/5,000 YD^3 or Change in Material	CL,CH,ML,MH, or SM
Atterberg Limits	D4318	1/5,000 YD^3 or Change in Material	Plasticity Index (PI) > 10
Laboratory Compaction	D698 – Standard	1/5,000 YD^3 or Change in Material	95% Maximum Dry Density
Permeability **	D5084	1/10,000 YD^3 or Change in Material	Less than or equal to 1×10^{-7} cm/sec

* Preconstruction test samples shall be taken from the borrow source and or clay stockpiled prior to construction.

** The Moisture-Density Curve shall show the region in which the required maximum permeability is met. A minimum of three (3) permeability tests shall be performed per curve to establish the zone of acceptable moistures and densities at which the required maximum permeability may be achieved. If the Contractor elects to run multiple curves to enlarge the zone of acceptance, all curves must be submitted.

All clay clods will be broken down with tillers and discs to provide a homogeneous clay soil.

The Compacted Clay Liner may consist of fill material modified by the addition of powdered bentonite in sufficient quantity to meet the specifications. Clay liner material modified with bentonite will be subject to the same testing criteria and frequencies as natural clay liner material, with the addition of percentage of bentonite used. If a bentonite admix is used, the mixing procedure shall be approved by the Engineer prior to construction. Material to be placed within the cell, either natural or augmented, shall have a minimum effective internal friction angle of twenty-five (25) degrees. The internal friction angle of the clay liner material shall be verified by the Contractor. The Contractor shall submit such verification prior to beginning construction. The test method used to verify the internal friction angle of the clay liner material shall be ASTM D4767 *Standard Test Method for Consolidated Undrained Triaxial Compression Test on Cohesive Soils.* The specimens must be compacted to design criteria for dry density and moisture content as determined by preconstruction testing. Test parameters require stepped confinement @ 1, 3, and 5ksf (nominally 5, 15 and 30 psi effective confining pressure).

Continuous and repeated visual inspection of the materials will be performed by the Contractor to ensure proper soils are being used. In addition, the Engineer will make frequent inspections of the clay liner placement operations and materials, and will consult with the Contractor on suitable liner fill and locations of such. All soil liner fill proposed shall be inspected by the Engineer prior to actual use.

02300.3 Construction

The following testing requirements and acceptable values shall apply to the construction of the Compacted Clay Liner unless specified otherwise as in the case of the construction of the required Test Pads:

Construction Testing			
Test	**ASTM Method**	**Frequency**	**Acceptable Values**
Field Density	D6938, D1556, D2973	1/10,000 FT^2/Lift	95% Maximum Dry Density
Field Moisture	D2216, D6938, D4643	1/10,000 FT^2/Lift	+0% - +5% optimum- Cell Floor +2% - +6% optimum – Side Slopes
Classification	D2487	1 per acre per lift	CL,CH,ML,MH, or

			SM
Permeability	Extracted per D1587 Tested per D5084	1/40,000 FT^2/Lift	Less than or equal to 1×10^{-7} cm/sec
Atterberg Limits	D4318	1/5,000 YD^3	Plasticity Index (PI) > 10
Grain Size	D422 or D1140	1/5,000 YD^3	< 3" in the lower 18", < ¼" in the upper 6", < 5% greater than No. 4 sieve
Soil Layer Thickness	Observation, Field Measurement	Continuous Observation, Minimum of Five (5) per Lift	Minimum two (2) foot thick

TEST PADS

Test pads, a minimum of 20 ft x 50 ft in area shall be constructed prior to beginning installation of the compacted clay liner and whenever there is a significant change in soil material properties or the borrow source is changed. The equipment used, liner thickness, subgrade slope, and all other conditions shall be representative of full scale construction. For each lift of the test pad, a minimum of three (3) test locations shall be established for testing moisture content and density. At least one (1) shelby tube sample for lab permeability testing and one (1) composite sample for recompacted lab permeability shall be obtained per lift/test pad. One test pad shall be constructed which shall be representative of the side slope clay liner and one for the cell floor. The test pads can be constructed independent of each other or in such a manner so that one test pad lies on the cell bottom and the other test pad lies on the side slope. Compaction and soil moisture content shall be in accordance with the previously approved moisture-density-permeability relationship. Field moisture and density tests and laboratory permeability tests will be performed by the Resident CQA Engineer for each lift placed on the test pads to verify the construction method, equipment, and material necessary to achieve the required permeability not greater than 1.0×10^{-7} cm/sec for the clay liner. The Contractor shall allow sufficient time for construction and testing of the test pad prior to placement of the Compacted Clay Liner.

LINER CONSTRUCTION

Prior to fill placement, the prepared subgrade shall be proofrolled with a smooth-drum roller (minimum 20 tons) by a minimum of two passes in each direction. Proofrolling shall be conducted at the discretion of the Engineer or his representative. Any soft, saturated or yielding areas exhibited by pumping and/or rutting will require removal and replacement with the appropriate soil at no additional cost to the Owner.

02300.4 Final clay liner lift thickness, after compaction, shall be a maximum of six (6) inches. Thinner lifts are permissible to achieve design grade.

02300.5 Equipment or truck traffic shall not be permitted during the period between scarifying and compaction of a lift unless approved by the Engineer.

02300.6 After the lift to be compacted is conditioned, representative samples will be taken by the Resident CQA Engineer and tested for moisture content prior to any compactive efforts. If the moisture content is within the range specified by the moisture-density-permeability relation, compaction may begin. If the moisture content is outside of this range, the clay liner fill will be wetted or dried and reworked accordingly. The soil fill should be sprinkled or sprayed with water utilizing equipment creating a uniform application and dozed, wind-rowed, and/or disc-plowed to uniformly increase the moisture content of the soil if the material moisture content is too low. The soil fill shall be dozed, wind-rowed, and/or disc-plowed to help air dry the soil if the moisture content is too high.

02300.7 Each lift shall be thoroughly compacted to satisfy moisture and density controls through field testing before a subsequent lift is placed.

02300.8 Compaction of lifts shall be as follows:

1) Compaction of lifts shall be performed with an appropriately heavy, properly ballasted compactor. A minimum of four (4) passes will be required on each lift regardless of whether the lift meets density specifications. A pass is defined as one trip of the compacting equipment over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers. This requirement is to allow thorough remolding of the soil by kneading action.

2) The daily work area shall extend a distance so as to maintain moist soil conditions (facilitate bonding) and continuous operations.

Desiccation and crusting of the lift surface shall be avoided as much as possible. Each lift shall be protected, at all times after placement, from desiccation and crusting.

3) If desiccation and crusting of the lift surface occurs before placement of the next lift, this area shall be scarified to a sufficient depth to mix with moist materials, or sprinkled with water and then scarified at the direction of the Engineer.

4) The transition between the bottom and side slopes shall be accomplished by compacting parallel (bottom to top) to the slope.

5) Dozer equipment shall not be used for primary compaction efforts.

6) The surface of the underlying lift shall be scarified a minimum of 2 inches prior to compaction of each subsequent lift (i.e., Lift 2 to Lift 3) to facilitate bonding of the lifts.

02300.9 During compaction of the soil liner material, the soil moisture content and dry density shall be maintained within the limits specified below.

1) To assure the moisture content and dry density requirements of the compacted soil are being satisfied, field and laboratory tests shall be made at minimal intervals as specified. Additional testing may be requested at the discretion of the Engineer.

2) Compaction moisture content shall be between 2 and 6 percent wet of optimum moisture content (OMC) on the side slopes.

3) The clay liner shall be compacted to a minimum of 95 percent of the maximum dry density. Where densities are less than 95 percent of the maximum dry density, the soil liner shall be recompacted and/or removed and reworked to meet density objectives.

02300.10 The clay liner, in addition to the other provisions of this section, shall have a permeability not greater than 1.0 x10-7 cm/sec on thin wall tube samples taken from the completed clay liner. If representative permeability tests do not achieve the required permeability, the clay liner shall be reworked to meet permeability requirements regardless of its previously achieved density. Representative soil samples taken from the clay liner that fail laboratory permeability testing must be re-sampled until passing results are achieved. Each failing sample must be replaced by one successful sample. The Owner will pay for the permeability testing at the frequency required by the Site Specific Construction Quality Assurance Plan. The Contractor will be responsible for all costs associated with re-sampling and re-testing for failing samples beyond a

5% failure rate by quantity. This includes the cost of lab and Construction Quality Assurance personnel. The minimum charge for re-sampling and re-testing for failing permeability tests exceeding 5% failure rate will be $500.00 per occurrence.

02300.11 Soil fill shall not be placed or compacted during sustained periods with air temperature below 32°F. Soil fill may be placed and compacted during periods of early morning and early evening freezing temperatures with warming trends above 45°F during the day. No fill shall be placed on frozen subgrade. If the clay liner or structural fill freezes or ices the fill section shall be rescarified and recompacted, at the discretion of the Engineer.

02300.12 During construction, finished lifts or sections of compacted clay liner shall be sprinkled with water a minimum of twice per day depending on weather conditions.

02300.13 At the end of each construction day's activities, completed lifts or sections of compacted clay liner shall be sealed by rolling with a rubber tired or smooth drum rollers and sprinkled with water as needed.

02300.14 The compacted clay liner shall be a minimum of twenty-four (24) inches thick in the cell. Thickness of the compacted soil liner on the side slopes shall be measured perpendicular to the slope face.

02300.15 The as-built thickness of the compacted clay liner shall be determined by survey methods (non-destructive) as described below. An individual lift may be sampled upon completion (but prior to subsequent lift placement) with an approved sampler or other investigative tool. Any penetration within any portion or lift of the clay liner shall be promptly backfilled by the Contractor with hand tamped soil and bentonite fill. Samples of the in place compacted soil liner shall be tested and evaluated in accordance with provisions of the Construction Quality Assurance Plan. All test locations shall be filled with a homogeneous mixture of one part bentonite and three parts soil.

02300.16 After completion of a segment of compacted clay liner, but before installation of the geomembrane liner, the surface of the clay liner shall be surveyed by the Contractor to ensure the specified thickness of Compacted Clay Liner (24 inches) has been achieved. The survey must be performed and stamped by a registered Professional Land Surveyor in the State of North Carolina. The survey information shall be provided to the Engineer in a format pre-approved by the Engineer and acceptable to the North Carolina DEHNR Division of Waste Management, Solid Waste Section. At a minimum, survey data shall be collected on a 50-foot grid and at least every 50-foot along all changes in grade.

02300.17 The surface of the compacted clay liner shall be smooth drum rolled and maintained free of rocks, organics, voids and sharp edges.

No vehicles other than a smooth-drum roller will be allowed on the Compacted Clay Liner once the Compacted Clay Liner has been approved. This includes equipment used to deploy geomembrane material. Any exceptions should have prior approval from the Project Engineer.

3260.18 The minimum interface friction angle between the Compacted Clay Liner and the 60 mil textured geomembrane shall be seventeen (17) degrees. This shall be verified by the Contractor and supporting documentation submitted to the Engineer prior to beginning construction.

The test method used to verify the interface friction angle between the clay liner and the 60-mil textured geomembrane shall be ASTM D5321 *Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear Method*. Soil specimens must be compacted to design criteria for dry density and moisture content as determined by preconstruction testing. Test parameters are to provide 3 points to range over minimum and maximum expected normal loads. Minimum will be a construction load of 260 psf. Maximum will be at the landfill's final filled condition or approximately 1,423 psf. The normal loadings used shall be 250, 750 and 1,500 psf.

END OF SECTION

SECTION 02400 LEACHATE COLLECTION REMOVAL SYSTEM (LCR)

02400.1 Scope of Work

The Contractor shall furnish all labor, materials, supervision, and equipment necessary to complete the LCR System including trench excavation, hauling, spreading, grading, rolling and all necessary and incidental items required to complete the Work, all in accordance with the Contract Drawings and these Contract Specifications.

02400.2 Materials

Pipe for the LCR System shall be High Density Polyethylene (HDPE) pipe.

1. HDPE piping shall have nominal diameters as noted on the Contract Drawing.

2. HDPE piping shall have a maximum Standard Dimension Ratio (SDR) of 17 or as specified on the Contract Drawings.

3. The HDPE pipe shall be manufactured from first quality virgin polyethylene with the following nominal properties.

Property	ASTM Method	Frequency	Acceptable Value
Relative Density	D1505	Per Shipment	.95 gms/cm^3
Melt Index	D1238	Per Shipment	0.08 gms/10 min.
Carbon Black Content	D3350	Per Shipment	Min. 2%
Tensile Strength @ Yield	D638, Type IV	Per Shipment	3200 psi
Elastic Modulus	D638	Per Shipment	> 150,000 psi

The HDPE pipe section to be perforated shall be as follows or approved by the Engineer:

1) Four rows of perforations; Two rows on each side of pipe at approximately 45° and between 75° and 90° from bottom of pipe.

2) Each row of perforations shall have holes approximately 6 inches on center; and

3) Each hole shall be 1/2-inch diameter.

The dual contained force main shall consist of HDPE carrier pipe inside HDPE containment pipe. The carrier pipe shall be concentrically located within containment pipe with spacers. The force main within the tank containment area shall consist of schedule 10 or schedule 40, 304 SS with lap joint stub end flange connections. Back up flanges are galvanized. Bolting is zinc plated grade 5. All necessary pipe supports to prevent sagging or movement shall be furnished.

All proposed exposed piping shall be heat traced and insulated, and any existing piping disturbed during construction shall be restored to original condition with insulation and heat tracing.

The chemical resistance of the HDPE pipe and all fittings shall be in keeping with typical properties of high quality polyethylene products currently available through commercial sources. All mechanical fasteners or fittings shall be stainless steel.

02400.3 Stone bedding surrounding the perforated HDPE piping shall be No. 5 washed stone. The Contractor shall be responsible for providing the stone bedding material.

02400.4 Non-woven Filter Geotextile shall be as indicated below:

Non-woven Geotextile

The geotextile used shall be ultraviolet stabilized 1) a non-woven, needlepunched, continuous filament polyester material or, 2) a non-woven, needlepunched continuous filament polypropylene material or, 3) a non-woven, needlepunched staple fiber polypropylene material.

A 16 oz. Geotextile cushion will be placed between the geomembrane and the drainage layer. The friction angle between the geotextile and the geomembrane shall be a minimum of 20 degrees. The Contractor shall verify and submit to the Engineer proper documentation prior to beginning construction. The test method used to verify the interface friction angle between the 60-mil geomembrane and the geotextile shall be ASTM D5321 *Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear Method*. Test parameters are to provide 3 points to range over minimum and maximum expected normal loads. Minimum will be a construction load of 260 psf. Maximum will be at the landfill's final filled condition or approximately 1,423 psf. The normal loadings used shall be 250, 750 and 1,500 psf.

A 6 oz. Geotextile will be used to wrap the leachate lines and the #5 stone bedding.

The non-woven material shall meet or exceed the following criteria using Minimum Average Values:

Property	ASTM Method	Frequency	Acceptable Values	
			6 oz. Geotextile	16 oz. Geotextile
Grab Tensile Strength	D4632	Every 5th Roll	160 lbs.	370 lbs.
Grab Tensile Elongation	D4632	Every 5th Roll	50 Percent	50 Percent
Puncture (pin) Strength	D4833	Every 5th Roll	110 lbs.	**170 lbs.**
Mass per Unit Area	D5261	Each Roll	6.0 oz.	**16 oz.**
Apparent Opening Size (AOS)	D4751	Every 5th Roll	.212 mm (70 Sieve max.)	0.150 mm (100 Sieve max.)

02400.5 **<u>HPDE Sumps, Catch Basins</u>**

All HDPE pipe and fittings (both interior carrier and exterior containment pipe) shall be manufactured from first quality virgin polyethylene with the following nominal properties:

Property	ASTM Method	Frequency	Acceptable Value
Relative Density	D1505	Per Shipment	.95 gms/cm^3
Melt Index	D1238	Per Shipment	0.08 gms/10 min.
Carbon Black Content	D3350	Per Shipment	Min. 2%
Tensile Strength @ Yield	D638, Type IV	Per Shipment	3200 psi
Elastic Modulus	D638	Per Shipment	> 150,000 psi

The chemical resistance of the HDPE pipe, welding rod and all fittings shall be equal or greater than that of the 60 mil. HDPE liner specified.

All interior pipe welds must be machine butt fusion welded and demonstrated to be watertight and sufficiently strong to develop the full strength of the joined sections, e.g. failure should not occur in a weld. Air testing of the pipe seams must be performed in accordance with the contract documents before acceptance by the Engineer.

02400.6 Drainage Layer

The drainage layer shall consist of washed stone with a maximum nominal diameter of 5/8". The chemical properties of the stone shall not be adversely affected by waste placement or leachate generated by the landfill. The washed stone material shall have a high permeability that allows lateral drainage through the drainage layer and along the surface of the base liner. The drainage layer material shall contain no more than 5% fines by weight.

The drainage layer shall be placed with a minimum compacted thickness of 24 inches with an overfill variance of + 0.2 feet allowed for a total allowable thickness of 2.2 feet. Any areas of the completed drainage layer that exceed this thickness will be measured and the volume of overfill calculated by the engineer. The Contractor will be required to compensate the owner for the overfill volume, calculated at a rate of $24.00 per cubic yard. The surface of the drainage layer shall be surveyed by the Contractor to ensure the specified thickness. The survey must be performed and stamped by a registered Professional Land Surveyor in the State of North Carolina. The survey information shall be provided to the Engineer in a format pre-approved by the Engineer and acceptable to the North Carolina DEHNR, Division of Waste Management, Solid Waste Section. All inverts, intersections, connection points and cleanouts for the LCS piping shall also be surveyed. At a minimum, survey data shall be collected at a 50-foot grid and every 50 feet along changes in grade.

Equipment used during placement of the drainage layer shall not be allowed to operate directly on the geomembrane. Equipment will not be allowed on any portion of the geomembrane without the protective geotextile and a minimum of 18 inches of stone material in place. The drainage layer shall be stable when placed on the interior slopes of the landfill. The friction angle between the Geotextile and the drainage layer shall be a minimum of 24 degrees. This friction angle shall be verified by the Contractor and proper documentation submitted to the Project Engineer prior to beginning construction. The test method used to verify the interface friction angle between the geotextile and the drainage layer material shall be ASTM D5321 *Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear Method.* Aggregate specimens must be compacted and/or conditioned to represent field conditions. Test parameters are to provide 3 points to range over minimum and maximum expected normal loads. Minimum will be a construction load of 260 psf. Maximum will be at the landfill's final filled condition or approximately 1,423 psf. The normal loadings used shall be 250, 750 and 1,500 psf.

02400.7 **Construction**

The geotextile for the bottom of the cell shall be installed as follows:

The specified geotextile shall be placed over the HDPE liner. The geotextile shall be immediately sewn by a methodology approved by the Engineer. The geotextile shall be extended up the side slopes and placed in the anchor trench as indicated on the Contract Drawings.

The perforated high density polyethylene collector pipe shall be as shown on the Contract Drawings.

a) The pipe section connections shall be made by:

(1) Heat fusion weld;
(2) Material extrusion weld;
(3) Threaded connection;
(4) Snap-couplings (approved mechanical); and/or
(5) Combination of any two or more of the above. No solvent or glued joints are allowed.

02400.8 The top of the gravel sump shall be completely covered with a 6 oz. filter geotextile to avoid "clogging" during placement of the first two lifts of the operational cover.

1) The sections of the geotextile shall be installed with a minimum overlap of 2 inches and field sewn together;

2) The overlapped edges of the geotextile shall be temporarily secured during periods of windy weather;

END OF SECTION

02620.1 Scope of Work

The Installer shall furnish all labor, materials, supervision and equipment to complete the HDPE Geomembrane Liner including, but not limited to, anchor trench excavation and backfill, liner layout, seaming, patching, and all necessary and incidental items required to complete the Work, in accordance with the Contract Drawings and these Specifications.

02620.2 Materials

The geomembrane liner shall be made of high-density polyethylene (HDPE) that has an absolute minimum thickness of 60 mils. This means that the geomembrane shall have a thickness of 60 mils at any point measured on the sheet. An average minimum thickness will not be considered. If during conformance testing or on-site testing and inspection, a thickness measurement is found to be less than 60 mils, the material will be rejected for use during construction.

The geomembrane used shall meet, at a minimum, the standards included in Tables 1, 2 and 3 located at the end of this section.

The chemical resistance of the geomembrane liner shall be in keeping with typical properties of high quality polyethylene products currently available through commercial sources.

Geomembrane liner shall be shipped rolled with a protective wrap around each roll, labeled with roll number and manufacturer's batch number. Manufacturer's quality control documentation shall be included with each roll.

The geomembrane shall be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. Any such defect shall be repaired in accordance with the geomembrane manufacturer's recommendations. The Engineer may reject all or portions of units (or rolls) of the geomembrane if in his opinion significant quantities of production or transporting flaws are observed.

The Installer shall submit proposed geomembrane panel layouts to the Engineer at least 14 days prior to mobilization of crews (2 copies). Once the panel layout is approved, the Installer may not change the layout without permission of the Engineer.

02620.3 **Construction**

The geomembrane liner shall be installed by a specialty contractor, and that specialty contractor must have installed a minimum of 5,000,000 square feet of geomembrane liner since November, 1998.

The geomembrane liner shall be constructed as soon as practical after completion and approval of the compacted clay liner or portion thereof. The top of the compacted clay liner will be surveyed to ensure adequate thickness of clay material and proper grades toward the collection sump area have been achieved. The Contractor shall be responsible for providing survey information for all panel locations, seam locations, destructive testing locations, repairs, and liner flap used to construct the temporary liner edge. The survey must be performed and stamped by a registered Professional Land Surveyor in the State of North Carolina. The survey information shall be provided to the Engineer in a format pre-approved by the Engineer and acceptable to the North Carolina DEHNR, Division of Waste Management, Solid Waste Section. The geomembrane is to cover the bottom of the cell and the side slopes in accordance with the Contract Drawings.

Areas to receive liner installation shall be relatively smooth and even, free of ruts, voids, etc., to the extent required by the Engineer. This shall be accomplished by final dressing of the compacted liner with smooth drum rollers. No vehicles are permitted on final dressed surfaces unless authorized by the Engineer.

An anchor trench (as illustrated on the Contract Drawings) will be required to secure the geomembrane. No loose soil will be allowed to underlie the geomembrane in the anchor trenches. The time schedule for excavation and backfilling of the anchor trenches is to be approved by the Engineer so that desiccation of trench soils does not occur prior to backfilling.

02620.4 Installation of the geomembrane shall be as follows:

All geomembrane installed on side slopes will be 60 mil textured material. The textured material shall be extended a minimum of ten (10) feet beyond the toe of slope.

Unroll only those sections that are to be seamed together in one day. Panels should be positioned with the overlap recommended by the manufacturer, but not less than 4 inches. The side slope geomembrane will be placed in an anchor trench that is then backfilled with soil and compacted as shown on the Contract Drawings.

After panels are initially in place, remove wrinkles as directed by the Engineer. Unroll several panels and allow the liner to "relax" before beginning field seaming. The purpose of this is to make the edges, which are to be bonded, as smooth and free of wrinkles as possible.

Once panels are in place and smooth, commence field seaming operations.

The Installer's Field Superintendent will complete a Daily Report at the end of each day and submit the form daily to the Engineer.

Field seaming shall be in accordance with EPA Technical Guidance document: "The Fabrication of Polyethylene FML Field Seams" EPA/530/SW-89/069 or as follows. Where conflicts exist between the two guidance specifications, the most stringent specification prevails or as directed by the Engineer.

02620.5 All foreign matter (dirt, water, oil, etc.) shall be removed from the edges to be bonded. For extrusion welds, the bonding surfaces must be thoroughly cleaned by mechanical abrasion or alternate methods approved by the Engineer to remove surface cure and prepare the surfaces for bonding. All abrasive buffing shall be performed using No. 80 grit or finer sandpaper. The grinding shall be performed so that any and all grind marks are perpendicular to the edge of sheet. No grinding greater than 1/8 inch outside the welds is permitted or the Engineer can require patching. No solvents shall be used to clean the geomembrane liner.

02620.6 As much as practical, field seaming shall start from the top of the slope down. This will minimize large wrinkles from becoming trapped, which requires cutting and patching. Tack welds (if used) shall use heat only; no double sided tape, glue, or other method will be permitted. The geomembrane should be seamed completely to the ends of all panels to minimize the potential of tear propagation along the seam.

The completed liner shall not exhibit <u>any</u> "trampolining" during any daylight hours (6:00 a.m. to 8:00 p.m.). All areas exhibiting trampolining must be repaired as directed by the Engineer. Additional slack (i..e., 1-3 percent) shall be allowed on the side slopes to reduce the potential for trampolining.

Seaming of the cell bottom membrane to the sidewall membrane (toe seam) shall be conducted when conditions minimize thermal expansion effects. All toe seams must be a minimum of 10 feet horizontally from the toe of the slope. Horizontal seams will not be allowed on the side slopes unless approved by the Engineer.

02620.7 At the end of each day or installation segment, all unseamed edges shall be anchored by sand bags or other approved device. Sand bags securing the geomembrane on the side slopes should be connected by a rope fastened at the top of the slope by a temporary anchor. If high winds are expected, boards along the edge of unseamed panels, with weighted sand bags on top, may be used to anchor the geomembrane on the bottom of the cell. Sand bags fastened by rope should be used to secure unseamed edges on the side slopes. Staples, U-shaped rods or other penetrating anchors shall not be used to secure the geomembrane on the side slopes. Any damage to the liner or clay liner including damage due to wind, rain, hail, or other weather shall be the sole responsibility of the Contractor.

02620.8 Field seaming may be extrusion or fusion welding or a combination of these methods. Solvent welding is not acceptable. The Engineer reserves the right to reject any proposed seaming method they believe unacceptable. Double hot wedge fusion welding shall be the predominant seaming method and shall be used when possible. Additional concepts and requirements of proper field seaming include the following.

02620.9 Extrusion welding applies a molten bead of material to preheated sheets of geomembrane. The sheets are then joined by pressure.

02620.10 The fusion welding process heats the area to be joined to the melting point and then applies pressure to join the melted surfaces.

02620.11 The sheets to be joined shall be overlapped at least four (4) inches after the necessary cleaning, aligning and cutting.

02620.12 The seams should be oriented parallel to the line of maximum slope, i.e., oriented up and down, not across, the slope. In corners and odd shaped geometric locations, the number of field seams shall be minimized.

02620.13 No horizontal seams shall be within ten (10) feet from the toe of the slope. No horizontal seams will be allowed on the side slopes unless approved by the Engineer.

02620.14 No seaming shall be attempted above 40°C (104°F) ambient air temperature. Below 5°C (41°F) ambient air temperature, preheating of the geomembrane will be required, unless it is demonstrated that this is not necessary (i.e., acceptable test (start-up) seams which duplicate, as closely as possible, actual field conditions can be achieved). Preheating may be achieved by natural and/or artificial means (shelters and heating devices). Ambient temperature is measured 18 inches above the liner surface. The Installer shall supply instrumentation for measurement of ambient temperature.

02620.15 A moveable protective layer of plastic or approved material may be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded. The protective layer must be removed after welding.

02620.16 Seaming will extend to the outside edge of panels to be placed in anchor trenches.

02620.17 If required, a firm substrata should be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

02620.18 Grinding prior to welding shall be done perpendicular to the sheet edge. Overgrind greater than 1/8 inch beyond the welded seam or improperly ground areas shall be replaced at the Installer's expense.

02620.19 **Seams at the Panel Corners**

Seams at the panel corners of 3 or 4 sheets shall be completed with a circular patch approximately 12 inches in diameter, extrusion welded to the parent sheets.

02620.20 **Quality Control**

All geomembrane sheet, seams, and patches will be tested and evaluated prior to acceptance. In general, testing of the sheet will be conducted by the manufacturer. Testing of the seams will be conducted by the Installer under observation by the Engineer. The Engineer or a designated, independent geosynthetics laboratory may perform additional testing, as required by these detailed Specifications or as required in the judgment of the Engineer or Authorized Representative to verify that the HDPE sheet and seams meet the specifications. The geosynthetics installer will be required to adhere to the requirements of the Site Specific Construction Quality Assurance Plan. Testing requirements are detailed in the following subsections:

02620.21 **Pre-shipping Sheet Tests**

The Installer or supplier (manufacturer) will be required to submit his Quality Control Program to the Owner prior to initiating field work. At a minimum, the Manufacturer will perform the tests, at the frequencies given in Table 3, on the HDPE sheet prior to shipping HDPE material to the site.

02620.22 **Test Seams (Destructive Tests)**

The Installer shall maintain and use equipment and personnel at the site to perform testing of test seams. These seams will be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. At a minimum, test seams shall be made upon each start of work for each seaming crew, upon every four hours of continuous seaming, every time seaming equipment is changed or if significant changes in geomembrane temperature and weather conditions are observed. The technician shall complete the Test Seam Form provided by the CQA Engineer immediately after each test. Requirements for test seams are as follows:

02620.23 The test seam sample will be at least 1.8m (6 feet) long by 0.3m (1 foot) wide with the seam centered lengthwise. Six adjoining specimens 25mm (1 inch) wide each will be cut from the test seam sample. At the Engineer's option, the shear tests may be eliminated for test seams. These specimens will be tested in the field with a tensiometer and/or manual seam tester for both shear (3 specimens) and peel (3 specimens). For dual wedge both inside and outside welds should be tested in the peel. Test seams will be tested by the Installer under approval of the Engineer. The specimens should not fail in the weld. The Installer shall supply all necessary knowledgeable personnel and testing equipment. Quantitative strength measurements from a calibrated field tensiometer, supplied by the Installer, shall be obtained for all three (3) specimens in shear and peel for the test seams. A passing test seam will be achieved when the criteria described in Table 1 (located at the end of this section) are satisfied. If a test seam fails, the entire operation will be repeated. If the additional test seam fails, the seaming apparatus or seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel.

02620.24 The Engineer will approve all test seam procedures and results. The six (6) test specimens shall be labeled with initials of the technician, date, and A.M. or P.M. as appropriate; bound together with electrical tape; and retained by the Engineer until the project is over. The Engineer will transfer these specimens to the Owner following the Engineer's acceptance of the geomembrane materials and installation.

02620.25 **Production Seams**

One hundred percent of the production seams will be tested by the Installer continuously using non-destructive techniques and at specified intervals using destructive tests.

All areas failing nondestructive test procedures described below shall be clearly marked both on the liner itself and on the Seam Inspection Quality Control Form.

02620.26 Non-Destructive Testing

Single Weld Seams: The Contractor shall maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams except those corner seams where vacuum box testing is impossible. The system shall be capable of applying a vacuum of at least 3 psi. The vacuum shall be held for a minimum of 15 seconds for each section of seam. All vacuum boxes to be used at this job site shall have new gaskets installed prior to reaching the job site. The geosynthetics installer shall also be required to have backup vacuum testing equipment at the job site. If the geosynthetics installer fails to provide the backup equipment, and it results in delays of the project, the geosynthetics installer will be liable for all costs associated with the delay.

Double Weld Seams: The Contractor shall maintain and use equipment and personnel to perform air pressure testing of all double weld seams. The system shall be capable of applying a pressure of at least 30 psi for not less than 5 minutes. All channels between the double weld seam must first be verified that the channel is open throughout the entire test area. The air pressure test results shall be documented. Pressure loss tests shall be conducted in accordance with the procedures outlined in "Pressurized Air Channel Test for Dual Seamed Geomembranes," Geosynthetic Research Institute Test Method GM-6. As outlined by the test method, following a 2 minute pressurized stabilization period, pressure losses over a measurement period of 5 minutes shall not exceed 3 psi.

Double weld seams will also be visually inspected on 100 percent of the seam. If necessary, the outside flap can be pulled back to aid in the visual inspection.

02620.27 Destructive Testing

Laboratory destructive testing (LDT) is defined as 12" X 48" samples cut on 500 foot centers for both extrusion and double welded seams. Field destructive testing (FDT) is defined as 3" X 6" samples cut at the end of each seamed area exceeding 200 feet. Both are described below:

Laboratory destructive testing will be performed on an average of every 500 linear feet of production seam. The locations will be selected by the CQA Engineer. Samples will be 12" X 48" in order to provide one sample to the archive, one sample to the Engineer for laboratory testing, and one sample to be retained by the Installer for possible field and/or additional laboratory testing at the option of the Installer.

Before the sample is sent to the laboratory, two specimens, one from each end of the specimen will be tested in peel in a calibrated field tensiometer, supplied by the Installer. Both specimens must meet the qualitative and quantitative criteria listed in Tables 1 and 2. Testing requirements are as follows: Each sample shall be large enough to test five specimens in peel and five specimens in shear. The average values of each set of five specimens must meet the values shown in Tables 1 and 2. If the average of the five specimens is adequate, but one of the specimens is below the required value, values for the specimen must be at least 90% of the values required for the sample to pass. All samples must fail in film tear bond (FTB). Samples which do not pass the shear and peel tests will be re-sampled from locations at least 10 feet on each side of the original location. These two re-test samples must pass both shear and peel testing. If these two samples do not pass, then the entire seam represented by the test shall be capped. Tests shall be conducted using a calibrated tensiometer and must meet the criteria outlined in Tables 1 and 2 located at the end of this section. The Owner will pay for destructive testing of the original destructive samples. The geosynthetics installer will be responsible for all costs associated with resampling and retesting for failing destructive samples beyond a 5% failure rate by quantity. This includes the cost of lab and CQA personnel. The minimum charge for each destructive re-test exceeding the 5% failure rate will be $500.00 per occurrence.

Field Destructive Testing (FDT) shall be small 2" X 6" samples cut out at the beginning and end of each seam exceeding 200 feet in length. Three 1" X 6" specimens will be tested in peel from each sample using the Installer's Field Tensiometer or qualitative peel tester at the option of the Installer. No qualitative peel strength values need to be determined with the Field Destructive test, but each specimen must meet all qualitative criteria listed in Tables 1 and 2.

The Engineer will approve all seam field and laboratory test procedures and results. All laboratory destructive test specimens will be marked with the seam number and letters then bound together for a particular seam and stored in the Owner's archives. The specimens for the FDT need not be retained.

Each sample area will be clearly marked both on the liner itself (LDT or FDT).

All areas cut out for testing shall be immediately patched by the Installer.

02620.28 Repair of Damaged and Sampled Areas

Damaged and sample coupon areas of geomembrane shall be repaired by the Installer by construction of an extrusion welded cap strip. No repairs shall be made to seams by application of an extrusion bead to a seam edge previously welded by fusion or extrusion methods. Repaired areas will be tested for seam integrity as outlined in Section 02620.27 of this specification. Damaged materials are the property of the Contractor and will be removed from the site at the Contractor's expense. The Contractor will retain all ownership and responsibility for the geomembrane until acceptance by the Engineer. The geomembrane shall be accepted by the Engineer after the installation and repair are complete, and after the Engineer has received documentation for the installation.

02620.29 Potentially Damaging Activities

No support equipment of any type, which may be used by the Contractor, shall be allowed on the geomembrane. Personnel working on the geomembrane shall not smoke, wear damaging shoes, or engage in any activity that could damage the geomembrane. No glass or sharp objects shall be allowed on the geomembrane.

02620.30 Anchor Trench Backfilling

The anchor trench will be backfilled and compacted by the Contractor to a dry density not less than 95 percent of the maximum dry density determined by the Standard Proctor (ASTM D-698). Care should be taken when backfilling the trench to prevent any damage to the geomembrane. Anchor trench soil shall be used as backfill material, wherever acceptable by the Engineer.

02620.31 Protection of Leading Edges

Between construction of partial sections of the membrane liner, excluding temporary phaselines, leading edges of the membrane may be exposed or buried for extended periods of time prior to their joining to adjacent, subsequent membrane sections. The combined action of abrasive soil and equipment impact stresses may "etch" unprotected membrane surfaces sufficiently to affect seam strengths. Therefore, it is necessary to protect leading edges in high activity areas with sacrificial layers of geotextile and HDPE sheet until they are ready for final seaming. As a

minimum, each leading edge to be seamed that must be buried or which must be exposed for periods of one month or longer shall be continuously covered by a layer of HDPE sheet. The geotextile shall be nonwoven and have a minimum weight of 8 oz. per square yard. The sacrificial HDPE sheet shall have a minimum thickness equal to that of the membrane liner to be protected. Both protective layers shall have a minimum width of 2 feet. The protective cover sheets shall be either covered with soil or weighted with sand bags to prevent displacement by wind. The edge of the sheet to be protected shall be approximately centered beneath the overlying protective layers prior to burial or weighing with sandbags. Leading edges located in areas expected to receive direct traffic from construction equipment shall be buried under a minimum thickness of one foot of buffer soil.

2620.32 Geomembrane Warranty

The installation shall be warranted against defects in workmanship for a period of 1 year from the date of substantial project completion.

Table 1

Required Physical Properties of Smooth Membrane Liner (HDPE) Sheet

Property	Test Method	Required Values (60 Mil. HDPE)
Thickness	ASTM D5199	60 mil minimum
Specific Gravity (Relative Density)	ASTM D1505	0.940 g/cm^3 min.
% Elongation at Yield (min. avg.)	ASTM D6693 Type IV	12
% Elongation at Break (min. avg.)	ASTM D6693 Type IV	700
Tensile Strength at Yield Min. Avg.)	ASTM D6693 Type IV	126 lb/in. min.
Tensile Strength at Break (min. Avg.)	ASTM D6693 Type IV	228 lb/in. min
Carbon Black Content	ASTM D-1603	2% min. - 3% max.
Carbon Black Dispersion	ASTM D-5596	**1, 2, Cat. (9 of 10 views) Cat. 3 (1 of 10 views)**
Puncture Resistance	ASTM D4833	108 lb. min.
Tear Resistance	ASTM D 1004	42 lb. min.

Seam Strengths

Shear Strength	ASTM D4437, NSF Modified	120 lb/in
Shear Strain @ Yield	ASTM D4437, NSF Modified	10% (min.)
Peel Strength (Fusion Weld)	ASTM D4437, NSF Modified	91 lb/in
Peel Strength (Extrusion Weld)	ASTM D4437, NSF Modified	78 lb/in

Non-Destructive Testing

Single Weld	Continuous Vacuum Box; Impact	Maintain vacuum of 3 psi, hold vacuum for 15 seconds.
Double Weld	Air Testing	Maintain 30 psi for no less than 5 min.; pressure loss not greater than 3 psi for last 3 minutes.

Table 2

Required Physical Properties of Textured Membrane Liner (HDPE) Sheet

Property	Test Method	Required Values (60 Mil. HDPE)
Thickness	ASTM D-5994	**60 mil minimum**
Specific Gravity (Relative Density)	ASTM D-1505	0.940 g/cm^3 min.
% Elongation at Yield	ASTM D6693 Type IV	12
% Elongation at Break	ASTM D6693 Type IV	**100**
Tensile Strength at Yield	ASTM D6693 Type IV	126 lb/in. min.
Tensile Strength at Break	ASTM D6693 Type IV	90 lb/in. min
Carbon Black Content	ASTM D-1603	2% min. - 3% max.
Carbon Black Dispersion	ASTM D-5596	**1, 2, Cat. (9 of 10 views) Cat. 3 (1 of 10 views)**
Puncture Resistance	ASTM D4833	90 lb. min.
Tear Resistance	ASTM D 1004	42 lb. min.

Seam Strengths

Shear Strength	ASTM D4437, NSF Modified	120 lb/in
Shear Strain @ Yield	ASTM D4437, NSF Modified	10% (min.)
Peel Strength (Fusion Weld)	ASTM D4437, NSF Modified	91 lb/in
Peel Strength (Extrusion Weld)	ASTM D4437, NSF Modified	78 lb/in

Non-Destructive Testing

Single Weld	Continuous Vacuum Box; Impact	Maintain vacuum of 3 psi, hold vacuum for 15 seconds.
Double Weld	Air Testing	Maintain 30 psi for no less than 5 min.; pressure loss not greater than 3 psi for last 3 minutes.

Table 3

Required Pre-Shipping Sheet Testing of Membrane Liner (HDPE)

Property	Test Method	Frequency
Thickness	ASTM D5994 (Textured) ASTM D5199 (Smooth)	Each Roll
Specific Gravity (Relative Density)	ASTM D1505	Every 5th roll
Tensile Properties	ASTM D6693 Type IV	Every 5th Roll
Tear Resistance	ASTM D1004	Every 5th Roll
Puncture Resistance	ASTM D-4833	Every 5th Roll
Carbon Black Content	ASTM D1603	Every 5th Roll
Carbon Black Dispersion	ASTM D-5596	Every 5th Roll

END OF SECTION

PART 1: GENERAL

1.01 SCOPE OF WORK

Furnish all labor, equipment, materials and incidentals necessary to install and complete installation of the geocomposite drainage layer.

1.02 WARRANTY

A. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geocomposite completion.

PART 2: PRODUCTS

2.01 GEOCOMPOSITE PROPERTIES

A. A geocomposite shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure with a non-woven geotextile bonded to one or both sides.

B. The geocomposite specified shall have properties that meet or exceed the values listed in the following Table:

Standard Property Drainage Sheet			
Tested Property	**Test Method**	**MINIMUM AVERAGE VALUES[c]**	
		6 oz. Fabric	**8 oz. Fabric**
Geocomposite			
Transmissivity[a], m^2/sec	ASTM D4716	1.0×10^{-4}	1.0×10^{-4}
Ply Adhesion, lb/in	ASTM D7005	1 [b]	1 [b]
Geonett Component [b]			
Transmissivity[a], m^2/sec	ASTM D4716	1×10^{-3}	1×10^{-3}
Thickness, mil	ASTM D 5199	200	200
Density, g/cm^3	ASTM D 1505 or ASTM D792, Method B	0.94	0.94
Peak Tensile	ASTM D 5035	45	45

Strength (MD), lb/in			
Carbon Black Content, %	ASTM D 1603	2.0 – 3.0	2.0 – 3.0
Geotextile Component [(b)]			
Mass Per Unit Area, oz/yd^2	ASTM D 5261	6	8
AOS, US Sieve	ASTM D 4751	70	80
Grab Tensile Strength	ASTM D4632	160	220
Grab Tensile Elongation	ASTM D4632	50	50
Puncture Strength	ASTM D4833	90	120
Permittivity (min. avg.) (Sec^{-1})	ASTM D 4491	1.6	1.3
UV Stability, % retained (500 hr.)	ASTM D 4355	70	70

(a) Gradient of 0.1, normal load of 10,000 psf, water at 70°, between stainless steel plates and a 15-minute seat time.
(b) Component properties prior to lamination.
(c) These are MARV values that are based on the cumulative results of specimens tested.

C. Resin
1. Resin shall be new first quality, compounded polyethylene resin.

PART 3: EXECUTION

3.01 FAMILIARIZATION

A. Inspection
1. Prior to implementing any of the work in the Section to be lined, the Installer shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of the Section may properly commence without adverse impact.

2. If the Installer has any concerns regarding the installed work of other Sections, he shall notify the Project Engineer.

B. Confirmation Testing

The friction angle between the geocomposite and the textured geomembrane shall be a minimum of 25 degrees. The Contractor shall verify prior to beginning construction. The test method used to verify the interface friction angle between the geocomposite and the textured geomembrane shall be ASTM D5321 *Standard Test Method for*

Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by Direct Shear Method. Test parameters are to provide 3 points to range over minimum and maximum expected normal loads. Minimum will be a construction load of 260 psf. Maximum will be at the landfill's final filled condition or approximately 1,423 psf. The normal loadings used shall be 250, 750 and 1,500 psf.

3.02 MATERIAL PLACEMENT

A. The geocomposite roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the Engineer.

B. If the project contains long, steep slopes, special care should be taken so that only full length rolls are used at the top of the slope.

C. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.

D. If the project includes an anchor trench at the top of the slopes, the geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

E. In applying fill material, no equipment can drive directly across the geocomposite. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

F. The cover soil shall be placed in the geocomposite in a manner that prevents damage to the geocomposite. Placement of the cover soil shall proceed immediately following the placement and inspection of the geocomposite.

3.03 SEAMS AND OVERLAPS

A. Each component of the geocomposite will be secured or seamed to the like component at overlaps.

B. Geonet Components

1. Adjacent edges of the geonet along the length of the geocomposite roll shall be placed with the edges of each geonet butted against each other.

2. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 3 feet along the roll length.
3. Adjoining geocomposite rolls (end to end) across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12

inches across the roll width.

4. The geonet portion should be tied every 6 inches in the anchor trench or as specified by the Engineer.

3.04 REPAIR

A. Prior to covering the deployed geocomposite, each roll shall be inspected for damage resulting from construction.

B. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be joined in accordance with Subsection 3.03.

PART 4: MEASUREMENT AND PAYMENT

See Section 01700.

END OF SECTION

02630.1 The temporary cover liner for the slopes shall be comprised of a minimum of 20 mil. Medium Density Polyethylene (MDPE) material as manufactured by Raven Industries (Product No. 2010B) or equal and as approved by the Engineer. The liner should be resistant to ultra violet degradation for the operational life of the landfill or until the material is removed by the Owner (18 months minimum). The minimum material properties values must be submitted to the Engineer prior to approval of the material.

02630.2 The liner shall be delivered to the site in a minimum of 15 feet wide rolls. Prefabricated factory seams are permitted using a method approved by the Engineer. The liner will be anchored at the top in the anchor trench.

02630.3 The Installer or Fabricator shall weld all seams with the wedge welding method or as otherwise approved. The quality control testing will include visual inspection and hand pulling of the seam for 100 percent of the factory and field seams.

02630.4 The Owner will periodically remove these portions of the temporary liner where waste is being placed, from the bottom up, and discard the cut-off portion.

02630.5 The Contractor is responsible for designing and installing an appropriate ballast system of the temporary liner to protect the liner against damage from up to 100 mph winds. The liner and ballast should be protected against:

1) Liner pull out from underneath the ballast;

2) Tearing of the liner or the welded seams;

3) Excessive billowing of the liner; and

4) Damage to either the ballast weights or the ropes tying them together.

Should the ballast system not adequately protect the liner against wind damage as defined above from the time the liner is placed until the liner is completely removed by the Owner, the Contractor will replace, repair, and/or supplement the liner and ballast system at no additional cost to the Owner. As a minimum, the ballast system should consist of 50 pound sand bags tied 3' on center down or parallel to the slope and tied 10' on center across or perpendicular to the slope. One line of ballast bags should also be placed down each seam. The sandbags and ropes used for the ballast system shall be "CIA Day Bag" manufactured by Dayton Bag & Burlap of Dayton, Ohio, or approved equal. The bags shall have a minimum 3-year warranty against degradation due to ultraviolet light exposure.

02630.6 Stormwater control liner shall have a minimum five (5) year warranty against degradation of material due to ultraviolet light exposure.

END OF SECTION

SECTION 02750 LEACHATE COLLECTION SYSTEM FORCE MAIN & NON-PERFORATED GRAVITY PIPING INSTALLATION

02750.1 DESCRIPTION OF WORK

The work covered under this section shall consist of furnishing all labor, equipment and services for the installation of the HDPE dual contained force main & non-perforated gravity piping for the leachate collection system as shown on the drawings and specified in Section 02400.

02750.2 HANDLING AND STORING MATERIALS

The Contractor shall unload material so as to avoid deformation or other injury thereto. Material shall not be rolled or dragged over gravel or rock during handling. The Contractor shall store the appurtenances on sills above storm drainage level and deliver for installation after the trench is excavated. When any material is damaged during transporting, unloading, handling or storing, the undamaged portions may be used or, if damaged sufficiently, the Engineer will reject the material as being unfit for installation.

If any defective material is discovered after installation, it shall be removed and replaced with sound material or shall be repaired by the Contractor in an approved manner and at his own expense.

02750.3 PIPE ALIGNMENT AND GRADE

The layout of underground force main pipe and gravity sewer lines shall be as shown on the contract drawings.

The Contractor shall do all field layout work for lines and grades from that information shown on the drawings or as furnished by the Engineer.

02750.4 PREPARATION OF PIPE FOUNDATION

The pipe foundation shall be prepared to be uniformly firm and the pipe bedding shall be in accordance with the typical trench cross-sections as shown on the drawings. Under no circumstances shall pipe be laid in water, on rock, or when trench conditions or weather is unsuitable for such work.

The Contractor shall remove all water which may be encountered or which may accumulate in the trenches by pumping or bailing and no pipes shall be laid until the water has been removed from the trench.

02750.5 PIPE LAYING

In all cases, pipe is to be installed in strict accordance with the manufacturer's recommendations and the contract material specifications. The Engineer may augment any manufacturer's installation recommendations if, in his opinion, it will best serve the interest of the Owner.

Proper tools, implements, and facilities satisfactory to the Engineer shall be provided and used for the safe and convenient prosecution of pipe laying. All pipe and other materials used in the laying of pipe will be lowered into the trench piece by piece by means of suitable equipment in such a manner to prevent damage to the pipe, materials, to the protective coating on the pipe materials, and to provide a safe working condition to all personnel in the trench. Each piece of pipe being lowered into the trench shall be clean, sound and free from defects. It shall be laid on the prepared foundation, as specified elsewhere to produce a straight line on a uniform grade, each pipe being laid so as to form a smooth and straight inside flow line. Pipe shall be removed at any time if broken, injured or displaced in the process of laying same, or of backfilling the trench.

During times when pipe laying is not in progress, the open ends of pipe shall be closed and no trench water or other material shall be permitted to enter the pipe.

02750.6 BACKFILLING

All backfill shall be compacted so as not to damage the pipe and appurtenances and shall be compacted to 95 percent of the Standard Proctor Test for the various types of backfill materials.

Methods of backfilling shall be in strict accordance with the pipe manufacturer's recommendations. All backfill materials shall have been approved by the Engineer. Select backfill material shall be used when requested by the Engineer. Select material shall be defined as a finely graded material free from stones over 1/2 inch in diameter, plastic clays, organic material, frozen lumps and various debris and shall be approved by the Engineer prior to its installation.

Care shall be taken during backfill and compaction operations to maintain alignment and prevent damage to the joints. The backfill shall be kept free from stones, frozen lumps, chunks of highly plastic clay, or other objectional material. All pipe backfill areas shall be graded and maintained in such a condition that erosion or saturation will not damage the pipe bed or backfill.

Heavy equipment shall not be operated over any pipe until it has been properly backfilled and has a minimum cover as required by the plans.

Where any part of the required cover is above the proposed finish grade, the Contractor shall place, maintain, and finally remove such material at no cost to the Owner. Pipe which becomes mis-aligned, shows excessive settlement, or has been otherwise damaged by the Contractor's operations shall be removed and replaced by the Contractor at no cost to the Owner. The Contractor shall maintain all pipes installed in a condition that they will function continuously from the time the pipe is installed until the project is accepted.

END OF SECTION

02760.1 DESCRIPTION OF WORK

The work covered under this section shall consist of furnishing all labor, equipment, and services for the proper inspection and testing of the leachate collection system force main lines and non-perforated gravity piping installed in accordance with Section 02750.

02760.2 LINE CLEANING

Prior to testing of any section(s) of the leachate collection system force main and non-perforated gravity piping, the Contractor shall completely clean the lines of all debris, silt, etc. The pipe shall be proved to be ready for use by the Owner and shall be proved to be in first class condition and constructed in accordance with the drawings and specifications.

The Contractor shall maintain the project, insofar as his construction work is concerned, in first class condition for such time as is necessary to satisfy the Engineer that all installations are correct and acceptable.

02760.3 INSPECTION

When the leachate collection system force main and non-perforated gravity piping is completed, the Engineer shall inspect the line for conformance with the provisions of the drawings and specifications, particularly with respect to alignment and depth.

02760.4 TESTING

All newly constructed force mains and non-perforated gravity pipe sections shall be subjected to a hydrostatic pressure-leakage test.

Each completed section of the pipeline shall be plugged at both ends and slowly filled with water. As the main is being filled with water in preparation of the test, all air shall be expelled from the pipe. The main shall be subjected to hydrostatic pressure of 100 pounds per square inch for a period of two hours unless otherwise specified. Pressure shall be applied to the main by means of a hand pump for small lines or by use of a gasoline pump or fire engine for larger lines. Both the Containment pipe and the Carrier pipe shall be tested.

The rate of leakage shall be determined at 15 minute intervals by means of volumetric measure of the water added during the test until the rate has stabilized at the constant value for three consecutive 15 minute periods.

Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted until the leakage tests have been performed with no leakage observed.

Cracked or defective pipe, joints, fittings, or valves discovered in consequence of this test shall be removed and replaced with sound materials, and the test shall be repeated until the test results are satisfactory. Precautions shall be taken to remove or otherwise protect equipment in, or attached to, pipe to prevent damage or injury thereto.

Tests of insulated and concealed piping shall be made before the piping is covered or concealed.

The Contractor shall notify the Engineer when the work is ready for testing with all testing done in the presence of the Engineer. All labor, equipment, water and materials, including meters and gauges, shall be furnished by the Contractor at his own expense.

02760.5 MEASUREMENT AND PAYMENT

There will be no specific quantities measured for the leachate force main & gravity sewer Inspection and Testing. The cost of providing all equipment, labor, materials, etc. required to perform the work described under this section, shall be considered incidental to that work covered under other sections of these specifications.

END OF SECTION

Section 9 - Erosion Control Plan

HELP MODEL ANALYSIS

WHITE OAK MSW LANDFILL
PHASES 3 & 4
HAYWOOD COUNTY, NORTH CAROLINA

JEFFREY R. BISHOP, P.E.

NORTH CAROLINA PROFESSIONAL SEAL 23574 ENGINEER JEFFREY R. BISHOP

McGill ASSOCIATES

Engineering • Planning • Finance
Asheville, North Carolina

September 2008

07518

An erosion control plan submittal to the North Carolina Department of Environment and Natural Resources – Land Quality Section is pending. A copy of the approved erosion control plan and permit will be forwarded to the Solid Waste Section upon receipt, and prior to an issuance of a Permit To Construct Phase 3.

Section 10- Help Model Analysis

HELP MODEL ANALYSIS

WHITE OAK MSW LANDFILL
PHASES 3 & 4
HAYWOOD COUNTY, NORTH CAROLINA

JEFFREY R. BISHOP, P.E.

McGill ASSOCIATES

Engineering • Planning • Finance
Asheville, North Carolina

September 2008

07518

Hydrological Evaluation of Landfill Performance (HELP) Model Analysis for the Haywood County Phases 3 & 4 Municipal Solid Waste Landfill

1. INTRODUCTION

Haywood County hired McGill Associates, P.A. to design Phases 3 & 4 of their municipal solid waste landfill. As part of the design process, the leachate collection pipes, pumps, and storage structures must be sized for the landfill cell. The Hydrological Evaluation of Landfill Performance (HELP) model version 3.07, which was developed by the environmental laboratory of the United States Army Corps of Engineers, was used to estimate the daily peak, monthly average, and annual average leachate collected in the drainage layer of the landfill cell. The HELP model utilizes the layer arrangement of the landfill, the weather conditions at the landfill site, and the hydraulic conductivity properties of each landfill layer to estimate leachate rates that are collected in the leachate drainage layer at the bottom of the landfill cell. The HELP model also estimates the amount of head on the bottom liner system using the above data.

2. MODEL INPUTS

The HELP model requires several inputs from the user to determine leachate generation. To calculate leachate flows, the **layers** of materials that make up the construction of a landfill were evaluated. The layers were grouped to form thirteen typical landfill **cross-sections**. Then, the cross-sections were combined to realistically simulate ten **stages of landfill development** over the course of filling Phases 3 and 4. Total leachate flows were calculated for each stage of landfill development. Weather data included with the HELP model for Haywood County was used for estimating rainfall at the site.

2.1 LAYERS

Landfill layers were examined as the basis for calculating leachate flows for Phases 3 and 4 at the White Oak Landfill. The layers consist of the clay barrier soils and geomembranes that make up the base and cap liner systems, the stone leachate drainage layer, the municipal solid waste layers, and the daily, intermediate, and final vegetative soil cover layers. The properties of the various layers and the classification in the HELP model are presented in Table 1. The soil and geosynthetics properties were selected from default values provided by the HELP model.

The landfill layers evaluated include the following, from top to bottom of the completed landfill:

1. 18-inch vegetative layer
2. 40-mil HDPE geomembrane
3. 18-inch barrier soil (clay with max. hydraulic conductivity = 1×10^{-5})

4. 12-inch local soil as intermediate cover
5. 6-inch local soil as daily cover over 10-foot waste lifts
6. 10-foot lifts of municipal solid waste (120 feet at maximum fill)
7. 24-inch gravel leachate drainage layer
8. 60-mil HDPE geomembrane
9. 24-inch barrier soil (clay with max. hydraulic conductivity = 1 x 10^{-7}) cm/sec

Table 1: Layer Properties And HELP Model Classifications

Material	HELP Model Classification	HELP Model Texture Number	Porosity (Vol/Vol)	Effective Saturated Hydraulic Conductivity (cm/sec)
Vegetation Layer	Type 1 – Vertical Percolation	6	0.4530	7.2×10^{-04}
Geomembrane	Type 4 – Flexible Membrane Liner	35	0.000	2×10^{-13}
Clay	Type 3 – Barrier Soil Liner	16	0.4510-Cap 0.4270-Base	1×10^{-05}-Cap 1×10^{-07}-Base
Intermediate Cover	Type 1 – Vertical Percolation	6	0.4530	7.2×10^{-04}
Municipal Waste	Type 1 – Vertical Percolation	18	0.6710	1×10^{-03}
Daily Cover	Type 1 – Vertical Percolation	6	0.4530	7.2×10^{-04}
Gravel Leachate Collection Layer	Type 2 – Lateral Drainage Layer	21	0.3970	0.300

2.2 CROSS-SECTIONS

Thirteen cross-sections of landfill construction were examined and utilized to produce the HELP model results. The cross-sections consist of the landfill layers listed in Section 2.1 above and were designed to represent a wide range of landfill construction, from the initial ten-foot lifts of waste with six inches of daily cover, to the final fill condition of the landfill consisting of approximately 120 feet of waste, and final cover soils and geomembrane.

The runoff Curve Number was computed by the HELP model based on the soil texture of the upper most layer in each landfill cross-section evaluated. Bare ground was assumed for the cases with either daily cover or intermediate cover. It was assumed that 100 percent of the area allowed runoff, although in the initial stages of landfill

development prior to the time that the working face elevations reach the elevations of the periphery berms, runoff will be collected and treated as leachate (Cross-Sections 1-3).

In order to model the leachate production rates, the HELP model is used to determine the rates based on 30 years of simulation. Because the active life of a landfill consists of a variety of waste thickness and cover types, leachate production rates were determined by evaluating thirteen cross-sections of the landfill that represent typical landfill construction throughout the lifetime of the landfill. The variations in the cross-sections are related to the waste thickness and the type of cover, which include daily cover (6-inches of local soil), intermediate cover (12-inches of local soil), or final cap construction (18-inches of vegetative support layer, geomembrane, and 18-inches of clay barrier soil). All of the cross-sections used in this analysis include beneath the waste layers, a 24-inch layer of washed stone on top of a 60-mil HDPE liner on top of a 24-inch layer of clay barrier soil (hydraulic conductivity of 1×10^{-7} cm/sec). The thirteen cross-sections used in this evaluation are as follows:

- **Cross-Section 1**: A 10-foot layer of compacted waste covered with a 6-inch layer of daily cover soil, at a slope of 5%; however, all runoff is collected and treated as leachate.
- **Cross-Section 2**: Two 10-foot layers of compacted waste covered with two 6-inch layers of daily cover soil, at a slope of 5%; however, all runoff is collected and treated as leachate.
- **Cross-Section 3**: Three 10-foot layers of compacted waste covered with three 6-inch layers of daily cover soil, at a slope of 5%; however, all runoff is collected and treated as leachate.
- **Cross-Section 4**: A 10-foot layer of compacted waste covered with a 12-inch layer of intermediate cover soil, at a 3:1 slope.
- **Cross-Section 5**: Two 10-foot layers of compacted waste covered with two 6-inch layers of daily cover soil, at a slope of 5%.
- **Cross-Section 6**: Two 10-foot layers of compacted waste covered with a 6-inch layer of daily cover soil and a 12-inch layer of intermediate cover soil, at a 3:1 slope.
- **Cross-Section 7**: Three 10-foot layers of compacted waste covered with three 6-inch layers of daily cover soil, at a slope of 5%.
- **Cross-Section 8**: Three 10-foot layers of compacted waste covered with two 6-inch layers of daily cover soil and a 12-inch layer of intermediate cover soil, at a 3:1 slope.
- **Cross-Section 9**: Six 10-foot layers of compacted waste covered with five 6-inch layers of daily cover soil and a 12-inch layer of intermediate cover soil, at a 5% slope.
- **Cross-Section 10**: Six 10-foot layers of compacted waste covered with five 6-inch layers of daily cover soil and a 12-inch layer of intermediate cover soil, at a 3:1 slope.
- **Cross-Section 11**: Twelve 10-foot layers of compacted waste covered with eleven 6-inch layers of daily cover soil and a 12-inch layer of intermediate cover soil, at a 5% slope.

- **Cross-Section 12**: Twelve 10-foot layers of compacted waste covered with eleven 6-inch layers of daily cover soil and a 12-inch layer of intermediate cover soil, at a 3:1 slope.
- **Cross-Section 13**: Twelve 10-foot layers of compacted waste covered with eleven 6-inch layers of daily cover soil, a 12-inch layer of intermediate cover soil, an 18-inch layer of clay barrier soil (hydraulic conductivity of 1×10^{-5} cm/sec), a 40-mil HDPE liner, a double-sided geocomposite, and an 18-inch vegetative soil layer, at a 5% slope. This is the final cap.

2.3 STAGES OF LANDFILL DEVELOPMENT

The thirteen cross-sections developed in Section 2.2 above are combined to simulate ten stages of landfill development. Each stage was designed to represent a realistic scenario of landfill development, as Phases 3 and 4 become operational and waste fill begins. Stages I through V will occur during the development of Phase 3. Phases VI through IX will be developed after Phase 4 comes on line. Phase X is the condition of both Phases 3 and 4 with a final cap. The total leachate production for each stage of development was calculated.

In order to design the leachate collection system for the a realistic scenario, the geomembrane in the bottom and top liner systems were assumed to have approximately 1 pinhole per acre, 1 installment defect per acre and have a good placement quality. These assumptions lead to a realistic leakage through the liner system as well as a realistic head on the bottom liner and drainage into the leachate collection pipes.

A brief description of the stages of landfill development examined is as follows:

- **Stage I**: Occurs approximately 6 months after filling of Phase 3 commences. Waste levels are generally thin lifts with no runoff to the perimeter berms. All runoff from the top of daily cover will be collected and treated as leachate.
- **Stage II**: Occurs at year 1 of Phase 3. Lift thickness is increasing, however, all runoff from the top of daily cover is still collected and treated as leachate.
- **Stage III**: Occurs at approximately 18-24 months of Phase 3 development. Waste levels are approaching periphery berm elevations, however, all runoff from the top of daily cover is still collected and treated as leachate. This stage of development represents the greatest footprint of landfill where stormwater does not runoff to periphery ditches.
- **Stage IV**: Represents year 3 of Phase 3. As waste thicknesses increase, temporary 3:1 and permanent 4:1 side slopes direct runoff to periphery ditches. There are areas with 5% slopes on top face of landfill.
- **Stage V**: Year 5 of Phase 3. Waste levels are approaching the limits of Phase 3 development. There are areas with 5% slopes, and temporary and permanent side slopes direct runoff to periphery ditches.

- **Stage VI**: Approximate year 6. Phase 3 has reached limits of development. Phase 4 has been on-line for approximately 1 year and waste thickness are assumed to be approximately 10'. Elevations of Phase 4 do not allow for runoff to reach periphery berms.
- **Stage VII**: Approximate year 7. Waste elevations within Phase 4 allow for removal of stormwater runoff to the perimeter ditches. Some 3:1 temporary slopes have been developed and a 5% slope is being developed on top of Phase 4.
- **Stage VIII**: Approximate year 8. Waste thicknesses are increasing and temporary and final slopes are being established.
- **Stage IX**: Approximate year 10. Permanent and temporary side slopes are well established. A majority of runoff is directed to periphery ditches.
- **Stage X**: Approximate year 11. This stage represents the build-out of Phases 3 and 4. A permanent cap per the Permit to Construct drawings is assumed for leachate flow calculations.

The Fill Sequence drawings developed in the Phases 3 & 4 Permit To Construct were utilized to estimate the acreage for each Cross-Section within any given Stage of development. The cross-section acreage for each stage of landfill development are shown in Table 2. Areas were rounded to the nearest 0.5 acre.

Table 2: Cross-Section Acreage for Each Stage of Landfill Development

Stage	Cross-Sections (Acreage)													Total Acres
	1	2	3	4	5	6	7	8	9	10	11	12	13	
I.	3.5													3.5
II.	0.5	2.0	2.0	0.5										5.0
III.				0.5	2.0	1.5	4.5	0.5						9.0
IV.				0.5	1.0	0.5	5.5	1.5						9.0
V.						1.5	2.5	3.0	2.0					9.0
VI.				6.5		1.5	2.5	3.0	2.0					15.5
VII.				1.5	2.0	3.0	4.0	3.0	2.0					15.5
VII.						1.0	3.0	3.0	3.0	2.0	2.5	1.0		15.5
IX.						1.0	1.0	3.5	4.0	2.0	3.0	1.0		15.5
X.													15.5	15.5

3. MODEL OUTPUT

The HELP model calculates a conservative value for the daily peak, the monthly average, and the annual average of leachate collected in the stone drainage layer (the leachate collection layer) of the landfill cell. These values than can then be used to design the necessary leachate piping, pump, and storage sizes.

3.1 DAILY LEACHATE PRODUCTION RESULTS

Tables 3, 4, and 5 pertain to daily leachate production calculations. Table 3 shows the peak daily production for each cross-section while Table 4 shows the total leachate volume collected for each stage of landfill development. Table 5 lists the average and maximum daily head on the bottom liner during the modeling period. At no time during the 30 year model did the head on the bottom liner exceed 12 inches.

Table 3: Peak Daily Leachate Production Rates By Cross-Section

Cross-Section	Peak Leachate Production Rate/Acre	
	Daily (Inches)	Daily (Cu. Ft.)
1	1.964*	7,129.3*
2	1.897*	6,886.1*
3	1.875*	6,806.3*
4	0.3096	1,123.8
5	0.2700	980.1
6	0.2776	1,007.7
7	0.2475	898.4
8	0.2480	900.2
9	0.2181	791.7
10	0.2162	784.8
11	0.1335	484.6
12	0.1385	502.8
13	0.0024	8.7

*Includes runoff totals as well as drainage layer totals, all of which will be treated as leachate.

Table 4: Peak Daily Leachate Production Volume Totals for Stages of Landfill Development

Stage	Cross-Sections (Values in cubic feet)													Total Volume
	1	2	3	4	5	6	7	8	9	10	11	12	13	
I.	24,953													24,953
II.	3,565	13,772	13,613	562										30,950
III.				562	1,960	1,512	4,043	450						8,527
IV.				562	980	504	4,941	1,350						8,337
V.						1,512	2,246	2,701	1,583					8,042
VI.				7,318		1,512	2,246	2,701	1,583					15,360
VII.				1,686	1,960	3,024	3,594	2,701	1,583					14,548
VII.						1,008	2,695	2,701	2,375	1,570	1,212	503		12,064
IX.						1,008	898	3,151	3,167	1,570	1,454	503		11,751
X.													135	135

Table 5: Head On Bottom Geomembrane By Cross-Section

Cross-Section	Head on Bottom Geomembrane	
	Daily Average (Inches)	Daily Maximum (Inches)
1	1.591	3.040
2	1.274	2.450
3	1.171	2.258
4	1.460	2.797
5	1.274	2.450
6	1.309	2.517
7	1.167	2.251
8	1.170	2.256
9	1.029	1.991
10	1.019	1.973
11	0.629	1.231
12	0.653	1.276
13	0.011	0.023

3.2 MONTHLY AND ANNUAL LEACHATE PRODUCTION RESULTS

Tables 6 and 7 refer to monthly and annual average leachate production results. Table 6 illustrates the monthly and annual average leachate production rates calculated for each cross-section of landfill construction. Table 7 shows the monthly leachate

volume totals calculated by summing the total leachate produced by each cross-section within any given stage of landfill development.

Table 6: Monthly and Annual Average Leachate Production Rates By Cross-Sections

Cross-Section	Monthly Average Production Rate/Acre		Annual Average
	(Inches)	(Cu. Ft.)	(Inches)
1	1.542*	5,597.5	18.51*
2	1.550*	5,627.1	18.60*
3	1.551*	5,630.1	18.61*
4	1.430	5,190.9	17.16
5	1.392	5,053.0	16.70
6	1.438	5,218.1	17.25
7	1.393	5,056.6	16.71
8	1.374	4,987.6	16.49
9	1.455	5,281.7	17.46
10	1.436	5,212.7	17.23
11	1.098	3,985.7	13.17
12	1.081	3,924.0	12.97
13	0.043	156.1	0.52

*Includes runoff totals as well as drainage layer totals, all of which will be treated as leachate.

Table 7: Average Monthly Leachate Production Totals for Stages of Landfill Development

Stage	Cross-Sections (Values in cubic feet)													Total Volume
	1	2	3	4	5	6	7	8	9	10	11	12	13	
I.	19,591													19,591
II.	2,814	11,254	11,260	2,595										27,923
III.				2,595	10,106	7,827	22,755	2,494						45,777
IV.				2,595	5,053	2,609	27,811	7,481						45,549
V.						7,827	12,642	14,963	10,563					45,995
VI.				33,741		7,827	12,642	14,963	10,563					79,736
VII.				7,786	10,106	15,654	20,226	14,963	10,563					79,298
VII.						5,218	15,170	14,963	15,845	10,425	8,658	3,924		74,203
IX.						5,218	5,057	17,457	21,127	10,425	10,389	3,924		73,597
X.													156	156

4. CONCLUSIONS

The period when the greatest peak daily leachate production will be observed is during the time period when waste lifts are thin and waste elevations are such that stormwater runoff does not reach periphery ditching. This will occur in landfill stages 1 and 2 during the first year and a half of operations within Phase 3. Peak daily leachate production will again spike when Phase 4 is brought on-line. The greatest daily leachate production volume is calculated to be 30,950 cu. ft., or approximately 231,500 gallons.

The period when the greatest monthly average leachate production will be observed is at stage VI when Phase 4 becomes operational and waste lifts within Phase 4 are thin. The addition of Phase 4 will add to the leachate production volumes already observed from Phase 3. The greatest monthly average leachate production volume is calculated to be 79,736 cu. ft., or approximately 596,400 gallons.

Project : WOLF-Ph 3 & 4 - Cross-Section 1

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 1

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.2. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.5. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P1668.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P1668.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P1668.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P1668.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P1668.VHP\I_386671.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P1668.VHP\O_386671.prt


TIME:  8:58    DATE:  8/28/2008


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

   TITLE:  Cross-Section-1

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


   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   6
      THICKNESS              =    15.24   CM
      POROSITY               =     0.4530 VOL/VOL
      FIELD CAPACITY         =     0.1900 VOL/VOL
      WILTING POINT          =     0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT =     0.2782 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720001612800E-03 CM/SEC
     NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =   304.80   CM
      POROSITY               =     0.6710 VOL/VOL
      FIELD CAPACITY         =     0.2920 VOL/VOL
      WILTING POINT          =     0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT =     0.2951 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0605 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 85.85
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 7.399 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 12.017 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.882 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 123.895 CM
TOTAL INITIAL WATER = 123.895 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50

START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 4
DRAIN #1: LATERAL DRAINAGE FROM LAYER 3 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.231	0.292	0.223	0.053	0.149	0.147
	0.092	0.175	0.124	0.141	0.173	0.102
STD. DEVIATIONS	0.333	0.710	0.354	0.062	0.202	0.194
	0.175	0.291	0.226	0.257	0.335	0.126
EVAPOTRANSPIRATION						
TOTALS	1.108	1.404	2.604	2.915	3.717	3.981

```
 STD. DEVIATIONS      0.242   0.295   0.412   0.981   0.910   1.206
                 1.138   1.000   0.894   0.281   0.137   0.151

LATERAL DRAINAGE COLLECTED FROM LAYER  3
-----------------------------------------
 TOTALS              2.0772  1.9972  2.1352  1.8917  1.4280  0.7054
                 0.6718  0.4910  0.9211  0.9151  1.5852  1.7890

 STD. DEVIATIONS      1.1174  1.0839  1.1921  1.3606  1.1941  0.7161
                 0.6841  0.6596  1.0410  0.8898  1.2430  1.2108

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  4
-------------------------------------
 AVERAGES            0.3160  0.3346  0.3248  0.2974  0.2172  0.1109
                 0.1022  0.0747  0.1448  0.1392  0.2492  0.2721

 STD. DEVIATIONS      0.1700  0.1832  0.1813  0.2139  0.1817  0.1126
                 0.1041  0.1003  0.1636  0.1354  0.1954  0.1842

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


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

  AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   30
-------------------------------------------------------------------------
                        INCHES        CU. FEET      PERCENT
                     ------------------  ------------  --------
PRECIPITATION              46.61   (  5.219)   169183.4    100.00

RUNOFF                    1.901   (  1.0504)    6901.45     4.079

EVAPOTRANSPIRATION          28.075   (  2.5945)   101909.82    60.236

LATERAL DRAINAGE COLLECTED    16.60782 (  4.46558)   60285.059   35.63297
 FROM LAYER  3

PERCOLATION/LEAKAGE THROUGH    0.00037 (  0.00009)       1.334     0.00079
 LAYER  5

AVERAGE HEAD ON TOP          0.215 (    0.058)
 OF LAYER  4

CHANGE IN WATER STORAGE       0.024   (  2.6560)       85.69     0.051

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



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

          PEAK DAILY VALUES FOR YEARS   1 THROUGH   30      and their dates (DDDYYYY)
 ------------------------------------------------------------------------
                                 (INCHES)     (CU. FT.)
                                 ---------  ------------
  PRECIPITATION                       3.66       13285.51042   3220012

  RUNOFF                             1.627       5906.95972    620018

  DRAINAGE COLLECTED FROM LAYER  3        0.33743      1224.85451    970002

  PERCOLATION/LEAKAGE THROUGH LAYER  5      0.000007        0.02376    970002

  AVERAGE HEAD ON TOP OF LAYER  4          1.591
```

MAXIMUM HEAD ON TOP OF LAYER 4 3.040

LOCATION OF MAXIMUM HEAD IN LAYER 3
(DISTANCE FROM DRAIN) 16.9 FEET

SNOW WATER 6.34 23023.4682 3590013

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3635

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0823

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.1442	0.1907
2	36.8336	0.3069
3	1.2598	0.0525
4	0.0000	0.0000
5	10.2480	0.4270

SNOW WATER 0.000

****
****

Project : WOLF-Ph 3 & 4 - Cross-Section 2

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 2

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam1

Top Slope Length: 0.0000
Bottom Slope Length: 0.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.2. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 0.0000
Bottom Slope Length: 0.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.6. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)

placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.7. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P1774.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P1774.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P1774.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P1774.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P1774.VHP\I_386798.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P1774.VHP\O_386798.prt


TIME:  9:13    DATE:  8/28/2008


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

  TITLE:  Cross-Section-2

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


   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   6
     THICKNESS              =    15.24   CM
     POROSITY               =    0.4530 VOL/VOL
     FIELD CAPACITY         =    0.1900 VOL/VOL
     WILTING POINT          =    0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =    0.2782 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  = 0.720000000000E-03 CM/SEC
   NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  18
     THICKNESS              =   304.80   CM
     POROSITY               =    0.6710 VOL/VOL
     FIELD CAPACITY         =    0.2920 VOL/VOL
     WILTING POINT          =    0.0770 VOL/VOL
     INITIAL SOIL WATER CONTENT =    0.2951 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2482 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3217 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0627 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND
A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 85.85
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 7.399 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 12.017 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.882 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 225.862 CM
TOTAL INITIAL WATER = 225.862 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 6
DRAIN #1: LATERAL DRAINAGE FROM LAYER 5 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 7

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.231	0.292	0.223	0.053	0.149	0.147
	0.092	0.175	0.124	0.141	0.173	0.102
STD. DEVIATIONS	0.334	0.710	0.354	0.062	0.202	0.194
	0.175	0.291	0.226	0.257	0.335	0.126
EVAPOTRANSPIRATION						
TOTALS	1.108	1.403	2.602	2.912	3.717	3.977
	3.679	3.396	2.105	1.298	1.056	0.822
STD. DEVIATIONS	0.242	0.295	0.414	0.973	0.909	1.200
	1.135	1.004	0.895	0.280	0.138	0.151
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	1.7954	1.8557	2.1977	2.0414	1.9800	1.4435
	0.8482	0.5364	0.5157	0.9743	0.9677	1.5449
STD. DEVIATIONS	1.0272	0.8724	1.1152	1.1950	1.2836	1.1525
	0.8335	0.6426	0.6281	1.0166	0.7812	1.1163
PERCOLATION/LEAKAGE THROUGH LAYER 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 6						
AVERAGES	0.2731	0.3102	0.3343	0.3209	0.3012	0.2269
	0.1290	0.0816	0.0811	0.1482	0.1521	0.2350
STD. DEVIATIONS	0.1563	0.1468	0.1696	0.1878	0.1953	0.1812
	0.1268	0.0978	0.0987	0.1546	0.1228	0.1698

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.61	(5.219)	169183.4	100.00
RUNOFF	1.901	(1.0504)	6901.83	4.080
EVAPOTRANSPIRATION	28.076	(2.5951)	101912.24	60.238

FROM LAYER 5

PERCOLATION/LEAKAGE THROUGH LAYER 7 0.00037 (0.00009) 1.353 0.00080

AVERAGE HEAD ON TOP OF LAYER 6 0.216 (0.054)

CHANGE IN WATER STORAGE -0.070 (2.6934) -254.86 -0.151

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.627	5906.87586	620018
DRAINAGE COLLECTED FROM LAYER 5	0.27009	980.41451	1210002
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000005	0.01941	1210002
AVERAGE HEAD ON TOP OF LAYER 6	1.274		
MAXIMUM HEAD ON TOP OF LAYER 6	2.450		
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	14.3 FEET		
SNOW WATER	6.34	23023.4682	3590013

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3635

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0823

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.1442	0.1907
2	36.8331	0.3069
3	1.4018	0.2336
4	35.7058	0.2975
5	1.4828	0.0618
6	0.0000	0.0000
7	10.2480	0.4270

SNOW WATER 0.000

****

Project : WOLF-Ph 3 & 4 - Cross-Section 3

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 3

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam2	35.5008	35.0008	0.5000
Municipal Waste (312 kg/cub.m)2	35.0008	25.0008	10.0000
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam2

Top Slope Length: 0.0000
Bottom Slope Length: 0.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.2. Layer. Municipal Waste (312 kg/cub.m)2

Top Slope Length: 0.0000
Bottom Slope Length: 0.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)

sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam1

Top Slope Length: 0.0000
Bottom Slope Length: 0.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 0.0000
Bottom Slope Length: 0.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.6. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)

field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.7. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.8. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.9. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 0.0000
Bottom Slope : 0.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P2060.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P2060.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P2060.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P2060.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P2060.VHP\I_387160.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P2060.VHP\O_387160.prt


TIME:  9:27    DATE:  8/28/2008


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

  TITLE:  Cross-Section-3

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


   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   6
     THICKNESS              =    15.24   CM
     POROSITY               =    0.4530 VOL/VOL
     FIELD CAPACITY         =    0.1900 VOL/VOL
     WILTING POINT          =    0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =    0.2782 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  = 0.720000000000E-03 CM/SEC
   NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  18
     THICKNESS              =   304.80   CM
     POROSITY               =    0.6710 VOL/VOL
     FIELD CAPACITY         =    0.2920 VOL/VOL
     WILTING POINT          =    0.0770 VOL/VOL
     INITIAL SOIL WATER CONTENT =    0.2951 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2482 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3217 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2719 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3024 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0542 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER

THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 85.85
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 7.399 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 12.017 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.882 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 321.670 CM
TOTAL INITIAL WATER = 321.670 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 9

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.231	0.292	0.223	0.053	0.149	0.147
	0.092	0.175	0.124	0.141	0.173	0.102
STD. DEVIATIONS	0.334	0.710	0.354	0.062	0.202	0.194
	0.175	0.291	0.226	0.257	0.335	0.126
EVAPOTRANSPIRATION						
TOTALS	1.108	1.403	2.602	2.912	3.717	3.977
	3.679	3.396	2.105	1.298	1.056	0.822
STD. DEVIATIONS	0.242	0.295	0.414	0.973	0.909	1.200
	1.135	1.004	0.895	0.280	0.138	0.151
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	1.4576	1.6653	1.9116	1.9878	2.1636	1.9766
	1.4965	0.9023	0.4941	0.5734	1.0094	1.0679
STD. DEVIATIONS	0.9686	0.8677	0.8268	0.9729	1.3050	1.1637
	1.1920	0.8524	0.6008	0.6219	0.8758	0.7295
PERCOLATION/LEAKAGE THROUGH LAYER 9						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.2217	0.2783	0.2908	0.3125	0.3291	0.3107
	0.2277	0.1373	0.0777	0.0872	0.1587	0.1625
STD. DEVIATIONS	0.1474	0.1452	0.1258	0.1529	0.1985	0.1829
	0.1813	0.1297	0.0944	0.0946	0.1377	0.1110

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.61	(5.219)	169183.4	100.00
RUNOFF	1.901	(1.0504)	6901.83	4.080
EVAPOTRANSPIRATION	28.076	(2.5951)	101912.24	60.238
LATERAL DRAINAGE COLLECTED FROM LAYER 7	16.70619	(3.91131)	60642.150	35.84404
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00038	(0.00008)	1.361	0.00080
AVERAGE HEAD ON TOP OF LAYER 8	0.216	(0.050)		
CHANGE IN WATER STORAGE	-0.076	(3.3153)	-274.23	-0.162

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.627	5906.87586	620018
DRAINAGE COLLECTED FROM LAYER 7	0.24832	901.37663	1800002
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000005	0.01798	1800002
AVERAGE HEAD ON TOP OF LAYER 8	1.171		
MAXIMUM HEAD ON TOP OF LAYER 8	2.258		
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	13.3 FEET		
SNOW WATER	6.34	23023.4682	3590013
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3635		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0823		

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

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

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.1442	0.1907
2	36.8331	0.3069
3	1.4018	0.2336
4	35.7058	0.2975
5	1.5998	0.2666
6	36.2043	0.3017
7	1.2382	0.0516
8	0.0000	0.0000
9	10.2480	0.4270

SNOW WATER 0.000

****
****

Project : WOLF-Ph 3 & 4 - Cross-Section 4

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 4

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam	15.0018	14.0018	1.0000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.2. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.5. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P2664.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P2664.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P2664.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P2664.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P2664.VHP\I_387903.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P2664.VHP\O_387903.prt


TIME: 16:39    DATE:  8/27/2008


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

   TITLE:  Cross-Section-4

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


    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   6
      THICKNESS              =    30.48   CM
      POROSITY               =    0.4530 VOL/VOL
      FIELD CAPACITY         =    0.1900 VOL/VOL
      WILTING POINT          =    0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2872 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720001612800E-03 CM/SEC
    NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
           FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =   304.80   CM
      POROSITY               =    0.6710 VOL/VOL
      FIELD CAPACITY         =    0.2920 VOL/VOL
      WILTING POINT          =    0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2921 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0673 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND
A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 86.55
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 6.492 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 10.356 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.943 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 127.919 CM
TOTAL INITIAL WATER = 127.919 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Haywood County NC

STATION LATITUDE = 35.59 DEGREES

START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 4
DRAIN #1: LATERAL DRAINAGE FROM LAYER 3 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 5

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.254	0.310	0.252	0.068	0.176	0.170
	0.108	0.204	0.142	0.163	0.198	0.122
STD. DEVIATIONS	0.349	0.718	0.372	0.076	0.228	0.215
	0.196	0.321	0.250	0.286	0.368	0.145
EVAPOTRANSPIRATION						
TOTALS	1.109	1.401	2.563	2.784	3.525	3.838

```
 STD. DEVIATIONS      0.241   0.292   0.452   0.971   0.846   1.152
                  1.088   1.001   0.879   0.292   0.148   0.152

LATERAL DRAINAGE COLLECTED FROM LAYER  3
-----------------------------------------
 TOTALS              2.0488  1.9712  2.0905  1.9480  1.5604  0.8724
                  0.8093  0.5670  1.0179  0.9815  1.5360  1.7569

 STD. DEVIATIONS      1.0912  1.0545  1.1603  1.3178  1.1953  0.7924
                  0.7064  0.6772  1.0241  0.8520  1.1939  1.1799

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  4
-------------------------------------
 AVERAGES            0.3117  0.3302  0.3180  0.3062  0.2374  0.1371
                  0.1231  0.0863  0.1600  0.1493  0.2414  0.2673

 STD. DEVIATIONS      0.1660  0.1783  0.1765  0.2071  0.1818  0.1246
                  0.1075  0.1030  0.1610  0.1296  0.1877  0.1795

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


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

   AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------
                          INCHES          CU. FEET      PERCENT
                       ------------------  -------------  ---------
PRECIPITATION              46.61   (  5.219)    169183.4    100.00

RUNOFF                   2.167   (  1.0958)     7866.32     4.650

EVAPOTRANSPIRATION          27.261   (  2.5666)    98956.73    58.491

LATERAL DRAINAGE COLLECTED    17.15980 (  4.40310)    62288.720   36.81729
 FROM LAYER  3

PERCOLATION/LEAKAGE THROUGH    0.00038 (  0.00009)       1.384     0.00082
 LAYER  5

AVERAGE HEAD ON TOP          0.222 (    0.057)
 OF LAYER  4

CHANGE IN WATER STORAGE       0.019   (  2.6373)       70.20     0.041

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



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

          PEAK DAILY VALUES FOR YEARS    1 THROUGH   30      and their dates (DDDYYYY)
 ------------------------------------------------------------------
                                 (INCHES)     (CU. FT.)
                                 ----------  -------------
  PRECIPITATION                       3.66       13285.51042   3220012

  RUNOFF                             1.632       5924.33551    620018

  DRAINAGE COLLECTED FROM LAYER  3        0.30961      1123.85705    980002

  PERCOLATION/LEAKAGE THROUGH LAYER  5      0.000006       0.02197    980002

  AVERAGE HEAD ON TOP OF LAYER  4          1.460
```

MAXIMUM HEAD ON TOP OF LAYER 4 2.797

LOCATION OF MAXIMUM HEAD IN LAYER 3
(DISTANCE FROM DRAIN) 15.9 FEET

SNOW WATER 6.34 23023.4682 3590013

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3365

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0850

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.6501	0.2208
2	36.7694	0.3064
3	1.2745	0.0531
4	0.0000	0.0000
5	10.2480	0.4270

SNOW WATER 0.000

****
****

Project : WOLF-Ph 3 & 4 - Cross-Section 5

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 5

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 1.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.2. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 1.0000
Bottom Slope Length: 1.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam

Top Slope Length: 1.0000
Bottom Slope Length: 1.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 1.0000
Bottom Slope Length: 1.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Gravel1

Top Slope Length: 1.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.6. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)

placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.7. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 1.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P2256.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P2256.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P2256.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P2256.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P2256.VHP\I_387414.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P2256.VHP\O_387414.prt


TIME:  16:43    DATE:  8/27/2008


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

  TITLE:  Cross-Section-5

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


   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   6
      THICKNESS              =    15.24   CM
      POROSITY               =    0.4530 VOL/VOL
      FIELD CAPACITY         =    0.1900 VOL/VOL
      WILTING POINT          =    0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT  =    0.2782 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720000000000E-03 CM/SEC
    NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =   304.80   CM
      POROSITY               =    0.6710 VOL/VOL
      FIELD CAPACITY         =    0.2920 VOL/VOL
      WILTING POINT          =    0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT  =    0.2951 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2482 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3217 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0627 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND
A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 85.85
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 7.399 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 12.017 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.882 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 225.862 CM
TOTAL INITIAL WATER = 225.862 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 6
DRAIN #1: LATERAL DRAINAGE FROM LAYER 5 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 7

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.231	0.292	0.223	0.053	0.149	0.147
	0.092	0.175	0.124	0.141	0.173	0.102
STD. DEVIATIONS	0.334	0.710	0.354	0.062	0.202	0.194
	0.175	0.291	0.226	0.257	0.335	0.126
EVAPOTRANSPIRATION						
TOTALS	1.108	1.403	2.602	2.912	3.717	3.977
	3.679	3.396	2.105	1.298	1.056	0.822
STD. DEVIATIONS	0.242	0.295	0.414	0.973	0.909	1.200
	1.135	1.004	0.895	0.280	0.138	0.151
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	1.7954	1.8557	2.1977	2.0414	1.9800	1.4435
	0.8482	0.5364	0.5157	0.9743	0.9677	1.5449
STD. DEVIATIONS	1.0272	0.8724	1.1152	1.1950	1.2836	1.1525
	0.8335	0.6426	0.6281	1.0166	0.7812	1.1163
PERCOLATION/LEAKAGE THROUGH LAYER 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 6						
AVERAGES	0.2731	0.3102	0.3343	0.3209	0.3012	0.2269
	0.1290	0.0816	0.0811	0.1482	0.1521	0.2350
STD. DEVIATIONS	0.1563	0.1468	0.1696	0.1878	0.1953	0.1812
	0.1268	0.0978	0.0987	0.1546	0.1228	0.1698

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.61	(5.219)	169183.4	100.00
RUNOFF	1.901	(1.0504)	6901.83	4.080
EVAPOTRANSPIRATION	28.076	(2.5951)	101912.24	60.238
LATERAL DRAINAGE COLLECTED	16.70086	(4.13439)	60622.786	35.83260

PERCOLATION/LEAKAGE THROUGH LAYER 7 0.00037 (0.00009) 1.353 0.00080

AVERAGE HEAD ON TOP OF LAYER 6 0.216 (0.054)

CHANGE IN WATER STORAGE -0.070 (2.6934) -254.86 -0.151

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.627	5906.87586	620018
DRAINAGE COLLECTED FROM LAYER 5	0.27009	980.41451	1210002
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000005	0.01941	1210002
AVERAGE HEAD ON TOP OF LAYER 6	1.274		
MAXIMUM HEAD ON TOP OF LAYER 6	2.450		
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	14.3 FEET		
SNOW WATER	6.34	23023.4682	3590013

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3635

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0823

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.1442	0.1907
2	36.8331	0.3069
3	1.4018	0.2336
4	35.7058	0.2975
5	1.4828	0.0618
6	0.0000	0.0000
7	10.2480	0.4270

SNOW WATER 0.000

****
****

Project : WOLF-Ph 3 & 4 - Cross-Section 6

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 6

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam1	25.0013	24.0013	1.0000
Municipal Waste (312 kg/cub.m)	24.0013	14.0013	10.0000
Sandy Loam	14.0018	13.5018	0.5000
Municipal Waste (312 kg/cub.m)1	13.5023	3.5023	10.0000
Gravel1	3.5023	1.5023	2.0000
High Density Polyethylene (HDPE)	1.5033	1.5000	0.0033
Barrier Soil	1.5000	-0.5000	2.0000

1.1. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.2. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 5.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.6. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)

placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.7. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 33.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P2558.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P2558.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P2558.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P2558.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P2558.VHP\I_387776.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P2558.VHP\O_387776.prt


TIME:  8: 2    DATE:  8/26/2008


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

  TITLE:  Cross-Section-6

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


   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   6
      THICKNESS              =    30.48   CM
      POROSITY               =    0.4530 VOL/VOL
      FIELD CAPACITY         =    0.1900 VOL/VOL
      WILTING POINT          =    0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2872 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720001612800E-03 CM/SEC
    NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =   304.80   CM
      POROSITY               =    0.6710 VOL/VOL
      FIELD CAPACITY         =    0.2920 VOL/VOL
      WILTING POINT          =    0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2921 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2729 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3206 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0590 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND
A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 86.55
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 6.492 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 10.356 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.943 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 229.297 CM
TOTAL INITIAL WATER = 229.297 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 6
DRAIN #1: LATERAL DRAINAGE FROM LAYER 5 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 7

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.254	0.310	0.252	0.068	0.176	0.170
	0.108	0.204	0.142	0.163	0.198	0.122
STD. DEVIATIONS	0.349	0.718	0.372	0.076	0.228	0.215
	0.196	0.321	0.250	0.286	0.368	0.145
EVAPOTRANSPIRATION						
TOTALS	1.109	1.401	2.563	2.784	3.525	3.838
	3.547	3.268	2.028	1.300	1.068	0.829
STD. DEVIATIONS	0.241	0.292	0.452	0.971	0.846	1.152
	1.088	1.001	0.879	0.292	0.148	0.152
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	1.7632	1.8239	2.1403	2.0230	2.0337	1.5733
	1.0292	0.6811	0.5947	1.0671	0.9978	1.5191
STD. DEVIATIONS	0.9844	0.8418	1.0773	1.1440	1.2305	1.1546
	0.9543	0.6530	0.6312	1.0112	0.7679	1.0664
PERCOLATION/LEAKAGE THROUGH LAYER 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 6						
AVERAGES	0.2682	0.3049	0.3256	0.3180	0.3094	0.2473
	0.1566	0.1036	0.0935	0.1623	0.1569	0.2311
STD. DEVIATIONS	0.1497	0.1416	0.1639	0.1798	0.1872	0.1815
	0.1452	0.0993	0.0992	0.1538	0.1207	0.1622

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.61	(5.219)	169183.4	100.00
RUNOFF	2.167	(1.0958)	7866.32	4.650
EVAPOTRANSPIRATION	27.261	(2.5666)	98956.73	58.491

FROM LAYER 5

PERCOLATION/LEAKAGE THROUGH LAYER 7 0.00039 (0.00008) 1.400 0.00083

AVERAGE HEAD ON TOP OF LAYER 6 0.223 (0.053)

CHANGE IN WATER STORAGE -0.067 (2.6392) -244.93 -0.145

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.632	5924.33551	620018
DRAINAGE COLLECTED FROM LAYER 5	0.27763	1007.77912	1210002
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000005	0.01990	1210002
AVERAGE HEAD ON TOP OF LAYER 6	1.309		
MAXIMUM HEAD ON TOP OF LAYER 6	2.517		
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	14.6 FEET		
SNOW WATER	6.34	23023.4682	3590013
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3365		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0850		

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.6501	0.2208
2	36.7694	0.3064
3	1.4103	0.2350
4	35.6999	0.2975
5	1.4724	0.0613
6	0.0000	0.0000
7	10.2480	0.4270

SNOW WATER 0.000

****

Project : WOLF-Ph 3 & 4 - Cross-Section 7

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 7

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam2	35.5008	35.0008	0.5000
Municipal Waste (312 kg/cub.m)2	35.0008	25.0008	10.0000
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.2. Layer. Municipal Waste (312 kg/cub.m)2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)

sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.6. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)

field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.7. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.8. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.9. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P4030.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P4030.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P4030.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P4030.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P4030.VHP\I_389021.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P4030.VHP\O_389021.prt


TIME:  17:19    DATE:  8/27/2008


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

   TITLE:  Cross-Section-7

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


   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   6
      THICKNESS              =    15.24   CM
      POROSITY               =     0.4530 VOL/VOL
      FIELD CAPACITY         =     0.1900 VOL/VOL
      WILTING POINT          =     0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT  =     0.2782 VOL/VOL
      EFFECTIVE SAT. HYD. COND.   = 0.720001612800E-03 CM/SEC
     NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =   304.80   CM
      POROSITY               =     0.6710 VOL/VOL
      FIELD CAPACITY         =     0.2920 VOL/VOL
      WILTING POINT          =     0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT  =     0.2951 VOL/VOL
      EFFECTIVE SAT. HYD. COND.   = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2483 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3217 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2719 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3024 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0542 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER

THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 85.85
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 7.399 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 12.017 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.882 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 321.671 CM
TOTAL INITIAL WATER = 321.671 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 9

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.231	0.292	0.223	0.053	0.149	0.147
	0.092	0.175	0.124	0.141	0.173	0.102
STD. DEVIATIONS	0.333	0.710	0.354	0.062	0.202	0.194
	0.175	0.291	0.226	0.257	0.335	0.126
EVAPOTRANSPIRATION						
TOTALS	1.108	1.404	2.604	2.915	3.717	3.981
	3.674	3.389	2.103	1.298	1.056	0.823
STD. DEVIATIONS	0.242	0.295	0.412	0.981	0.910	1.206
	1.138	1.000	0.894	0.281	0.137	0.151
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	1.4571	1.6649	1.9122	1.9851	2.1669	1.9724
	1.4932	0.9009	0.4938	0.5729	1.0159	1.0717
STD. DEVIATIONS	0.9668	0.8682	0.8260	0.9743	1.3011	1.1641
	1.1875	0.8566	0.5932	0.6180	0.8805	0.7359
PERCOLATION/LEAKAGE THROUGH LAYER 9						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.2217	0.2783	0.2909	0.3120	0.3296	0.3100
	0.2271	0.1370	0.0776	0.0872	0.1597	0.1630
STD. DEVIATIONS	0.1471	0.1453	0.1257	0.1532	0.1979	0.1830
	0.1806	0.1303	0.0932	0.0940	0.1384	0.1119

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.61	(5.219)	169183.4	100.00
RUNOFF	1.901	(1.0504)	6901.45	4.079
EVAPOTRANSPIRATION	28.075	(2.5945)	101909.82	60.236
LATERAL DRAINAGE COLLECTED FROM LAYER 7	16.70705	(3.92188)	60645.264	35.84588
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00038	(0.00008)	1.361	0.00080
AVERAGE HEAD ON TOP OF LAYER 8	0.216	(0.051)		
CHANGE IN WATER STORAGE	-0.076	(3.3180)	-274.54	-0.162

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.627	5906.95972	620018
DRAINAGE COLLECTED FROM LAYER 7	0.24754	898.56790	1800002
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000005	0.01793	1800002
AVERAGE HEAD ON TOP OF LAYER 8	1.167		
MAXIMUM HEAD ON TOP OF LAYER 8	2.251		
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	13.3 FEET		
SNOW WATER	6.34	23023.4682	3590013

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3635

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0823

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	1.1442	0.1907
2	36.8336	0.3069
3	1.4016	0.2336
4	35.7044	0.2975
5	1.5989	0.2665
6	36.2066	0.3017
7	1.2359	0.0515
8	0.0000	0.0000
9	10.2480	0.4270

SNOW WATER 0.000

****
****

Project : WOLF-Ph 3 & 4 - Cross-Section 8

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 8

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam2	35.5008	35.0008	0.5000
Municipal Waste (312 kg/cub.m)2	35.0008	25.0008	10.0000
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.2. Layer. Municipal Waste (312 kg/cub.m)2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)

sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.6. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)

field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.7. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.8. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.9. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P5216.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P5216.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P5216.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P5216.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P5216.VHP\I_390444.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P5216.VHP\O_390444.prt


TIME:  7:20    DATE:  8/28/2008


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

   TITLE:  Cross-Section-8

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


   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   6
      THICKNESS              =    15.24  CM
      POROSITY               =    0.4530 VOL/VOL
      FIELD CAPACITY         =    0.1900 VOL/VOL
      WILTING POINT          =    0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2778 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720001612800E-03 CM/SEC
     NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =   304.80  CM
      POROSITY               =    0.6710 VOL/VOL
      FIELD CAPACITY         =    0.2920 VOL/VOL
      WILTING POINT          =    0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2950 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2465 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3213 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2713 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3023 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0539 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER

THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 86.55
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 7.361 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 12.017 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.882 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 321.418 CM
TOTAL INITIAL WATER = 321.418 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 8
DRAIN #1: LATERAL DRAINAGE FROM LAYER 7 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 9

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.249	0.305	0.247	0.066	0.174	0.169
	0.107	0.201	0.140	0.160	0.194	0.118
STD. DEVIATIONS	0.345	0.713	0.368	0.074	0.226	0.214
	0.195	0.318	0.247	0.282	0.363	0.141
EVAPOTRANSPIRATION						
TOTALS	1.109	1.403	2.604	2.914	3.716	3.974
	3.675	3.392	2.099	1.297	1.056	0.823
STD. DEVIATIONS	0.243	0.293	0.412	0.979	0.904	1.204
	1.136	1.008	0.891	0.281	0.137	0.151
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	1.4482	1.6518	1.8954	1.9628	2.1516	1.9564
	1.4700	0.8534	0.4770	0.5705	0.9879	1.0610
STD. DEVIATIONS	0.9542	0.8503	0.8144	0.9671	1.2851	1.1656
	1.1837	0.8144	0.5985	0.6030	0.8622	0.7230
PERCOLATION/LEAKAGE THROUGH LAYER 9						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Project : WOLF - Ph 3 & 4 - Cross-Section 9

Description

Model : HELP

An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 9

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam5	67.5008	66.5008	1.0000
Municipal Waste (312 kg/cub.m)5	66.5008	56.5008	10.0000
Sandy Loam4	56.5008	56.0008	0.5000
Municipal Waste (312 kg/cub.m)4	56.0008	46.0008	10.0000
Sandy Loam3	46.0008	45.5008	0.5000
Municipal Waste (312 kg/cub.m)3	45.5008	35.5008	10.0000
Sandy Loam2	35.5008	35.0008	0.5000
Municipal Waste (312 kg/cub.m)2	35.0008	25.0008	10.0000
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam5

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.2. Layer. Municipal Waste (312 kg/cub.m)5

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000

Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam4

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.4. Layer. Municipal Waste (312 kg/cub.m)4

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Sandy Loam3

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.6. Layer. Municipal Waste (312 kg/cub.m)3

Top Slope Length: 400.0000

Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.7. Layer. Sandy Loam2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.8. Layer. Municipal Waste (312 kg/cub.m)2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.9. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.10. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.11. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.12. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.13. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.14. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.15. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P5322.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P5322.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P5322.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P5322.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P5322.VHP\I_390571.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P5322.VHP\O_390571.prt


TIME:  16:51    DATE:  8/27/2008


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

   TITLE:  Cross-Section-9

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


   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   6
     THICKNESS              =    30.48   CM
     POROSITY               =     0.4530 VOL/VOL
     FIELD CAPACITY         =     0.1900 VOL/VOL
     WILTING POINT          =     0.0850 VOL/VOL
     INITIAL SOIL WATER CONTENT =     0.2887 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  = 0.720000000000E-03 CM/SEC
   NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
             MATERIAL TEXTURE NUMBER  18
     THICKNESS              =   304.80   CM
     POROSITY               =     0.6710 VOL/VOL
     FIELD CAPACITY         =     0.2920 VOL/VOL
     WILTING POINT          =     0.0770 VOL/VOL
     INITIAL SOIL WATER CONTENT =     0.2922 VOL/VOL
     EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2733 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720000000000E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3211 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2631 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720000000000E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3017 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2523 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 8

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM

```
FIELD CAPACITY              =     0.2920 VOL/VOL
WILTING POINT               =     0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.100000000000E-02 CM/SEC


              LAYER  9
              --------

       TYPE 1 - VERTICAL PERCOLATION LAYER
         MATERIAL TEXTURE NUMBER   6
THICKNESS                   =    15.24   CM
POROSITY                    =     0.4530 VOL/VOL
FIELD CAPACITY              =     0.1900 VOL/VOL
WILTING POINT               =     0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.2161 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.720001612800E-03 CM/SEC


              LAYER 10
              --------

       TYPE 1 - VERTICAL PERCOLATION LAYER
         MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   304.80   CM
POROSITY                    =     0.6710 VOL/VOL
FIELD CAPACITY              =     0.2920 VOL/VOL
WILTING POINT               =     0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.100000000000E-02 CM/SEC


              LAYER 11
              --------

       TYPE 1 - VERTICAL PERCOLATION LAYER
         MATERIAL TEXTURE NUMBER   6
THICKNESS                   =    15.24   CM
POROSITY                    =     0.4530 VOL/VOL
FIELD CAPACITY              =     0.1900 VOL/VOL
WILTING POINT               =     0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.2495 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.720001612800E-03 CM/SEC


              LAYER 12
              --------

       TYPE 1 - VERTICAL PERCOLATION LAYER
         MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   304.80   CM
POROSITY                    =     0.6710 VOL/VOL
FIELD CAPACITY              =     0.2920 VOL/VOL
WILTING POINT               =     0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.2974 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.100000000000E-02 CM/SEC


              LAYER 13
              --------

       TYPE 2 - LATERAL DRAINAGE LAYER
         MATERIAL TEXTURE NUMBER  21
THICKNESS                   =    60.96   CM
POROSITY                    =     0.3970 VOL/VOL
FIELD CAPACITY              =     0.0320 VOL/VOL
WILTING POINT               =     0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT  =     0.0534 VOL/VOL
EFFECTIVE SAT. HYD. COND.   = 0.300000672000     CM/SEC
SLOPE                       =     5.00   PERCENT
DRAINAGE LENGTH             =    121.9    METERS
```

LAYER 14

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 15

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 85.85
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 6.512 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 10.356 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.943 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 604.752 CM
TOTAL INITIAL WATER = 604.752 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 14
DRAIN #1: LATERAL DRAINAGE FROM LAYER 13 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 15

****

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.236	0.297	0.227	0.054	0.151	0.148
	0.092	0.177	0.126	0.144	0.177	0.106
STD. DEVIATIONS	0.337	0.715	0.357	0.064	0.204	0.194
	0.175	0.294	0.229	0.261	0.340	0.130
EVAPOTRANSPIRATION						
TOTALS	1.109	1.400	2.564	2.786	3.530	3.831
	3.547	3.270	2.031	1.301	1.068	0.829
STD. DEVIATIONS	0.241	0.292	0.449	0.970	0.848	1.156
	1.086	1.001	0.881	0.291	0.148	0.153
LATERAL DRAINAGE COLLECTED FROM LAYER 13						
TOTALS	1.0061	0.9609	1.1876	1.4239	1.6339	1.6399
	1.5779	1.9137	1.9012	2.0319	1.2875	0.8930

0.7596 0.9983 1.1192 1.3217 1.1327 0.5707

PERCOLATION/LEAKAGE THROUGH LAYER 15

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 14

AVERAGES	0.1531	0.1606	0.1807	0.2238	0.2485	0.2578
	0.2400	0.2911	0.2989	0.3091	0.2024	0.1358
STD. DEVIATIONS	0.0791	0.0926	0.0812	0.0856	0.1155	0.0992
	0.1156	0.1519	0.1759	0.2011	0.1780	0.0868

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.61 (5.219)	169183.4	100.00
RUNOFF	1.933 (1.0596)	7016.69	4.147
EVAPOTRANSPIRATION	27.266 (2.5701)	98975.07	58.502
LATERAL DRAINAGE COLLECTED FROM LAYER 13	17.45737 (4.22441)	63368.887	37.45575
PERCOLATION/LEAKAGE THROUGH LAYER 15	0.00040 (0.00009)	1.439	0.00085
AVERAGE HEAD ON TOP OF LAYER 14	0.225 (0.055)		
CHANGE IN WATER STORAGE	-0.049 (4.0206)	-178.73	-0.106

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.632	5924.33336	620018
DRAINAGE COLLECTED FROM LAYER 13	0.21814	791.82666	3200002
PERCOLATION/LEAKAGE THROUGH LAYER 15	0.000004	0.01599	3200002
AVERAGE HEAD ON TOP OF LAYER 14	1.029		
MAXIMUM HEAD ON TOP OF LAYER 14	1.991		
LOCATION OF MAXIMUM HEAD IN LAYER 13 (DISTANCE FROM DRAIN)	12.0 FEET		
SNOW WATER	6.34	23023.4682	3590013
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3399		

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0850

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.6501	0.2208
2	36.7864	0.3066
3	1.3995	0.2332
4	35.7003	0.2975
5	1.5936	0.2656
6	36.1773	0.3015
7	1.4250	0.2375
8	35.0400	0.2920
9	1.3905	0.2318
10	36.0022	0.3000
11	1.6360	0.2727
12	35.2485	0.2937
13	1.3169	0.0549
14	0.0000	0.0000
15	10.2480	0.4270

SNOW WATER 0.000

****
****

Project : WOLF - Ph 3 & 4 - Cross-Section 10

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/17/2008

1. Profile. Cross-Section-niner1

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam5	67.5008	66.5008	1.0000
Municipal Waste (312 kg/cub.m)5	66.5008	56.5008	10.0000
Sandy Loam4	56.5008	56.0008	0.5000
Municipal Waste (312 kg/cub.m)4	56.0008	46.0008	10.0000
Sandy Loam3	46.0008	45.5008	0.5000
Municipal Waste (312 kg/cub.m)3	45.5008	35.5008	10.0000
Sandy Loam2	35.5008	35.0008	0.5000
Municipal Waste (312 kg/cub.m)2	35.0008	25.0008	10.0000
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam5

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.2. Layer. Municipal Waste (312 kg/cub.m)5

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000

Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam4

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. Municipal Waste (312 kg/cub.m)4

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Sandy Loam3

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.6. Layer. Municipal Waste (312 kg/cub.m)3

Top Slope Length: 400.0000

Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.7. Layer. Sandy Loam2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.8. Layer. Municipal Waste (312 kg/cub.m)2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.9. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.10. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.11. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.12. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.13. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 5.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.14. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.15. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 33.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P5428.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P5428.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P5428.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P5428.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P5428.VHP\I_390717.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P5428.VHP\O_390717.prt


TIME:  16:56    DATE:  8/27/2008


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

   TITLE:  Cross-Section-10

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


   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   6
      THICKNESS              =    30.48   CM
      POROSITY               =    0.4530 VOL/VOL
      FIELD CAPACITY         =    0.1900 VOL/VOL
      WILTING POINT          =    0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2872 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720001612800E-03 CM/SEC
    NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =   304.80   CM
      POROSITY               =    0.6710 VOL/VOL
      FIELD CAPACITY         =    0.2920 VOL/VOL
      WILTING POINT          =    0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2921 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2729 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3206 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2625 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3016 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2520 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 8

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM

FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2172 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2384 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18.
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2979 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 13

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0507 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 14

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 15

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND
A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 86.55
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 6.492 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 10.356 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.943 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 604.289 CM
TOTAL INITIAL WATER = 604.289 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 14
DRAIN #1: LATERAL DRAINAGE FROM LAYER 13 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 15

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.254	0.310	0.252	0.068	0.176	0.170
	0.108	0.204	0.142	0.163	0.198	0.122
STD. DEVIATIONS	0.349	0.718	0.372	0.076	0.228	0.215
	0.196	0.321	0.250	0.286	0.368	0.145
EVAPOTRANSPIRATION						
TOTALS	1.109	1.401	2.563	2.784	3.525	3.838
	3.547	3.268	2.028	1.300	1.068	0.829
STD. DEVIATIONS	0.241	0.292	0.452	0.971	0.846	1.152
	1.088	1.001	0.879	0.292	0.148	0.152
LATERAL DRAINAGE COLLECTED FROM LAYER 13						
TOTALS	1.0047	0.9510	1.1863	1.4136	1.6296	1.6034
	1.5679	1.8866	1.8723	2.0074	1.2496	0.8544
STD. DEVIATIONS	0.5285	0.5452	0.5196	0.5455	0.7650	0.6196
	0.7668	0.9841	1.1378	1.3080	1.1305	0.5133

PERCOLATION/LEAKAGE THROUGH LAYER 15

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 14

AVERAGES 0.1528 0.1589 0.1805 0.2222 0.2479 0.2520
0.2385 0.2870 0.2943 0.3054 0.1964 0.1300

STD. DEVIATIONS 0.0804 0.0907 0.0790 0.0857 0.1164 0.0974
0.1167 0.1497 0.1788 0.1990 0.1777 0.0781

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.61 (5.219)	169183.4	100.00
RUNOFF	2.167 (1.0958)	7866.32	4.650
EVAPOTRANSPIRATION	27.261 (2.5666)	98956.73	58.491
LATERAL DRAINAGE COLLECTED FROM LAYER 13	17.22682 (4.15850)	62532.003	36.96109
PERCOLATION/LEAKAGE THROUGH LAYER 15	0.00039 (0.00009)	1.421	0.00084
AVERAGE HEAD ON TOP OF LAYER 14	0.222 (0.054)		
CHANGE IN WATER STORAGE	-0.048 (3.9495)	-173.12	-0.102

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.632	5924.33551	620018
DRAINAGE COLLECTED FROM LAYER 13	0.21616	784.65919	3190002
PERCOLATION/LEAKAGE THROUGH LAYER 15	0.000004	0.01585	3190002
AVERAGE HEAD ON TOP OF LAYER 14	1.019		
MAXIMUM HEAD ON TOP OF LAYER 14	1.973		
LOCATION OF MAXIMUM HEAD IN LAYER 13 (DISTANCE FROM DRAIN)	11.9 FEET		
SNOW WATER	6.34	23023.4682	3590013
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3365		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0850		

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.6501	0.2208
2	36.7694	0.3064
3	1.4103	0.2350
4	35.6999	0.2975
5	1.5955	0.2659
6	36.1699	0.3014
7	1.4189	0.2365
8	35.0400	0.2920
9	1.3947	0.2325
10	35.7308	0.2978
11	1.6303	0.2717
12	35.4416	0.2953
13	1.2789	0.0533
14	0.0000	0.0000
15	10.2480	0.4270

SNOW WATER 0.000

****
****

Project : WOLF - Ph 3 & 4 - Cross-Section 11

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 11

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam8	129.0008	128.0008	1.0000
Municipal Waste (312 kg/cub.m)8	128.0008	88.0008	40.0000
Sandy Loam7	88.0008	87.5008	0.5000
Municipal Waste (312 kg/cub.m)7	87.5008	77.5008	10.0000
Sandy Loam6	77.5008	77.0008	0.5000
Municipal Waste (312 kg/cub.m)6	77.0008	67.0008	10.0000
Sandy Loam5	67.0008	66.5008	0.5000
Municipal Waste (312 kg/cub.m)5	66.5008	56.5008	10.0000
Sandy Loam4	56.5008	56.0008	0.5000
Municipal Waste (312 kg/cub.m)4	56.0008	46.0008	10.0000
Sandy Loam3	46.0008	45.5008	0.5000
Municipal Waste (312 kg/cub.m)3	45.5008	35.5008	10.0000
Sandy Loam2	35.5008	35.0008	0.5000
Municipal Waste (312 kg/cub.m)2	35.0008	25.0008	10.0000
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam8

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.2. Layer. Municipal Waste (312 kg/cub.m)8

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam7

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.4. Layer. Municipal Waste (312 kg/cub.m)7

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Sandy Loam6

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 0.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)

sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.6. Layer. Municipal Waste (312 kg/cub.m)6

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.7. Layer. Sandy Loam5

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.8. Layer. Municipal Waste (312 kg/cub.m)5

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.9. Layer. Sandy Loam4

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)

field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.10. Layer. Municipal Waste (312 kg/cub.m)4

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.11. Layer. Sandy Loam3

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.12. Layer. Municipal Waste (312 kg/cub.m)3

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.13. Layer. Sandy Loam2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.14. Layer. Municipal Waste (312 kg/cub.m)2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.15. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.16. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.17. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.18. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.19. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.20. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.21. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000

Bottom Slope : 5.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P5534.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P5534.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P5534.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P5534.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P5534.VHP\I_390844.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P5534.VHP\O_390844.prt


TIME: 16:58    DATE:  8/27/2008


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

  TITLE:  Cross-Section-11

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


   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   6
      THICKNESS              =    30.48   CM
      POROSITY               =    0.4530 VOL/VOL
      FIELD CAPACITY         =    0.1900 VOL/VOL
      WILTING POINT          =    0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2887 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720000000000E-03 CM/SEC
    NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =  1219.20   CM
      POROSITY               =    0.6710 VOL/VOL
      FIELD CAPACITY         =    0.2920 VOL/VOL
      WILTING POINT          =    0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2970 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2726 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720000000000E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3070 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2444 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720000000000E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2968 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2488 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 8

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM

FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2284 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2383 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2978 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2326 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 14

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 15

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2308 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 16

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 17

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2504 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 18

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 19

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0545 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 20

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 85.85
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 6.512 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 10.356 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.943 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 1123.703 CM
TOTAL INITIAL WATER = 1123.703 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 20
DRAIN #1: LATERAL DRAINAGE FROM LAYER 19 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 20

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.236	0.297	0.227	0.054	0.151	0.148
	0.092	0.177	0.126	0.144	0.177	0.106
STD. DEVIATIONS	0.337	0.715	0.357	0.064	0.204	0.194
	0.175	0.294	0.229	0.261	0.340	0.130
EVAPOTRANSPIRATION						
TOTALS	1.109	1.400	2.564	2.786	3.530	3.831
	3.547	3.270	2.031	1.301	1.068	0.829
STD. DEVIATIONS	0.241	0.292	0.449	0.970	0.848	1.156
	1.086	1.001	0.881	0.291	0.148	0.153
LATERAL DRAINAGE COLLECTED FROM LAYER 19						
TOTALS	1.0407	1.0081	1.2210	1.2741	1.2626	1.0791
	0.9983	1.0337	1.0084	1.1800	0.9810	1.0844
STD. DEVIATIONS	0.5612	0.6407	0.6965	0.7108	0.6918	0.5508
	0.3998	0.4474	0.3647	0.4650	0.5147	0.5322
PERCOLATION/LEAKAGE THROUGH LAYER 20						
TOTALS	0.3458	0.3224	0.3790	0.3888	0.3941	0.3595
	0.3492	0.3563	0.3439	0.3777	0.3313	0.3547
STD. DEVIATIONS	0.1114	0.1234	0.1315	0.1195	0.1128	0.0919
	0.0765	0.0806	0.0724	0.0871	0.0989	0.0982

DAILY AVERAGE HEAD ON TOP OF LAYER 20

AVERAGES	0.1583	0.1677	0.1857	0.2003	0.1921	0.1696
	0.1519	0.1573	0.1585	0.1795	0.1542	0.1650
STD. DEVIATIONS	0.0854	0.1049	0.1059	0.1117	0.1052	0.0866
	0.0608	0.0681	0.0573	0.0707	0.0809	0.0810

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	46.61	(5.219)	169183.4	100.00
RUNOFF	1.933	(1.0596)	7016.69	4.147
EVAPOTRANSPIRATION	27.266	(2.5701)	98975.07	58.502
LATERAL DRAINAGE COLLECTED FROM LAYER 19	13.17152	(3.31956)	47811.564	28.26021
PERCOLATION/LEAKAGE THROUGH LAYER 20	4.30264	(0.63946)	15618.232	9.23154
AVERAGE HEAD ON TOP OF LAYER 20	0.170	(0.043)		
CHANGE IN WATER STORAGE	-0.066	(5.7161)	-238.20	-0.141

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.632	5924.33336	620018
DRAINAGE COLLECTED FROM LAYER 19	0.13349	484.54449	1310003
PERCOLATION/LEAKAGE THROUGH LAYER 20	0.025138	91.25012	1310003
AVERAGE HEAD ON TOP OF LAYER 20	0.629		
MAXIMUM HEAD ON TOP OF LAYER 20	1.231		
LOCATION OF MAXIMUM HEAD IN LAYER 19 (DISTANCE FROM DRAIN)	8.0 FEET		
SNOW WATER	6.34	23023.4682	3590013

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3399

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0850

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.6501	0.2208
2	141.9788	0.2958
3	1.3861	0.2310
4	36.0633	0.3005
5	1.6126	0.2688
6	35.4848	0.2957
7	1.4576	0.2429
8	35.0400	0.2920
9	1.4394	0.2399
10	35.8558	0.2988
11	1.5925	0.2654
12	35.1668	0.2931
13	1.4901	0.2483
14	35.0400	0.2920
15	1.4187	0.2364
16	35.0400	0.2920
17	1.4202	0.2367
18	35.0400	0.2920
19	1.2577	0.0524
20	0.0000	0.0000

SNOW WATER 0.000

****
****

Project : WOLF-Ph 3 & 4 - Cross Section 12

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section - 12

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam8	129.0008	128.0008	1.0000
Municipal Waste (312 kg/cub.m)8	128.0008	88.0008	40.0000
Sandy Loam7	88.0008	87.5008	0.5000
Municipal Waste (312 kg/cub.m)7	87.5008	77.5008	10.0000
Sandy Loam6	77.5008	77.0008	0.5000
Municipal Waste (312 kg/cub.m)6	77.0008	67.0008	10.0000
Sandy Loam5	67.0008	66.5008	0.5000
Municipal Waste (312 kg/cub.m)5	66.5008	56.5008	10.0000
Sandy Loam4	56.5008	56.0008	0.5000
Municipal Waste (312 kg/cub.m)4	56.0008	46.0008	10.0000
Sandy Loam3	46.0008	45.5008	0.5000
Municipal Waste (312 kg/cub.m)3	45.5008	35.5008	10.0000
Sandy Loam2	35.5008	35.0008	0.5000
Municipal Waste (312 kg/cub.m)2	35.0008	25.0008	10.0000
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam8

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.2. Layer. Municipal Waste (312 kg/cub.m)8

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.3. Layer. Sandy Loam7

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.4. Layer. Municipal Waste (312 kg/cub.m)7

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Sandy Loam6

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)

sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.6. Layer. Municipal Waste (312 kg/cub.m)6

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.7. Layer. Sandy Loam5

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.8. Layer. Municipal Waste (312 kg/cub.m)5

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.9. Layer. Sandy Loam4

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)

field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.10. Layer. Municipal Waste (312 kg/cub.m)4

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.11. Layer. Sandy Loam3

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.12. Layer. Municipal Waste (312 kg/cub.m)3

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.13. Layer. Sandy Loam2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.14. Layer. Municipal Waste (312 kg/cub.m)2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.15. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.16. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.17. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.18. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.19. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.20. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000
Bottom Slope : 33.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.21. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 33.0000

Bottom Slope : 33.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P5640.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P5640.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P5640.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P5640.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P5640.VHP\I_390990.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P5640.VHP\O_390990.prt


TIME:  16:59    DATE:  8/27/2008


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

   TITLE:  Cross-Section-12

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


   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   6
      THICKNESS              =    30.48   CM
      POROSITY               =    0.4530 VOL/VOL
      FIELD CAPACITY         =    0.1900 VOL/VOL
      WILTING POINT          =    0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2872 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720001612800E-03 CM/SEC
     NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
      THICKNESS              =  1219.20   CM
      POROSITY               =    0.6710 VOL/VOL
      FIELD CAPACITY         =    0.2920 VOL/VOL
      WILTING POINT          =    0.0770 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.2969 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.100000000000E-02 CM/SEC
```

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2725 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.3067 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2435 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2968 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2495 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 8

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM

FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2281 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2368 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2961 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2460 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 14

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 15

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2474 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 16

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 17

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2497 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 18

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 19

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0513 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

LAYER 20

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 33.% AND A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 86.55
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 6.492 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 10.356 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.943 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 1123.155 CM
TOTAL INITIAL WATER = 1123.155 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 20
DRAIN #1: LATERAL DRAINAGE FROM LAYER 19 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 20

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	0.254	0.310	0.252	0.068	0.176	0.170
	0.108	0.204	0.142	0.163	0.198	0.122
STD. DEVIATIONS	0.349	0.718	0.372	0.076	0.228	0.215
	0.196	0.321	0.250	0.286	0.368	0.145
EVAPOTRANSPIRATION						
TOTALS	1.109	1.401	2.563	2.784	3.525	3.838
	3.547	3.268	2.028	1.300	1.068	0.829
STD. DEVIATIONS	0.241	0.292	0.452	0.971	0.846	1.152
	1.088	1.001	0.879	0.292	0.148	0.152
LATERAL DRAINAGE COLLECTED FROM LAYER 19						
TOTALS	1.0225	0.9857	1.1803	1.2767	1.2292	1.0395
	0.9786	1.0303	1.0467	1.1324	0.9695	1.0791
STD. DEVIATIONS	0.5749	0.5948	0.6829	0.6933	0.6755	0.5320
	0.4114	0.4138	0.3862	0.4606	0.5276	0.5712
PERCOLATION/LEAKAGE THROUGH LAYER 20						
TOTALS	0.3429	0.3196	0.3720	0.3897	0.3894	0.3523
	0.3457	0.3555	0.3514	0.3682	0.3288	0.3534
STD. DEVIATIONS	0.1136	0.1168	0.1286	0.1174	0.1095	0.0897
	0.0772	0.0769	0.0758	0.0872	0.1012	0.1050

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 20

AVERAGES	0.1555	0.1641	0.1796	0.2007	0.1870	0.1634
	0.1489	0.1567	0.1645	0.1723	0.1524	0.1642
STD. DEVIATIONS	0.0875	0.0976	0.1039	0.1090	0.1028	0.0836
	0.0626	0.0629	0.0607	0.0701	0.0829	0.0869

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.61 (5.219)	169183.4	100.00
RUNOFF	2.167 (1.0958)	7866.32	4.650
EVAPOTRANSPIRATION	27.261 (2.5666)	98956.73	58.491
LATERAL DRAINAGE COLLECTED FROM LAYER 19	12.97063 (3.27552)	47082.345	27.82918
PERCOLATION/LEAKAGE THROUGH LAYER 20	4.26878 (0.63296)	15495.332	9.15890
AVERAGE HEAD ON TOP OF LAYER 20	0.167 (0.042)		
CHANGE IN WATER STORAGE	-0.060 (5.6228)	-217.37	-0.128

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	3.66	13285.51042	3220012
RUNOFF	1.632	5924.33551	620018
DRAINAGE COLLECTED FROM LAYER 19	0.13853	502.86535	1310003
PERCOLATION/LEAKAGE THROUGH LAYER 20	0.025651	93.11206	1310003
AVERAGE HEAD ON TOP OF LAYER 20	0.653		
MAXIMUM HEAD ON TOP OF LAYER 20	1.276		
LOCATION OF MAXIMUM HEAD IN LAYER 19 (DISTANCE FROM DRAIN)	8.2 FEET		
SNOW WATER	6.34	23023.4682	3590013

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3365

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0850

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.6501	0.2208
2	141.9621	0.2958
3	1.3944	0.2324
4	36.0559	0.3005
5	1.6145	0.2691
6	35.4980	0.2958
7	1.4506	0.2418
8	35.0400	0.2920
9	1.4327	0.2388
10	35.7008	0.2975
11	1.5939	0.2656
12	35.2684	0.2939
13	1.4688	0.2448
14	35.0400	0.2920
15	1.4718	0.2453
16	35.0400	0.2920
17	1.4636	0.2439
18	35.0400	0.2920
19	1.2048	0.0502
20	0.0000	0.0000

SNOW WATER 0.000

****
****

Project : WOLF - Ph 3 & 4 - Cross-Section 13

Description

Model : HELP
An US EPA model for predicting landfill hydrologic processes and testing of effectiveness of landfill designs

Author : Senior Engineering Technician Dave Pasko

Client : Haywood County Solid Waste Director Stephen King

Location : Haywood County, NC

8/13/2008

1. Profile. Cross-Section-twelver1

Model Settings

[HELP] Case Settings

Parameter	Value	Units
Runoff Method	Model calculated	(-)
Initial Moisture Settings	Model calculated	(-)

[HELP] Surface Water Settings

Parameter	Value	Units
Runoff Area	100	(%%)
Vegetation Class	Bare soil	(-)

Profile Structure

Layer	Top (ft)	Bottom (ft)	Thickness (ft)
Sandy Loam8	131.0021	129.5021	1.5000
High Density Polyethylene (HDPE)1	129.5031	129.4998	0.0033
Clay, moderately compacted	129.4998	127.9998	1.5000
Sandy Loam5	128.0003	127.0003	1.0000
Municipal Waste (312 kg/cub.m)7	127.0003	67.0003	60.0000
Sandy Loam6	67.0008	66.5008	0.5000
Municipal Waste (312 kg/cub.m)5	66.5008	56.5008	10.0000
Sandy Loam4	56.5008	56.0008	0.5000
Municipal Waste (312 kg/cub.m)4	56.0008	46.0008	10.0000
Sandy Loam3	46.0008	45.5008	0.5000
Municipal Waste (312 kg/cub.m)3	45.5008	35.5008	10.0000
Sandy Loam2	35.5008	35.0008	0.5000
Municipal Waste (312 kg/cub.m)2	35.0008	25.0008	10.0000
Sandy Loam1	25.0013	24.5013	0.5000
Municipal Waste (312 kg/cub.m)	24.5013	14.5013	10.0000
Sandy Loam	14.5018	14.0018	0.5000
Municipal Waste (312 kg/cub.m)1	14.0023	4.0023	10.0000
Gravel1	4.0023	2.0023	2.0000
High Density Polyethylene (HDPE)	2.0033	2.0000	0.0033
Barrier Soil	2.0000	0.0000	2.0000

1.1. Layer. Sandy Loam8

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.2. Layer. High Density Polyethylene (HDPE)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	4	(-)
geotextile transmissivity	0	(cm2/sec)

1.3. Layer. Clay, moderately compacted

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.451	(vol/vol)
field capacity	0.419	(vol/vol)
wilting point	0.332	(vol/vol)
sat.hydr.conductivity	1.0E-5	(cm/sec)
subsurface inflow	0	(mm/year)

1.4. Layer. Sandy Loam5

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.5. Layer. Municipal Waste (312 kg/cub.m)7

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)

subsurface inflow	0	(mm/year)

1.6. Layer. Sandy Loam6

Top Slope Length: 400.0000
Bottom Slope Length: 0.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.453	(vol/vol)
field capacity	0.19	(vol/vol)
wilting point	0.085	(vol/vol)
sat.hydr.conductivity	7.2E-4	(cm/sec)
subsurface inflow	0	(mm/year)

1.7. Layer. Municipal Waste (312 kg/cub.m)5

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.8. Layer. Sandy Loam4

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.9. Layer. Municipal Waste (312 kg/cub.m)4

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)

wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.10. Layer. Sandy Loam3

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.11. Layer. Municipal Waste (312 kg/cub.m)3

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.12. Layer. Sandy Loam2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.13. Layer. Municipal Waste (312 kg/cub.m)2

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units

total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.14. Layer. Sandy Loam1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.15. Layer. Municipal Waste (312 kg/cub.m)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.16. Layer. Sandy Loam

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.4530	(vol/vol)
field capacity	0.1900	(vol/vol)
wilting point	0.0850	(vol/vol)
sat.hydr.conductivity	62.20800000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.17. Layer. Municipal Waste (312 kg/cub.m)1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Vertical Perc. Layer Parameters

Parameter	Value	Units
total porosity	0.671	(vol/vol)
field capacity	0.292	(vol/vol)
wilting point	0.077	(vol/vol)
sat.hydr.conductivity	0.001	(cm/sec)
subsurface inflow	0	(mm/year)

1.18. Layer. Gravel1

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Lateral Drainage Layer Parameters

Parameter	Value	Units
total porosity	0.3970	(vol/vol)
field capacity	0.0320	(vol/vol)
wilting point	0.0130	(vol/vol)
sat.hydr.conductivity	25920.0000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

1.19. Layer. High Density Polyethylene (HDPE)

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Geomembrane Liner Parameters

Parameter	Value	Units
sat.hydr.conductivity	2E-13	(cm/sec)
pinhole density	2	(#/ha)
installation defects	2	(#/ha)
placement quality	3	(-)
geotextile transmissivity	0	(cm2/sec)

1.20. Layer. Barrier Soil

Top Slope Length: 400.0000
Bottom Slope Length: 400.0000
Top Slope: 5.0000
Bottom Slope : 5.0000

[HELP] Barrier Soil Liner Parameters

Parameter	Value	Units
total porosity	0.4270	(vol/vol)
field capacity	0.4180	(vol/vol)
wilting point	0.3670	(vol/vol)
sat.hydr.conductivity	0.08640000000000	(cm/day)
subsurface inflow	0.0000	(cm/day)

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


PRECIPITATION DATA FILE:    C:\WHI\VHELP22\data\P5746.VHP\_weather1.dat

TEMPERATURE DATA FILE:      C:\WHI\VHELP22\data\P5746.VHP\_weather2.dat

SOLAR RADIATION DATA FILE:  C:\WHI\VHELP22\data\P5746.VHP\_weather3.dat

EVAPOTRANSPIRATION DATA:    C:\WHI\VHELP22\data\P5746.VHP\_weather4.dat

SOIL AND DESIGN DATA FILE:  C:\WHI\VHELP22\data\P5746.VHP\I_391117.inp

OUTPUT DATA FILE:           C:\WHI\VHELP22\data\P5746.VHP\O_391117.prt


TIME:  17: 1    DATE:  8/27/2008


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

   TITLE:  Cross-Section-13

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


   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   6
      THICKNESS              =    45.72   CM
      POROSITY               =    0.4530 VOL/VOL
      FIELD CAPACITY         =    0.1900 VOL/VOL
      WILTING POINT          =    0.0850 VOL/VOL
      INITIAL SOIL WATER CONTENT =    0.4530 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  = 0.720001612800E-03 CM/SEC
     NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
          FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                    LAYER  2
                    --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
      THICKNESS              =    0.10   CM
      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.  = 0.200000000000E-12 CM/SEC
      FML PINHOLE DENSITY        =    2.00   HOLES/HECTARE
      FML INSTALLATION DEFECTS   =    2.00   HOLES/HECTARE
      FML PLACEMENT QUALITY      = 4 - POOR
```

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 29
THICKNESS = 45.72 CM
POROSITY = 0.4510 VOL/VOL
FIELD CAPACITY = 0.4190 VOL/VOL
WILTING POINT = 0.3320 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4510 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-04 CM/SEC

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 30.48 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1908 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720000000000E-03 CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 1828.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1903 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720000000000E-03 CM/SEC

LAYER 7

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 8

MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1901 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 10

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1900 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 11

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 12

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1900 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL

LAYER 14

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1900 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 15

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 16

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 15.24 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1900 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC

LAYER 17

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18
THICKNESS = 304.80 CM
POROSITY = 0.6710 VOL/VOL
FIELD CAPACITY = 0.2920 VOL/VOL
WILTING POINT = 0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.2920 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-02 CM/SEC

LAYER 18

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21
THICKNESS = 60.96 CM
POROSITY = 0.3970 VOL/VOL
FIELD CAPACITY = 0.0320 VOL/VOL
WILTING POINT = 0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0412 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.300000672000 CM/SEC
SLOPE = 5.00 PERCENT
DRAINAGE LENGTH = 121.9 METERS

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35
THICKNESS = 0.10 CM
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. = 0.200000000000E-12 CM/SEC
FML PINHOLE DENSITY = 2.00 HOLES/HECTARE
FML INSTALLATION DEFECTS = 2.00 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 20

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16
THICKNESS = 60.96 CM
POROSITY = 0.4270 VOL/VOL
FIELD CAPACITY = 0.4180 VOL/VOL
WILTING POINT = 0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4270 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000224000E-05 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 122. METERS.

SCS RUNOFF CURVE NUMBER = 85.85
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 0.4047 HECTARES
EVAPORATIVE ZONE DEPTH = 22.9 CM
INITIAL WATER IN EVAPORATIVE ZONE = 10.356 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 10.356 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 1.943 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 1161.090 CM
TOTAL INITIAL WATER = 1161.090 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Haywood County NC

STATION LATITUDE = 35.59 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 96
END OF GROWING SEASON (JULIAN DATE) = 298
EVAPORATIVE ZONE DEPTH = 9.0 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 Haywood County NC

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

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

3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Haywood County NC

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 Haywood County NC
AND STATION LATITUDE = 35.66 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 2
DRAIN #1: LATERAL DRAINAGE FROM LAYER 1 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 3
HEAD #2: AVERAGE HEAD ON TOP OF LAYER 19
DRAIN #2: LATERAL DRAINAGE FROM LAYER 18 (RECIRCULATION AND COLLECTION)
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 20

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.23	3.59	4.54	4.01	4.58	4.72
	4.25	4.71	3.15	3.38	3.08	3.38
STD. DEVIATIONS	1.56	1.67	2.24	2.04	1.67	1.79
	1.85	2.23	1.87	2.13	1.94	1.75
RUNOFF						
TOTALS	2.222	2.217	2.214	1.160	0.729	0.293
	0.188	0.453	0.263	1.038	1.664	2.138
STD. DEVIATIONS	1.506	1.684	1.839	1.278	0.950	0.555
	0.510	0.981	0.436	1.795	1.469	1.357
EVAPOTRANSPIRATION						
TOTALS	1.101	1.403	2.673	3.204	4.964	4.694
	4.280	3.696	2.427	1.282	0.989	0.800
STD. DEVIATIONS	0.244	0.292	0.300	0.755	0.551	1.168
	1.315	1.025	0.996	0.213	0.102	0.139
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0529	0.0472	0.0514	0.0465	0.0428	0.0336
	0.0329	0.0333	0.0348	0.0429	0.0485	0.0525
STD. DEVIATIONS	0.0030	0.0036	0.0023	0.0038	0.0048	0.0060
	0.0052	0.0065	0.0070	0.0090	0.0074	0.0053
LATERAL DRAINAGE COLLECTED FROM LAYER 18						

```
 TOTALS              0.0464  0.0435  0.0477  0.0469  0.0486  0.0459
                  0.0478  0.0420  0.0359  0.0349  0.0367  0.0429

 STD. DEVIATIONS      0.0048  0.0025  0.0035  0.0018  0.0022  0.0039
                  0.0047  0.0054  0.0071  0.0054  0.0070  0.0065

PERCOLATION/LEAKAGE THROUGH LAYER 20
-----------------------------------
 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  2
-----------------------------------
 AVERAGES            17.0409  16.6798  16.5545  15.4209  13.6719  10.9481
                  10.3480  10.4749  11.3581  13.6863  16.1155  16.9077

 STD. DEVIATIONS      0.9959  1.3285  0.7786  1.3138  1.6043  2.0657
                  1.7323  2.1819  2.4203  3.0145  2.5698  1.7757

DAILY AVERAGE HEAD ON TOP OF LAYER 19
-----------------------------------
 AVERAGES             0.0071  0.0073  0.0073  0.0074  0.0074  0.0072
                  0.0073  0.0064  0.0056  0.0053  0.0058  0.0065

 STD. DEVIATIONS      0.0007  0.0004  0.0005  0.0003  0.0003  0.0006
                  0.0007  0.0008  0.0011  0.0008  0.0011  0.0010

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


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

  AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS   1 THROUGH   30
-------------------------------------------------------------------------------
                          INCHES        CU. FEET      PERCENT
                       ------------------  ------------  ---------
PRECIPITATION              46.61   (  5.219)    169183.4    100.00

RUNOFF                    14.579  (  4.4540)    52919.16    31.279

EVAPOTRANSPIRATION          31.514  (  2.8861)    114391.91    67.614

PERCOLATION/LEAKAGE THROUGH    0.51918 (  0.03115)     1884.569    1.11392
 LAYER  3

AVERAGE HEAD ON TOP          14.101 (    0.886)
 OF LAYER  2

LATERAL DRAINAGE COLLECTED     0.51912 (  0.02844)     1884.372    1.11380
 FROM LAYER 18

PERCOLATION/LEAKAGE THROUGH    0.00002 (  0.00000)       0.069    0.00004
 LAYER 20

AVERAGE HEAD ON TOP           0.007 (    0.000)
 OF LAYER 19

CHANGE IN WATER STORAGE       -0.003  (  1.1034)      -12.16    -0.007

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


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

          PEAK DAILY VALUES FOR YEARS   1 THROUGH   30      and their dates (DDDYYYY)
 ------------------------------------------------------------------------
                                 (INCHES)     (CU. FT.)
                                 ----------  -------------
  PRECIPITATION                        3.66       13285.51042   3220012
```

RUNOFF 3.332 12093.40760 3220012

PERCOLATION/LEAKAGE THROUGH LAYER 3 0.001798 6.52699 250001

AVERAGE HEAD ON TOP OF LAYER 2 18.000

DRAINAGE COLLECTED FROM LAYER 18 0.00239 8.68317 2160007

PERCOLATION/LEAKAGE THROUGH LAYER 20 0.000000 0.00029 2160007

AVERAGE HEAD ON TOP OF LAYER 19 0.011

MAXIMUM HEAD ON TOP OF LAYER 19 0.023

LOCATION OF MAXIMUM HEAD IN LAYER 18
(DISTANCE FROM DRAIN) 0.0 FEET

SNOW WATER 6.34 23023.4682 3590013

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4530

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0850

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

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

****

****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	8.0523	0.4474
2	0.0000	0.0000
3	8.1180	0.4510
4	2.2915	0.1910
5	210.2400	0.2920
6	1.1402	0.1900
7	35.0400	0.2920
8	1.1400	0.1900
9	35.0400	0.2920
10	1.1401	0.1900
11	35.0400	0.2920
12	1.1404	0.1901
13	35.0400	0.2920
14	1.1400	0.1900
15	35.0400	0.2920
16	1.1400	0.1900
17	35.0400	0.2920
18	0.9909	0.0413

20 10.2480 0.4270

SNOW WATER 0.000

****
****

Section 11 - LF Leachate Production Records

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT: HAYWOOD Co. - WOLF - PH 3 & 4
PROJECT NO.:
DESCRIPTION:
CALCULATED BY: CHECKED BY:
DATE: SHEET NO. OF

LEACHATE SUMMARY
WHITE OAK L.F.

F.Y.	LEACHATE REMOVED (GAL)	AVG GAL/MONTH	PEAK GAL/MONTH
July 1, '02 - June 30, '03 2003	3,354,000	280,000	468,000
'04	2,298,000	192,000	300,000
05'	3,882,000	323,500	486,000*
06'	2,616,000	218,000	276,000
07'	1,962,000	163,500	210,000
08'	1,722,000	143,500	294,000

NOTES:
1) LEACHATE IS REMOVED BY 6,000 GAL TANKER TRUCK
2) PEAK DAILY REMOVAL HAS BEEN 36,000 GAL/DAY
*3) FROM 9/14/04 - 10/14/04, 600,000 GAL REMOVED DURING TROPICAL STORMS FRANCIS & IVAN.
4) LOWEST MONTHLY TOTALS: 96,000 GAL/MONTH (SUMMER '0
5) LEACHATE IS FROM 21.5 AC OF LANDFILL AREA FOR ALL YEARS SHOWN.

HAYWOOD Co. — W.O.L.F.

Leachate Removal

F.Y. '03

Date	# Loads	Total Gallons		Gallons Since	Removed 7/1/2002		Loads Since	Removed 7/1/2002
1/10/2003	3	18000			1206000		201	
1/11/2003	2	12000			1218000		203	
1/13/2003	2	12000			1230000		205	
1/14/2003	3	18000			1248000		208	
1/15/2003	3	18000			1266000		211	
1/16/2003	4	24000			1290000		215	
1/18/2003	2	12000			1302000		217	
1/20/2003	3	18000			1320000		220	
1/21/2003	4	24000			1344000		224	
1/22/2003	4	24000			1368000		228	
1/28/2003	3	18000			1386000		231	
1/29/2003	1	6000			1392000		232	
1/30/2003	1	6000			1398000		233	
1/31/2003	3	18000			1416000		236	
2/3/2003	2	12000			1428000		238	
2/4/2003	3	18000			1446000		241	
2/5/2003	3	18000			1464000		244	
2/6/2003	2	12000			1476000		246	
2/7/2003	2	12000			1488000		248	
2/10/2003	2	12000			1500000		250	
2/11/2003	3	18000			1518000		253	
2/12/2003	3	18000			1536000		256	
2/13/2003	2	12000			1548000		258	
2/14/2003	2	12000			1560000		260	
2/17/2003	3	18000			1578000		263	
2/18/2003	3	18000			1596000		266	
2/19/2003	3	18000			1614000		269	
2/20/2003	3	18000			1632000		272	
2/21/2003	2	12000			1644000		274	
2/22/2003	2	12000			1656000		276	
2/24/2003	2	12000			1668000		278	
2/26/2003	1	6000			1674000		279	
2/27/2003	3	18000			1692000		282	
2/28/2003	3	18000			1710000		285	
3/1/2003	3	18000			1728000		288	
3/3/2003	3	18000			1746000		291	
3/4/2003	3	18000			1764000		294	
3/5/2003	3	18000			1782000		297	
3/6/2003	3	18000			1800000		300	
3/7/2003	3	18000			1818000		303	
3/8/2003	3	18000	3BR		1836000		306	
3/9/2003	3	18000	1BR		1854000		309	
3/10/2003	4	24000			1878000		313	
3/11/2003	4	24000			1902000		317	
3/12/2003	4	24000			1926000		321	
3/13/2003	4	24000			1950000		325	
3/14/2003	4	24000			1974000		329	
3/15/2003	4	24000			1998000		333	
3/17/2003	3	18000			2016000		336	
3/18/2003	3	18000	1BR		2034000		339	
3/19/2003	3	18000	3BR		2052000		342	
3/20/2003	3	18000	3BR		2070000		345	
Date	#	Total		Gallons	Removed		Loads	Removed

Leachate Removal

	Loads	Gallons		Since	7/1/2002		Since	7/1/2002
3/21/2003	3	18000	3BR		2088000		348	
3/22/2003	4	24000			2112000		352	
3/24/2003	3	18000	3BR		2130000		355	
3/25/2003	3	18000	3BR		2148000		358	
3/26/2001	3	18000	3BR		2166000		361	
3/27/2001	1	6000	1BR		2172000		362	
3/28/2001	2	12000	1BR		2184000		364	
3/29/2003	3	18000			2202000		367	
3/31/2003	2	12000	1BR	(26BR)	2214000	(343W)	369	
4/1/2003	1	6000	1BR		2220000		370	
4/2/2003	3	18000	3BR		2238000		373	
4/3/2003	3	18000	3BR	(33BR)	2256000		376	
4/4/2003	3	18000			2274000		379	
4/5/2003	3	18000			2292000		382	
4/7/2003	4	24000			2316000		386	
4/8/2003	1	6000			2322000		387	
4/9/2003	3	18000			2340000		390	
4/10/2003	2	12000			2352000		392	
4/11/2003	4	24000			2376000		396	
4/12/2003	1	6000			2382000	(364W)	397	
4/18/2003	3	18000	2BR		2400000		400	
4/19/2003	3	18000		(35BR)	2418000	(368W)	403	
4/21/2003	3	18000	(3BR)		2436000		406	
4/25/2003	3	18000	(3BR)	(41BR)	2454000		409	
4/26/2003	3	18000			2472000	(371W)	412	
4/28/2003	3	18000	(3BR)		2490000		415	
4/29/2003	2	12000	(2BR)		2502000		417	
4/30/2003	3	18000		(46BR)	2520000	(374W)	420	
5/1/2003	4	24000			2544000		424	
5/2/2003	3	18000			2562000		427	
5/3/2003	2	12000			2574000		429	
5/5/2003	1	6000			2580000		430	
5/6/2003	4	24000			2604000		434	
5/7/2003	3	18000	(3BR)		2622000		437	
5/8/2003	3	18000	(3BR)		2640000		440	
5/9/2002	3	18000	(3BR)		2658000		443	
5/10/2003	2	12000		(55BR)	2670000	(390W)	445	
5/12/2003	2	12000			2682000		447	
5/13/2003	3	18000	(3BR)		2700000		450	
5/14/2003	3	18000	(3BR)		2718000		453	
5/15/2003	3	18000	(2BR)		2736000		456	
5/16/2003	3	18000	(3BR)	(66BR)	2754000		459	
5/17/2003	2	12000			2766000	(395W)	461	
5/19/2003	2	12000	(2BR)		2778000		463	
5/20/2003	3	18000	(3BR)		2796000		466	
5/21/2003	1	6000	(1BR)		2802000		467	
5/22/2003	3	18000	(3BR)		2820000		470	
5/23/2003	3	18000	(3BR)	(78BR)	2838000		473	
5/24/2003	2	12000			2850000		475	
5/25/2003	1	6000			2856000	(398W)	476	
5/26/2003	2	12000	(1BR)		2868000		478	
5/27/2003	4	24000		(79BR)	2892000	(403W)	482	
Date	#	Total		Gallons	Removed		Loads	Removed
	Loads	Gallons		Since	7/1/2002		Since	7/1/2002

Leachate Removal

5/28/2003	4	24000	(4BR)		2916000		486	
5/29/2003	4	24000	(4BR)		2940000		490	
5/30/2003	4	24000	(3BR)	(90BR)	2964000		494	
5/31/2003	6	36000			3000000	(410W)	500	
6/1/2003	1	6000			3006000		501	
6/2/2003	4	24000	(4BR)		3030000		505	
6/3/2003	3	18000	(3BR)		3048000		508	
6/4/2003	4	24000	(4BR)		3072000		512	
6/5/2003	2	12000	(2BR)		3084000		514	
6/6/2003	3	18000	(3BR)	(106BR)	3102000	(411W)	517	
6/9/2003	2	12000	(1BR)		3114000		519	
6/10/2003	3	18000	(3BR)		3132000		522	
6/11/2003	3	18000	(3BR)		3150000		525	
6/12/2003	3	18000	(3BR)		3168000		528	
6/13/2003	3	18000	(3BR)		3186000		531	
6/14/2003	2	12000	(2BR)	(121BR)	3198000	(412W)	533	
6/16/2003	2	12000	(2BR)		3210000		535	
6/17/2003	3	18000	(3BR)		3228000		538	
6/18/2003	3	18000	(3BR)		3246000		541	
6/19/2003	3	18000	(3BR)		3264000		544	
6/20/2003	3	18000	(3BR)	(135BR)	3282000	(412W)	547	
6/23/2003	2	12000	(1BR)		3294000		549	
6/24/2003	2	12000	(1BR)		3306000		551	
6/25/2003	2	12000	(1BR)		3318000		553	
6/26/2003	1	6000	(1BR)		3324000		554	
6/27/2003	2	12000	(1BR)		3336000		556	
6/28/2003	1	6000	(1BR)		3342000		557	
6/30/2003	2	12000	(2BR)	(143BR)	3354000	(416W)	559	

Leachate Removal

F.Y. '04

Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2003	(W)	Since	7/1/2003
7/1/2003	3	18000	3		18000		3	
7/2/2003	3	18000	3		36000		6	
7/3/2003	2	12000	2		48000		8	
7/5/2003	3	18000	3	(11BR)	66000		11	
7/7/2003	3	18000	3		84000		14	
7/8/2003	1	6000	1		90000		15	
7/9/2003	1	6000	1		96000		16	
7/10/2003	1	6000	1	(17BR)	102000		17	
7/17/2003	2	12000	2		114000		19	
7/18/2003	2	12000	2	(21BR)	126000		21	
7/22/2003	1	6000	1		132000		22	
7/23/2003	1	6000	1		138000		23	
7/24/2003	1	6000	1	(24BR)	144000		24	
7/30/2003	1	6000	1		150000		25	
7/31/2003	2	12000	2	(27BR)	162000		27	
8/1/2003	2	12000	2		174000		29	
8/5/2003	2	12000	2		186000		31	
8/6/2003	2	12000	2		198000		33	
8/7/2003	1	6000	1		204000		34	
8/8/2003	1	6000	1	(35BR)	210000		35	
8/12/2003	2	12000	2		222000		37	
8/13/2003	1	6000	1		228000		38	
8/14/2003	1	6000	1		234000		39	
8/15/2003	1	6000	1	(40BR)	240000		40	
8/19/2003	1	6000	1		246000		41	
8/20/2003	1	6000	1		252000		42	
8/21/2003	1	6000	1	(43BR)	258000		43	
8/28/2003	1	6000	1	(44BR)	264000		44	
9/2/2003	1	6000	1		270000		45	
9/3/2003	1	6000	1		276000		46	
9/4/2003	1	6000	1		282000		47	
9/5/2003	1	6000	1	(48BR)	288000		48	
9/8/2003	1	6000	1		294000		49	
9/11/2003	1	6000	1	(50BR)	300000		50	
9/16/2003	1	6000	1		306000		51	
9/17/2003	1	6000	1	(52BR)	312000		52	
9/23/2003	1	6000	1		318000		53	
9/26/2003	1	6000	1	(54BR)	324000		54	
9/30/2003	2	12000	2		336000		56	
10/1/2003	1	6000	1	(57BR)	342000		57	
10/9/2003	1	6000	1	(58BR)	348000		58	
10/15/2003	1	6000	1		354000		59	
10/16/2003	1	6000	1		360000		60	
10/18/2003	1	6000	1	(61BR)	366000		61	
10/22/2003	2	12000	2		378000		63	
10/23/2003	1	6000	1	(64BR)	384000		64	
10/28/2003	1	6000	1		390000		65	
10/29/2003	2	12000	2	(67BR)	402000		67	
11/5/2003	1	6000	1		408000		68	
11/6/2003	1	6000	1		414000		69	
11/7/2003	1	6000	1	(70BR)	420000		70	
11/10/2003	1	6000	1	(71BR)	426000		71	
Date	#		Total	Gallons	Removed		Loads	Removed

Leachate Removal

	Loads	Gallons	(BR)	Since	7/1/2003	(W)	Since	7/1/2003
11/11/2003	2	12000	2		438000		73	
11/12/2003	2	12000	2		450000		75	
11/13/2003	2	12000	2		462000		77	
11/14/2003	2	12000	2	(79BR)	474000		79	
11/17/2003	2	12000	2		486000		81	
11/18/2003	2	12000	2		498000		83	
11/19/2003	2	12000	2		510000		85	
11/20/2003	2	12000	2		522000		87	
11/21/2003	1	6000	1	(88BR)	528000		88	
12/1/2003	1	6000	1		534000		89	
12/2/2003	3	18000	3		552000		92	
12/3/2003	3	18000	3		570000		95	
12/4/2003	1	6000	1	(96BR)	576000		96	
12/9/2003	2	12000	2		588000		98	
12/10/2003	1	6000	1		594000		99	
12/12/2003	1	6000	1	(100BR)	600000		100	
12/15/2003	1	6000	1		606000		101	
12/17/2003	1	6000	1		612000		102	
12/18/2003	1	6000	1		618000		103	
12/19/2003	1	6000	1	(104BR)	624000		104	
12/24/2003	1	6000	1		630000		105	
12/29/2003	1	6000	1		636000		106	
12/30/2003	1	6000	1		642000		107	
12/31/2003	1	6000	1	(108BR)	648000		108	
1/2/2004	2	12000	2		660000		110	
1/6/2004	2	12000	2		672000		112	
1/7/2004	2	12000	2		684000		114	
1/8/2004	2	12000	2		696000		116	
1/9/2004	2	12000	2	(118BR)	708000		118	
1/12/2004	3	18000	3		726000		121	
1/13/2004	3	18000	3		744000		124	
1/14/2004	3	18000	3		762000		127	
1/15/2004	3	18000	3		780000		130	
1/16/2004	3	18000	3	(133BR)	798000		133	
1/19/2004	3	18000	3		816000		136	
1/20/2004	3	18000	3		834000		139	
1/21/2004	3	18000	3		852000		142	
1/22/2004	3	18000	3		870000		145	
1/23/2004	3	18000	3	(148BR)	888000		148	
1/26/2004	2	12000	2		900000		150	
1/27/2004	3	18000	3		918000		153	
1/28/2004	2	12000	2		930000		155	
1/29/2004	2	12000	2		942000		157	
1/30/2004	3	18000	3	(160BR)	960000		160	
2/2/2004	2	12000	2		972000		162	
2/3/2004	4	24000	4		996000		166	
2/5/2004	3	18000	3		1014000		169	
2/6/2004	3	18000	3	(172BR)	1032000		172	
2/10/2004	3	18000	3		1050000		175	
2/11/2004	3	18000	3		1068000		178	
2/12/2004	2	12000	2		1080000		180	
2/13/2004	3	18000	3	(183BR)	1098000		183	
Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2003	(W)	Since	7/1/2003

Leachate Removal

2/18/2004	2	12000	2		1110000		185	
2/19/2004	3	18000	3		1128000		188	
2/20/2004	2	12000	2	(190BR)	1140000		190	
2/24/2004	3	18000	3		1158000		193	
2/25/2004	3	18000	3		1176000		196	
2/27/2004	3	18000	3	(199BR)	1194000		199	
3/2/2004	2	12000	2		1206000		201	
3/3/2004	2	12000	2		1218000		203	
3/4/2004	3	18000	3		1236000		206	
3/5/2004	2	12000	2	(208BR)	1248000		208	
3/8/2004	3	18000	3		1266000		211	
3/9/2004	2	12000	2		1278000		213	
3/10/2004	3	18000	3		1296000		216	
3/11/2004	3	18000	3		1314000		219	
3/12/2004	3	18000	3	(222BR)	1332000		222	
3/16/2004	3	18000	3		1350000		225	
3/17/2004	3	18000	3		1368000		228	
3/18/2004	3	18000	3		1386000		231	
3/19/2004	3	18000	3	(234BR)	1404000		234	
3/24/2004	2	12000	2		1416000		236	
3/25/2004	3	18000	3		1434000		239	
3/26/2004	3	18000	3	(242BR)	1452000		242	
3/30/2004	3	18000	3		1470000		245	
3/31/2004	3	18000	3		1488000		248	
4/1/2004	2	12000	2		1500000		250	
4/2/2004	3	18000	3	(253BR)	1518000		253	
4/6/2004	4	24000	4		1542000		257	
4/8/2004	2	12000	2		1554000		259	
4/9/2004	4	24000	4	(263BR)	1578000		263	
4/12/2004	4	24000	4		1602000		267	
4/13/2004	4	24000	4		1626000		271	
4/15/2004	3	18000	3	(274BR)	1644000		274	
4/19/2004	1	12000	1		1650000		275	
4/20/2004	3	18000	3		1668000		278	
4/22/2004	4	24000	4	(282BR)	1692000		282	
4/26/2004	2	12000	2		1704000		284	
4/27/2004	4	24000	4		1728000		288	
4/28/2004	4	24000	4		1752000		292	
4/29/2004	4	24000	4		1776000		296	
4/30/2004	3	18000	3	(299BR)	1794000		299	
5/6/2004	4	24000	4		1818000		303	
5/7/2004	4	24000	4	(307BR)	1842000		307	
5/11/2004	2	12000	2		1854000		309	
5/12/2004	2	12000	2		1866000		311	
5/13/2004	4	24000	4		1890000		315	
5/14/2004	4	24000	4	(319BR)	1914000		319	
5/18/2004	4	24000	4		1938000		323	
5/19/2004	4	24000	4		1962000		327	
5/20/2004	3	18000	3		1980000		330	
5/21/2004	4	24000	4	(334BR)	2004000		334	
5/25/2004	4	24000	4		2028000		338	
5/26/2004	3	18000	3	(341BR)	2046000		341	
Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2003	(W)	Since	7/1/2003
5/27/2004	4	24000	4		2070000		345	

Leachate Removal

5/28/2004	1	6000	1		2076000		346	
5/31/2004	1	6000	1	(347BR)	2082000		347	
6/1/2004	4	24000	4		2106000		351	
6/2/2004	2	12000	2		2118000		353	
6/3/2004	3	18000	3	(356BR)	2136000		356	
6/9/2004	2	12000	2		2148000		358	
6/10/2004	1	6000	1	(359BR)	2154000		359	
6/15/2004	4	24000	4		2178000		363	
6/16/2004	4	24000	4		2202000		367	
6/17/2004	2	12000	2		2214000		369	
6/18/2004	1	6000	1	(370BR)	2220000		370	
6/22/2004	4	24000	4		2244000		374	
6/23/2004	2	12000	2		2256000		376	
6/25/2004	4	24000	4	(380BR)	2280000		380	
6/30/2004	3	18000	3	(383BR)	2298000		383	

Leachate 2004-2005

F. Y. '05

Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2004	(W)	Since	7/1/2004
7/1/2004	2	12000	2		12000		2	
7/2/2004	1	6000	1	(3BR)	18000		3	
7/6/2004	1	6000	1		24000		4	
7/7/2004	1	6000	1		30000		5	
7/9/2004	1	6000	1	(6BR)	36000		6	
7/13/2004	1	6000	1		42000		7	
7/16/2004	1	6000	1	(8BR)	48000		8	
7/27/2004	2	12000			60000	2	10	
7/28/2004	2	12000			72000	2	12	
7/30/2004	3	18000			90000	3	15	
7/31/2004	1	6000		(8BR-8W)	96000	1	16	
8/2/2004	2	12000			108000	2	18	
8/3/2004	1	6000			114000	1	19	
8/4/2004	2	12000			126000	2	21	
8/5/2004	3	18000			144000	3	24	
8/6/2004	3	18000			162000	3	27	
8/7/2004	3	18000		(8BR-22W)	180000	3	30	
8/9/2004	3	18000			198000	3	33	
8/10/2004	3	18000			216000	3	36	
8/11/2004	3	18000			234000	3	39	
8/12/2004	3	18000			252000	3	42	
8/13/2004	1	6000		(8BR-35W)	258000	1	43	
8/16/2004	3	18000			276000	3	46	
8/17/2004	3	18000			294000	3	49	
8/18/2004	3	18000			312000	3	52	
8/19/2004	3	18000			330000	3	55	
8/20/2004	3	18000		(8BR-50W)	348000	3	58	
8/23/2004	1	6000			354000	1	59	
8/24/2004	2	12000			366000	2	61	
8/25/2004	3	18000			384000	3	64	
8/26/2004	1	6000			390000	2	65	
8/27/2004	2	12000		(8BR-59W)	402000	1	67	
8/30/2004	2	12000			414000	2	69	
8/31/2004	1	6000		(8BR-62W)	420000	1	70	
9/1/2004	2	12000			432000	2	72	
9/2/2004	2	12000			444000	2	74	
9/3/2004	2	12000		(8BR-68W)	456000	2	76	
9/7/2004	2	12000			468000	2	78	
9/9/2004	2	12000			480000	2	80	
9/10/2004	2	12000			492000	2	82	
9/11/2004	2	12000			504000	2	84	
9/13/2004	1	6000		(8BR-77W)	510000	1	85	
9/14/2004	3	18000			528000	3	88	
9/15/2004	3	18000			546000	3	91	
9/16/2004	2	12000			558000	2	93	
9/17/2004	2	12000			570000	2	95	
9/18/2004	4	24000			594000	4	99	
9/19/2004	5	30000		(8BR-96W)	624000	5	104	
9/20/2004	5	30000		(8BR-101W)	654000	5	109	
Date	#		Total	Gallons	Removed		Loads	Removed

Leachate 2004-2005

	Loads	Gallons	(BR)	Since	7/1/2004	(W)	Since	7/1/2004
9/21/2004	5	30000			684000	5	114	
9/22/2004	4	24000			708000	4	118	
9/23/2004	4	24000			732000	4	122	
9/24/2004	5	30000			762000	5	127	
9/25/2004	5	30000			792000	5	132	
9/26/2004	5	30000		(8BR-129W)	822000	5	137	
9/27/2004	2	12000			834000	2	139	
9/28/2004	4	24000			858000	4	143	
9/29/2004	4	24000			882000	4	147	
9/30/2004	4	24000		(8BR-143W)	906000	4	151	
10/1/2004	1	6000			912000	1	152	
10/2/2004	4	24000			936000	4	156	
10/3/2004	2	12000		(8BR-150W)	948000	2	158	
10/4/2004	3	18000			966000	3	161	
10/5/2004	3	18000			984000	3	164	
10/6/2004	4	24000			1008000	4	168	
10/7/2004	4	24000			1032000	4	172	
10/9/2004	3	18000		(8BR-167W)	1050000	3	175	
10/11/2004	2	12000			1062000	2	177	
10/12/2004	4	24000			1086000	4	181	
10/13/2004	4	24000			1110000	4	185	
10/14/2004	5	30000			1140000	5	190	
10/15/2004	2	12000			1152000	2	192	
10/16/2004	2	12000			1164000	2	194	
10/18/2004	2	12000		(8BR-188W)	1176000	2	196	
10/19/2004	4	24000			1200000	4	200	
10/20/2004	4	24000			1224000	4	204	
10/21/2004	4	24000			1248000	4	208	
10/22/2004	4	24000		(8BR-204W)	1272000	4	212	
10/25/2004	2	12000			1284000	2	214	
10/26/2004	2	12000			1296000	2	216	
10/27/2004	2	12000			1308000	2	218	
10/28/2004	4	24000			1332000	4	222	
10/29/2004	4	24000		(8BR-218W)	1356000	4	226	
11/1/2004	2	12000			1368000	2	228	
11/2/2004	4	24000			1392000	4	232	
11/3/2004	4	24000			1416000	4	236	
11/4/2004	4	24000			1440000	4	240	
11/5/2004	4	24000		(8BR-236W)	1464000	4	244	
11/8/2004	2	12000			1476000	2	246	
11/9/2004	3	18000			1494000	3	249	
11/10/2004	3	18000			1512000	3	252	
11/11/2004	3	18000			1530000	3	255	
11/12/2004	1	6000		(8BR-248W)	1536000	1	256	
11/16/2004	4	24000			1560000	4	260	
11/17/2004	3	18000			1578000	3	263	
11/18/2004	3	18000			1596000	3	266	
11/19/2004	3	18000			1614000	3	269	
11/22/2004	3	18000		(8BR-264W)	1632000	3	272	
Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2004	(W)	Since	7/1/2004

Leachate 2004-2005

11/23/2004	3	18000			1650000	3	275	
11/24/2004	3	18000			1668000	3	278	
11/26/2004	3	18000		(8BR-273)	1686000	3	281	
11/30/2004	3	18000			1704000	3	284	
12/1/2004	3	18000			1722000	3	287	
12/2/2004	3	18000			1740000	3	290	
12/3/2004	2	12000		(8BR-284W)	1752000	2	292	
12/6/2004	2	12000			1764000	2	294	
12/8/2004	3	18000			1782000	3	297	
12/9/2004	4	24000			1806000	4	301	
12/10/2004	2	12000		(8BR-295W)	1818000	2	303	
12/13/2004	4	24000			184200	4	307	
12/14/2004	1	6000			184800	1	308	
12/15/2004	2	12000			1860000	2	310	
12/16/2004	4	24000			1884000	4	314	
12/17/2004	2	12000			1896000	2	316	
12/18/2004	2	12000		(8BR-310W)	1908000	2	318	
12/21/2004	1	6000			1914000	1	319	
12/22/2004	4	24000			1938000	4	323	
12/23/2004	4	24000			1962000	4	327	
12/24/2004	4	24000		(8BR-323W)	1986000	4	331	
12/27/2004	4	24000			2010000	4	335	
12/28/2004	4	24000			2034000	4	339	
12/29/2004	4	24000			2058000	4	343	
12/30/2004	4	24000			2082000	4	347	
12/31/2004	1	6000		(8BR-340W)	2088000	1	348	
1/3/2005	1	6000			2094000	1	349	
1/4/2005	2	12000			2106000	2	351	
1/5/2005	4	24000			2130000	4	355	
1/6/2005	4	24000			2154000	4	359	
1/7/2005	2	12000		(8BR-353W)	2166000	2	361	
1/10/2005	3	18000			2184000	3	364	
1/11/2005	4	24000			2208000	4	368	
1/12/2005	4	24000			2232000	4	372	
1/13/2005	3	18000			2250000	3	375	
1/14/2005	4	24000		(8BR-371W)	2274000	4	379	
1/17/2005	1	6000			2280000	1	380	
1/18/2005	3	18000			2298000	3	383	
1/19/2005	4	24000			2322000	4	387	
1/20/2005	4	24000			2346000	4	391	
1/21/2005	3	18000		(8BR-386W)	2364000	3	394	
1/25/2005	2	12000			2376000	2	396	
1/26/2005	4	24000			2400000	4	400	
1/27/2005	3	18000		(8BR-395W)	2418000	3	403	
2/1/2005	3	18000			2436000	3	406	
2/2/2005	2	12000			2448000	2	408	
2/3/2005	4	24000			2474000	4	412	
2/4/2005	4	24000		(8BR-408W)	2496000	4	416	
2/8/2005	4	24000		(8BR-412W)	2520000	4	420	
Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2004	(W)	Since	7/1/2004
2/9/2005	4	24000			2544000	4	424	

Leachate 2004-2005

2/10/2005	3	18000			2562000	3	427	
2/11/2005	2	12000		(8BR-421W)	2574000	2	429	
2/15/2005	4	24000			2598000	4	433	
2/16/2005	4	24000			2622000	4	437	
2/17/2005	4	24000			2646000	4	441	
2/18/2005	4	24000		(8BR-437W)	2670000	4	445	
2/21/2005	1	6000			2676000	1	446	
2/22/2005	3	18000			2694000	3	449	
2/23/2005	3	18000			2712000	3	452	
2/24/2005	4	24000			2736000	4	456	
2/25/2005	4	24000		(8BR-452W)	2760000	4	460	
3/1/2005	1	6000			2766000	1	461	
3/2/2005	4	24000			2790000	4	465	
3/3/2005	4	24000			2814000	4	469	
3/4/2005	2	12000		(8BR-463W)	2826000	2	471	
3/7/2005	1	6000			2832000	1	472	
3/8/2005	2	12000			2844000	2	474	
3/9/2005	2	12000			2856000	2	476	
3/10/2005	4	24000			2880000	4	480	
3/11/2005	4	24000		(8BR-476W)	2904000	4	484	
3/14/2005	1	6000			2910000	1	485	
3/15/2005	4	24000			2934000	4	489	
3/16/2005	4	24000			2958000	4	493	
3/17/2005	4	24000			2982000	4	497	
3/18/2005	4	24000		(8BR-493W)	3006000	4	501	
3/23/2005	4	24000			3030000	4	505	
3/24/2005	4	24000			3054000	4	509	
3/25/2005	4	24000		(8BR_505W)	3078000	4	513	
3/28/2005	2	12000			3090000	2	515	
3/29/2005	3	18000			3108000	3	518	
3/30/2005	4	24000			3132000	4	522	
3/31/2005	4	24000			3156000	4	526	
4/1/2005	4	24000		(8BR-522W)	3180000	4	530	
4/4/2005	2	12000			3192000	2	532	
4/5/2005	4	24000			3216000	4	536	
4/6/2005	4	24000			3240000	4	540	
4/7/2005	4	24000			3264000	4	544	
4/8/2005	4	24000		(8BR-540W)	3288000	4	548	
4/13/2005	4	24000			3312000	4	552	
4/14/2005	3	18000			3330000	3	555	
4/15/2005	3	18000		(8BR-550W)	3348000	3	558	
4/18/2005	2	12000			3360000	2	560	
4/19/2005	2	12000			3372000	2	562	
4/20/2005	2	12000		(8BR-556W)	3384000	2	564	
4/25/2005	3	18000			3402000	3	567	
4/26/2005	4	24000			3426000	4	571	
4/28/2005	3	18000			3444000	3	574	
4/29/2005	3	18000		(8BR-569W)	3462000	3	577	
Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2004	(W)	Since	7/1/2004
5/2/2005	2	12000			3474000	2	579	
5/3/2005	2	12000			3486000	2	581	

Leachate 2004-2005

5/4/2005	2	12000			3498000	2	583	
5/5/2005	1	6000			3504000	1	584	
5/6/2005	2	12000		(8BR-578W)	3516000	2	586	
5/9/2005	3	18000			3534000	3	589	
5/10/2005	2	12000			3546000	2	591	
5/11/2005	2	12000			3558000	2	593	
5/12/2005	1	6000			3564000	1	594	
5/13/2005	1	6000		(8BR-587W)	3570000	1	595	
5/16/2005	2	12000			3582000	2	597	
5/17/2005	2	12000			3594000	2	599	
5/18/2005	1	6000			3600000	1	600	
5/19/2005	1	6000			3606000	1	601	
5/20/2005	2	12000		(8BR-595W)	3618000	2	603	
5/23/2005	2	12000			3630000	2	605	
5/24/2005	2	12000			3642000	2	607	
5/25/2005	1	6000			3648000	1	608	
5/26/2005	1	6000			3654000	1	609	
5/27/2005	1	6000		(8BR-602W)	3660000	1	610	
5/30/2005	3	18000			3678000	3	613	
5/31/2005	1	6000		(8BR-606W)	3684000	1	614	
6/1/2005	1	6000			3690000	1	615	
6/2/2005	2	12000			3702000	2	617	
6/3/2005	1	6000		(8BR-610W)	3708000	1	618	
6/6/2005	1	6000			3714000	1	619	
6/7/2005	2	12000			3726000	2	621	
6/8/2005	1	6000			3732000	1	622	
6/9/2005	2	12000		(8BR-616W)	3744000	2	624	
6/13/2005	2	12000			3756000	2	626	
6/14/2005	2	12000			3768000	2	628	
6/15/2005	1	6000			3774000	1	629	
6/16/2005	1	6000			3780000	1	630	
6/17/2005	1	6000			3786000	1	631	
6/18/2005	1	6000		(8BR-624W)	3792000	1	632	
6/20/2005	1	6000			3798000	1	633	
6/21/2005	2	12000			3810000	2	635	
6/22/2005	1	6000			3816000	1	636	
6/23/2005	2	12000			3828000	2	638	
6/24/2005	2	12000		(8BR-632W)	3840000	2	640	
6/27/2005	2	12000			3852000	2	642	
6/28/2005	2	12000			3864000	2	644	
6/29/2005	2	12000			3876000	2	646	
6/30/2005	1	6000		(8BR-639W)	3882000	1	647	

F. Y. '06

Leachate 2005-2006

Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2005	(W)	Since	7/1/2005
7/1/2005	1	6000			6000	1	1	
7/2/2005	1	6000		(2W)	12000	1	2	
7/5/2005	3	18000			30000	3	5	
7/6/2005	2	12000			42000	2	7	
7/7/2005	3	18000			60000	3	10	
7/8/2005	2	12000			72000	2	12	
7/9/2005	1	6000		(13W)	78000	1	13	
7/11/2005	1	6000			84000	1	14	
7/12/2005	1	6000			90000	1	15	
7/14/2005	2	12000			102000	2	17	
7/15/2005	2	12000		(19W)	114000	2	19	
7/18/2005	2	12000			126000	2	21	
7/19/2005	1	6000			132000	1	22	
7/20/2005	1	6000			138000	1	23	
7/21/2005	1	6000			144000	1	24	
7/22/2005	1	60000		(25W)	150000	1	25	
7/25/2005	2	12000			162000	2	27	
7/26/2005	2	12000			174000	2	29	
7/27/2005	2	12000			186000	2	31	
7/28/2005	2	12000		(33W)	198000	2	33	
8/15/2005	1	6000			204000	1	34	
8/16/2005	3	18000			222000	3	37	
8/17/2005	3	18000			240000	3	40	
8/18/2005	3	18000			258000	3	43	
8/19/2005	1	6000		(44W)	264000	1	44	
8/22/2005	2	12000			276000	2	46	
8/23/2005	1	6000			282000	1	47	
8/24/2005	1	6000			288000	1	48	
8/5/2005	1	6000			294000	1	49	
8/26/2005	1	6000		(50W)	300000	1	50	
8/29/2005	2	12000			312000	2	52	
8/30/2005	3	18000			330000	3	55	
8/31/2005	3	18000		(58W)	348000	3	58	
9/1/2005	1	6000			354000	1	59	
9/2/2005	1	6000			360000	1	60	
9/3/2005	1	6000		(61W)	366000	1	61	
9/6/2005	3	18000			384000	3	64	
9/7/2005	1	6000			390000	1	65	
9/8/2005	1	6000			396000	1	66	
9/9/2005	1	6000		(67W)	402000	1	67	
9/12/2005	1	6000			408000	1	68	
9/13/2005	1	6000			414000	1	69	
9/14/2005	1	6000			420000	1	70	
9/15/2005	1	6000			426000	1	71	
9/16/2005	2	12000		(73W)	438000	2	73	
9/19/2005	1	6000			444000	1	74	
9/20/2005	2	12000			456000	2	76	
9/21/2005	2	12000			468000	2	78	
9/22/2005	3	18000		(81W)	486000	3	81	
Date	#		Total	Gallons	Removed		Loads	Removed

Leachate 2005-2006

	Loads	Gallons	(BR)	Since	7/1/2005	(W)	Since	7/1/2005
9/23/2005	2	12000		(83W)	498000	2	83	
9/26/2005	2	12000			510000	2	85	
9/27/2005	2	12000			522000	2	87	
9/28/2005	1	6000			528000	1	88	
9/29/2005	1	6000			534000	1	89	
9/30/2005	1	6000		(90W)	540000	1	90	
10/3/2005	2	12000			552000	2	92	
10/4/2005	2	12000			564000	2	94	
10/5/2005	1	6000			570000	1	95	
10/6/2005	1	6000			576000	1	96	
10/7/2005	1	6000		(97W)	582000	1	97	
10/10/2005	2	12000			594000	2	99	
10/11/2005	1	6000			600000	1	100	
10/12/2005	2	12000			612000	2	102	
10/13/2005	1	6000			618000	1	103	
10/14/2005	1	6000		(104W)	624000	1	104	
10/17/2005	1	6000			630000	1	105	
10/18/2005	2	12000			642000	2	107	
10/19/2005	3	18000			660000	3	110	
10/21/2005	1	6000		(111W)	666000	1	111	
10/24/2005	2	12000			678000	2	113	
10/25/2005	1	6000			684000	1	114	
10/26/2005	2	12000			696000	2	116	
10/27/2005	2	12000			708000	2	118	
10/28/2005	1	6000			714000	1	119	
10/31/2005	1	6000		(120W)	720000	1	120	
11/1/2005	2	12000			732000	2	122	
11/2/2005	2	12000			744000	2	124	
11/3/2005	1	6000			750000	1	25	
11/4/2005	1	6000		(126W)	756000	1	126	
11/7/2005	2	12000			768000	2	128	
11/8/2005	1	6000			774000	1	129	
11/9/2005	1	6000			780000	1	130	
11/10/2005	1	6000			786000	1	131	
11/11/2005	1	6000		(132W)	792000	1	132	
11/14/2005	2	12000			804000	2	134	
11/15/2005	2	12000			816000	2	136	
11/16/2005	1	6000			822000	1	137	
11/17/2005	1	6000			828000	1	138	
11/18/2005	1	6000		(139W)	834000	1	139	
11/21/2005	1	6000			840000	1	140	
11/22/2005	2	12000			852000	2	142	
11/23/2005	2	12000		(144W)	864000	2	144	
11/28/2005	1	6000			870000	1	145	
11/29/2005	1	6000			876000	1	146	
11/30/2005	2	12000		(148W)	888000	2	148	
12/1/2005	2	12000			900000	1	150	
12/2/2005	1	6000			906000	1	151	
12/5/2005	2	12000		(153W)	918000	2	153	
Date	#		Total	Gallons	Removed		Loads	Removed
	Loads	Gallons	(BR)	Since	7/1/2005	(W)	Since	7/1/2005

Leachate 2005-2006

12/6/2005	2	12000			930000	2	155	
12/7/2005	1	6000			936000	1	156	
12/8/2005	1	6000			942000	1	157	
12/9/2005	3	18000		(160W)	960000	3	160	
12/12/2005	2	12000			972000	2	162	
12/13/2005	2	6000			984000	2	164	
12/14/2005	1	6000			990000	1	165	
12/15/2005	2	12000			1002000	2	167	
12/16/2005	1	6000		(168W)	1008000	1	168	
12/21/2005	2	12000			1020000	2	170	
12/22/2005	2	12000			1032000	2	172	
12/23/2005	2	12000			1044000	2	174	
12/28/2005	3	180000			1062000	3	177	
12/30/2005	3	18000		(180W)	1080000	3	180	
1/3/2006	2	12000			1092000	2	182	
1/4/2006	1	6000			1098000	1	183	
1/5/2006	2	12000			1110000	2	185	
1/6/2006	2	12000		(187W)	1122000	2	187	
1/9/2006	2	12000			1134000	2	189	
1/10/2006	1	6000			1140000	1	190	
1/11/2006	2	12000			1152000	2	192	
1/12/2006	1	6000			1158000	1	193	
1/13/2006	2	12000		(195W)	1170000	2	195	
1/16/2006	2	12000			1182000	2	197	
1/17/2006	3	18000			1200000	3	200	
1/18/2006	2	12000			1212000	2	202	
1/19/2006	2	12000			1224000	2	204	
1/20/2006	2	12000		(206W)	1236000	2	206	
1/23/2006	2	12000			1248000	2	208	
1/24/2006	2	12000			1260000	2	210	
1/25/2006	2	12000			1272000	2	212	
1/26/2006	2	12000			1284000	2	214	
1/27/2006	2	12000		(216W)	1296000	2	216	
1/30/2006	3	18000			1314000	3	219	
1/31/2006	3	18000			1332000	3	222	
2/1/2006	3	18000			1350000	3	225	
2/2/2006	3	18000			1368000	3	228	
2/3/2006	2	12000		(230W)	1380000	2	230	
2/6/2006	1	6000			1386000	1	231	
2/7/2006	3	18000			1404000	3	234	
2/8/2006	3	18000			1422000	3	237	
2/9/2006	2	12000			1434000	2	239	
2/10/2006	2	12000		(241W)	1446000	2	241	
2/13/2006	1	6000			1452000	1	242	
2/14/2006	3	18000			1470000	3	245	
2/15/2006	2	12000			1482000	2	247	
2/16/2006	3	18000			1500000	3	250	
2/17/2006	3	18000			1518000	3	253	
2/20/2006	2	12000		(255W)	1530000	2	255	
Date	#	Total		Gallons	Removed		Loads	Removed
	Loads	Gallons		Since	7/1/2005		Since	7/1/2005
2/21/2006	3	18000			1548000	3	258	

Leachate 2005-2006

2/22/2006	3	18000			1566000	3	261	
2/23/2006	3	18000			1584000	3	264	
2/24/2006	3	18000		(267W)	1602000	3	267	
2/27/2006	1	6000			1608000	1	268	
2/28/2006	3	18000		(271W)	1626000	3	271	
3/1/2006	2	12000			1638000	2	273	
3/2/2006	2	12000			1650000	2	275	
3/3/2006	2	12000		(277W)	1662000	2	277	
3/6/2006	2	12000			1674000	2	279	
3/7/2006	2	12000			1686000	2	281	
3/8/2006	2	12000			1698000	2	283	
3/9/2006	2	12000			1710000	2	285	
3/10/2006	2	12000		(287W)	1722000	2	287	
3/13/2006	2	12000			1734000	2	289	
3/14/2006	2	12000			1746000	2	291	
3/15/2006	1	6000			1752000	1	292	
3/16/2006	3	18000			1770000	3	295	
3/17/2006	1	6000		(296W)	1776000	1	296	
3/20/2006	2	12000			1788000	2	298	
3/21/2006	2	12000			1800000	2	300	
3/22/2006	2	12000			1812000	2	302	
3/23/2006	2	12000			1824000	2	304	
3/24/2006	2	12000		(306W)	1836000	2	306	
3/27/2006	2	12000			1848000	2	308	
3/28/2006	2	12000			186000	2	310	
3/29/2006	2	12000			1872000	2	312	
3/30/2006	2	12000			1884000	2	314	
3/31/2006	3	18000		(317W)	1902000	3	317	
4/4/2006	3	18000			1920000	3	320	
4/5/2006	2	12000			1932000	2	322	
4/6/2006	2	12000			1944000	2	324	
4/7/2006	2	12000		(326W)	1956000	2	326	
4/10/2006	2	12000			1968000	2	328	
4/11/2006	2	12000			1980000	2	330	
4/12/2006	2	12000			1992000	2	332	
4/13/2006	3	18000			2010000	3	335	
4/14/2006	2	12000		(337W)	2022000	2	337	
4/17/2006	1	6000			2028000	1	338	
4/18/2006	3	18000			2046000	3	341	
4/19/2006	3	18000		(344W)	2064000	3	344	
4/24/2006	1	6000			2070000	1	345	
4/25/2006	3	18000			2088000	3	348	
4/26/2006	3	18000			2106000	3	351	
4/27/2006	3	18000			2124000	3	354	
4/28/2006	2	12000		(356W)	2136000	2	356	
5/1/2006	2	12000			2148000	2	358	
5/2/2006	2	12000			2160000	2	360	
5/3/2006	1	6000			2166000	1	361	
5/5/2006	1	6000		(362W)	2172000	1	362	
5/8/2006	2	12000			2184000	2	364	
5/9/2006	3	18000			2202000	3	367	
5/10/2006	3	18000			2220000	3	370	

Leachate 2005-2006

5/11/2006	2	12000			2232000	2	372	
5/12/2006	2	12000		(374W)	2244000	2	374	
5/15/2006	2	12000			2256000	2	376	
5/16/2006	2	12000			2268000	2	378	
5/18/2006	2	12000			2280000	2	380	
5/19/2006	2	12000		(382W)	2292000	2	382	
5/22/2006	2	12000			2304000	2	384	
5/23/2006	1	6000			2310000	1	385	
5/24/2006	3	18000			2328000	3	388	
5/25/2006	3	18000			2346000	3	391	
5/26/2006	1	6000		(392W)	2352000	1	392	
5/29/2006	2	12000			2364000	2	394	
5/30/2006	3	18000			2382000	3	397	
5/31/2006	3	18000		(400W)	2400000	3	400	
6/1/2006	2	12000			2412000	2	402	
6/2/2006	3	18000		(405W)	2430000	3	405	
6/5/2006	1	6000			2436000	1	406	
6/8/2006	2	12000			2448000	2	408	
6/9/2006	3	18000		(411W)	2466000	3	411	
6/20/2006	3	18000			2484000	3	414	
6/21/2006	3	18000			2502000	3	417	
6/22/2006	3	18000			2520000	3	420	
6/23/2006	3	18000		(423W)	2538000	3	423	
6/26/2006	2	12000			2550000	2	425	
6/27/2006	3	18000			2568000	3	428	
6/28/2006	3	18000			2586000	3	431	
6/29/2006	3	18000			2604000	3	434	
6/30/2006	2	12000		(436W)	2616000	2	436	

Leachate 2006-2007

F.Y. '07

DATE	#	Total		Gallons	Removed		Loads	Removed
	Loads	Gallons		Since	7/1/2006		Since	7/1/2007
7/3/2006	1	6000			6000	1	1	
7/5/2006	2	12000			18000	2	3	
7/6/2006	1	6000			24000	1	4	
7/7/2006	3	18000		(7W)	42000	3	7	
7/11/2006	1	6000			48000	1	8	
7/17/2006	1	6000			54000	1	9	
7/18/2006	2	12000			66000	2	11	
7/20/2006	1	6000			72000	1	12	
7/21/2006	2	12000		(14W)	84000	2	14	
7/24/2006	1	6000			90000	1	15	
7/25/2006	1	6000			96000	1	16	
7/27/2006	3	18000			114000	3	19	
7/28/2006	3	18000		(22W)	132000	3	22	
7/31/2006	1	6000		(23W)	138000	1	23	
8/1/2006	1	6000			144000	1	24	
8/2/2006	1	6000		(25W)	150000	1	25	
8/7/2006	1	6000			156000	1	26	
8/8/2006	1	6000			162000	1	27	
8/9/2006	1	6000			168000	1	28	
8/10/2006	1	6000			174000	1	29	
8/11/2006	2	12000		(31W)	186000	2	31	
8/14/2006	1	6000			192000	1	32	
8/15/2006	1	6000			198000	1	33	
8/16/2006	1	6000			204000	1	34	
8/17/2006	1	6000			210000	1	35	
8/18/2006	1	6000		(36W)	216000	1	36	
8/21/2006	1	6000			222000	1	37	
8/22/2006	1	6000			228000	1	38	
8/24/2006	1	6000			234000	1	39	
8/25/2006	2	12000		(41W)	246000	2	41	
8/28/2006	1	6000			252000	1	42	
8/29/2006	2	12000			264000	2	44	
8/30/2006	1	6000			270000	1	45	
8/31/2006	2	12000		(47W)	282000	2	47	
9/1/2006	2	12000		(49W)	294000	2	49	
9/6/2006	1	6000			300000	1	50	
9/7/2006	2	12000			312000	2	52	
9/8/2006	2	12000			324000	2	54	
9/9/2006	1	6000		(55W)	330000	1	55	
9/11/2006	1	6000			336000	1	56	
9/12/2006	2	12000			348000	2	58	
9/13/2006	1	6000			354000	1	59	
9/14/2006	2	12000			366000	2	61	
9/15/2006	2	12000		(63W)	378000	2	63	
9/19/2006	3	18000			396000	3	66	
9/20/2006	3	18000			414000	3	69	
9/21/2006	3	18000			432000	3	72	
9/22/2006		12000		(74W)	444000	2	74	
9/25/2006	1	6000		(75W)	450000	1	75	
Date	#	Total		Gallons	Removed		Loads	Removed

Leachate 2006-2007

	Loads	Gallons		Since	7/1/2006		Since	7/1/2006
9/26/2006	1	6000			456000	1	76	
9/27/2006	1	6000			462000	1	77	
9/28/2006	1	6000			468000	1	78	
9/29/2006	2	12000		(80W)	480000	2	80	
10/2/2006	2	12000			492000	2	82	
10/3/2006	2	12000			504000	2	84	
10/6/2006	2	12000		(86W)	516000	2	86	
10/9/2006	2	12000			528000	2	88	
10/10/2006	2	12000			540000	2	90	
10/13/2006	1	6000		(91W)	546000	1	91	
10/16/2006	1	6000			552000	1	92	
10/17/2006	2	12000			564000	2	94	
10/18/2006	2	12000			576000	2	96	
10/19/2006	1	6000			582000	1	97	
10/20/2006	3	18000		(100W)	600000	3	100	
10/24/2006	1	6000			606000	1	101	
10/25/2006	3	18000			624000	3	104	
10/26/2006	2	12000			636000	2	106	
10/27/2006	2	12000		(108W)	648000	2	108	
10/31/2006	2	12000		(110W)	660000	2	110	
11/1/2006	2	12000		(112W)	672000	2	112	
11/6/2006	1	60000			678000	1	113	
11/7/2006	2	12000			690000	2	115	
11/8/2006	2	12000			702000	2	177	
11/9/2006	2	12000			714000	2	119	
11/10/2006	1	6000		(120W)	720000	1	120	
11/13/2006	1	6000			726000	1	121	
11/14/2006	2	12000			738000	2	123	
11/15/2006	2	12000			750000	2	125	
11/16/2006	2	12000			762000	2	127	
11/17/2006	2	12000		(129W)	774000	2	129	
11/20/2006	1	6000			780000	1	130	
11/21/2006	2	12000			792000	2	132	
11/22/2006	2	12000			804000	2	134	
11/24/2006	2	12000		(136W)	816000	2	136	
11/28/2006	1	6000			822000	1	137	
11/29/2006	1	6000			828000	1	138	
11/30/2006	1	6000		(139W)	834000	1	139	
12/1/2006	1	6000			840000	1	140	
12/4/2006	1	6000			846000	1	141	
12/5/2006	2	12000			858000	2	143	
12/7/2006	2	12000		(145W)	870000	2	145	
12/14/2006	2	12000			882000	2	147	
12/15/2006	2	12000		(149W)	894000	2	149	
12/19/2006	2	12000			906000	2	151	
12/20/2006	2	12000			918000	2	153	
12/21/2006	2	12000			930000	2	155	
12/22/2006	3	18000		(158W)	948000	3	158	
12/26/2006	3	18000			966000	3	161	
Date	#	Total		Gallons	Removed		Loads	Removed
	Loads	Gallons		Since	7/1/2006		Since	7/1/2006

Leachate 2006-2007

12/28/2006	2	12000			978000	2	163	
12/29/2006	2	12000		(165W)	990000	2	165	
1/2/2007	3	18000			1008000	3	168	
1/4/2007	1	6000			1014000	1	169	
1/5/2007	3	18000		(172W)	1032000	3	172	
1/8/2007	2	12000			1044000	2	174	
1/9/2007	2	12000			1056000	2	176	
1/10/2007	1	6000			1062000	1	177	
1/11/2007	1	6000			1068000	1	178	
1/12/2007	1	6000		(179W)	1074000	1	179	
1/15/2007	1	6000			1080000	1	180	
1/16/2007	1	6000			1086000	1	181	
1/17/2007	1	6000			1092000	1	182	
1/18/2007	2	12000			1104000	2	184	
1/19/2007	2	12000		(186W)	1116000	2	186	
1/23/2007	2	12000			1128000	2	188	
1/24/2007	2	12000			1140000	2	190	
1/25/2007	2	12000			1152000	2	192	
1/26/2007	2	12000		(194W)	1164000	2	194	
1/30/2007	2	12000			1176000	2	196	
1/31/2007	2	12000		(198W)	1188000	2	198	
2/1/2007	1	6000			1194000	1	199	
2/2/2007	2	12000		(201W)	1206000	2	201	
2/6/2007	1	6000			1212000	1	202	
2/13/2007	2	12000			1224000	2	204	
2/14/2007	3	18000		(207W)	1242000	3	207	
2/20/2007	2	12000			1254000	2	209	
2/23/2007	3	18000			1272000	3	212	
2/27/2007	2	12000			1284000	2	214	
2/28/2007	3	18000		(217W)	1302000	3	217	
3/1/2007	3	18000						
3/2/2007	3	18000						
3/8/2007	1	6000						
3/9/2007	3	18000						
3/15/2007	3	18000						
3/15/2007	3	18000						
3/16/2007	2	12000						
3/19/2007	1	6000						
3/20/2007	1	6000						
3/21/2007	2	12000						
3/22/2007	2	12000						
3/23/2007	1	6000						
3/24/2007	1	6000						
3/26/2007	1	6000						
3/27/2007	3	18000						
3/28/2007	2	12000						
3/30/2007	3	18000						

07 MAR – 210,000 –
APR – 180,000 – 30 LOADS
MAY – 174,000 – 29 LOADS
JUNE – 96,000 – 16 LOADS (6,000 gal/load)

Jul LOADS 49
Aug 40
Sept 15

Ext 07 – [illegible] 1,962,000

McGill ASSOCIATES
Engineering • Planning • Finance
McGill Associates, P.A. P.O. Box 2259, Asheville, NC 28802
55 Broad Street, Asheville, NC 28801 828-252-0575 Fax 828-252-2518

PROJECT:
PROJECT NO.:
DESCRIPTION:
CALCULATED BY: CHECKED BY:
DATE: SHEET NO. OF

DATA FROM HAYWOOD CO STAFF, AUGUST 2008
W.O.L.F.

LEACHATE TOTALS *6,000 GAL/LOAD
F.Y. 2008

	LEACHATE LOADS*	GALLONS
JULY	49	294,000
AUG	40	240,000
SEPT	15	90,000
OCT	13	78,000
NOV	21	126,000
DEC	21	126,000
JAN	8	48,000
FEB	20	120,000
MAR	27	162,000
APR	26	156,000
MAY	37	222,000
JUNE	10	60,000
	287 LOADS	1,722,000 GAL

MONTHLY AVG: 143,500 GAL

Section 12- 404/401 Permits
Stream/Wetlands Impact

CLEARWATER ENVIRONMENTAL CONSULTANTS, INC.

August 12, 2008

Ms. Lori Beckwith
US Army Corps of Engineers
Asheville Regulatory Field Office
151 Patton Avenue, Room 208
Asheville, North Carolina 28801-2638

Ms. Cyndi Karoly
401 Oversight/Express Review Permitting Unit
1650 Mail Service Center
Raleigh, North Carolina 27699

RE: White Oak Landfill
Haywood County, North Carolina

Ms. Beckwith and Ms. Karoly,

The attached Pre-Construction Notification (PCN) is being submitted on behalf of Haywood County represented by Mr. Mark Shumpert. Haywood County is currently undergoing expansion at the existing White Oak Landfill near Fines Creek in Haywood County, North Carolina and is seeking permit authorization under Nationwide Permit 39 for impacts associated with expansion of the landfill.

Should you have any questions regarding the attached PCN and supplemental information please do not hesitate to contact me at 828-698-9800. A copy of this package has been sent to Mr. David McHenry of the NC Wildlife Resources Commission and Mr. Bryan Tompkins of the US Fish and Wildlife Service for review. A copy of this application has also been submitted to Ms. Starr Silvis of the NC Division of Water Quality, Asheville Regional Office.

Respectfully,

Rebekah L. Newton
Project Biologist

R. Clement Riddle, P.W.S
Principal

Copy Furnished:
NC Wildlife Resources Commission – David McHenry
US Fish and Wildlife Service – Bryan Tompkins
NC Division of Water Quality, Asheville – Starr Silvis

718 Oakland Street
Hendersonville, North Carolina 28791
Phone: 828-698-9800 Fax: 828-698-9003
www.cwenv.com

Corps Submittal Cover Sheet

Please provide the following info:

1. Project Name: White Oak Landfill
2. Name of Property Owner/Applicant: Haywood County
3. Name of Consultant/Agent: ClearWater Environmental Consultants, Inc.
   *Agent authorization needs to be attached.
4. Related/previous Action ID numbers(s): none
5. Site Address: 3898 Fines Creek Road
6. Subdivision Name: N/A
7. City: Fines Creek
8. County: Haywood
9. Lat: 35.665597N Long: 83.002427W (Decimal Degrees *Please*)
10. Quadrangle Name: Cove Creek Gap
11. Waterway: UT Pigeon River
12. Watershed: Pigeon 06010106
13. Requested Action:
    - __X Nationwide Permit #_39_
    - ___ General Permit # ____
    - ___ Jurisdictional Determination Request
    - ___ Pre-Application Request

The following information will be completed by the Corps office:

AID:_____

_____Prepare File Folder _____ Assign number in ORM _____ Begin Date

Authorization: _____ Section 10 _____ Section 404

Project Description/Nature of Activity/Project Purpose:

_____

Site/Waters Name:_____
Keywords:_____

CLEARWATER ENVIRONMENTAL CONSULTANTS, INC.

Department of the Army
Wilmington District, Corps of Engineers
Attn: Ken Jolly, Chief Regulatory Division
PO Box 1890
Wilmington, North Carolina 28402-1890

-and-

NC Division of Water Quality
Attn: Cyndi Karoly
1650 Mail Service Center
Raleigh, NC 27699-1650

I, the current landowner/managing partner of the property identified below, hereby authorize ClearWater Environmental Consultants, Inc. (CEC) to act on my behalf as my agent during the processing of permits to impact Wetlands and Waters of the US that are regulated by the Clean Water Act and the Rivers and Harbors Act.

CEC is authorized to provide supplemental information needed for permit processing at the request of the USACE or DWQ.

Property Owner of Record: HAYWOOD COUNTY

Property Owner Address: 1233 N. Main St, Box 2
Waynesville, NC 28786

Phone number: 828-356-2114

Property Location: 3898 FINES CREEK Rd.

Owner/Managing partner Signature:

Date: 2/4/08

718 Oakland Street
Hendersonville, North Carolina 28791
Phone: 828-698-9800 Fax: 828-698-9003
www.cwenv.com

Office Use Only: Form Version March 05

USACE Action ID No. _____ **DWQ No.** _____

(If any particular item is not applicable to this project, please enter "Not Applicable" or "N/A".)

I. Processing

1. Check all of the approval(s) requested for this project:
   - ☒ Section 404 Permit
   - ☐ Section 10 Permit
   - ☒ 401 Water Quality Certification
   - ☐ Riparian or Watershed Buffer Rules
   - ☐ Isolated Wetland Permit from DWQ
   - ☐ Express 401 Water Quality Certification

2. Nationwide, Regional or General Permit Number(s) Requested: NW 39

3. If this notification is solely a courtesy copy because written approval for the 401 Certification is not required, check here: ☐

4. If payment into the North Carolina Ecosystem Enhancement Program (NCEEP) is proposed for mitigation of impacts, attach the acceptance letter from NCEEP, complete section VIII, and check here: ☒

5. If your project is located in any of North Carolina's twenty coastal counties (listed on page 4), and the project is within a North Carolina Division of Coastal Management Area of Environmental Concern (see the top of page 2 for further details), check here: ☐

II. Applicant Information

1. Owner/Applicant Information
   Name: Haywood County
   Mailing Address: Attn: Mark Shumpert
   1233 North Main Street, Box 2
   Waynesville, North Carolina 28786
   Telephone Number: 828-356-2114 Fax Number: _____
   E-mail Address: mshumpert@haywoodnc.net

2. Agent/Consultant Information (A signed and dated copy of the Agent Authorization letter must be attached if the Agent has signatory authority for the owner/applicant.)
   Name: R. Clement Riddle
   Company Affiliation: ClearWater Environmental Consultants, Inc.
   Mailing Address: 718 Oakland Street
   Hendersonville, North Carolina 28791
   Telephone Number: 828-698-9800 Fax Number: 828-698-9003
   E-mail Address: rebekah@cwenv.com

III. Project Information

Attach a **vicinity map** clearly showing the location of the property with respect to local landmarks such as towns, rivers, and roads. Also provide a detailed **site plan** showing property boundaries and development plans in relation to surrounding properties. Both the vicinity map and site plan must include a scale and north arrow. The specific footprints of all buildings, impervious surfaces, or other facilities must be included. If possible, the maps and plans should include the appropriate USGS Topographic Quad Map and NRCS Soil Survey with the property boundaries outlined. Plan drawings, or other maps may be included at the applicant's discretion, so long as the property is clearly defined. For administrative and distribution purposes, the USACE requires information to be submitted on sheets no larger than 11 by 17-inch format; however, DWQ may accept paperwork of any size. DWQ prefers full-size construction drawings rather than a sequential sheet version of the full-size plans. If full-size plans are reduced to a small scale such that the final version is illegible, the applicant will be informed that the project has been placed on hold until decipherable maps are provided.

1. Name of project: White Oak Landfill

2. T.I.P. Project Number or State Project Number (NCDOT Only): N/A

3. Property Identification Number (Tax PIN): 8712-11-8775

4. Location
   County: Haywood Nearest Town: Fines Creek
   Subdivision name (include phase/lot number): n/a
   Directions to site (include road numbers/names, landmarks, etc.): From Asheville, take I-40 West to Exit 15. Turn left at the end of the exit ramp and go under I-40. The entrance to the White Oak Landfill is on the right less than 1 mile from the interstate.

5. Site coordinates (For linear projects, such as a road or utility line, attach a sheet that separately lists the coordinates for each crossing of a distinct waterbody.)
   Decimal Degrees (6 digits minimum): 35.665597 °N 83.002427 °W

6. Property size (acres): Expansion area is approximately 8.5 acres. Entire landfill is approximately 105 acres.

7. Name of nearest receiving body of water: UT Pigeon River

8. River Basin: French Broad River Basin
   (Note – this must be one of North Carolina's seventeen designated major river basins. The River Basin map is available at http://h2o.enr.state.nc.us/admin/maps/.)

9. Describe the existing conditions on the site and general land use in the vicinity of the project at the time of this application: The project site is an existing landfill facility. The expansion area is at the toe of an existing landfill cell. There is a sediment basin with a dam and riser located in the expansion area, along with one wetland and a stream segment flowing out of the wetland. General land use in the vicinity is residential and agricultural.

10. Describe the overall project in detail, including the type of equipment to be used: The project includes the expansion of the existing landfill facility and construction of landfill cells 3 and 4. Typical construction and earth-moving equipment will be utilized on site.

11. Explain the purpose of the proposed work: The purpose of the proposed work is to provide additional area to dispose of waste within the existing landfill facility.

IV. Prior Project History

If jurisdictional determinations and/or permits have been requested and/or obtained for this project (including all prior phases of the same subdivision) in the past, please explain. Include the USACE Action ID Number, DWQ Project Number, application date, and date permits and certifications were issued or withdrawn. Provide photocopies of previously issued permits, certifications or other useful information. Describe previously approved wetland, stream and buffer impacts, along with associated mitigation (where applicable). If this is a NCDOT project, list and describe permits issued for prior segments of the same T.I.P. project, along with construction schedules. According to information provided by Haywood County, there is no prior project history for the site.

V. Future Project Plans

Are any future permit requests anticipated for this project? If so, describe the anticipated work, and provide justification for the exclusion of this work from the current application.
The landfill will continue to expand as waste disposal needs increase. To date there are no other expansions proposed that will require impacts to streams and wetlands. The proposed expansion will provide enough airspace to last approximately 10.5 years before additional expansion will be needed.

VI. Proposed Impacts to Waters of the United States/Waters of the State

It is the applicant's (or agent's) responsibility to determine, delineate and map all impacts to wetlands, open water, and stream channels associated with the project. Each impact must be listed separately in the tables below (e.g., culvert installation should be listed separately from riprap dissipater pads). Be sure to indicate if an impact is temporary. All proposed impacts, permanent and temporary, must be listed, and must be labeled and clearly identifiable on an accompanying site plan. All wetlands and waters, and all streams (intermittent and perennial) should be shown on a delineation map, whether or not impacts are proposed to these systems. Wetland and stream evaluation and delineation forms should be included as appropriate. Photographs may be included at the applicant's discretion. If this proposed impact is strictly for wetland or stream mitigation, list and describe the impact in Section VIII below. If additional space is needed for listing or description, please attach a separate sheet.

1. Provide a written description of the proposed impacts: The impacts associated with this project include the filling of 0.45 acres of wetland and culverting 185 linear feet of stream.

2. Individually list wetland impacts. Types of impacts include, but are not limited to mechanized clearing, grading, fill, excavation, flooding, ditching/drainage, etc. For dams, separately list impacts due to both structure and flooding.

Wetland Impact Site Number (indicate on map)	Type of Impact	Type of Wetland (e.g., forested, marsh, herbaceous, bog, etc.)	Located within 100-year Floodplain (yes/no)	Distance to Nearest Stream (linear feet)	Area of Impact (acres)
1	Fill	Herbaceous	No	0	0.45
Total Wetland Impact (acres)					0.45

3. List the total acreage (estimated) of all existing wetlands on the property: 0.45 acre

4. Individually list all intermittent and perennial stream impacts. Be sure to identify temporary impacts. Stream impacts include, but are not limited to placement of fill or culverts, dam construction, flooding, relocation, stabilization activities (e.g., cement walls, rip-rap, crib walls, gabions, etc.), excavation, ditching/straightening, etc. If stream relocation is proposed, plans and profiles showing the linear footprint for both the original and relocated streams must be included. To calculate acreage, multiply length X width, then divide by 43,560.

Stream Impact Number (indicate on map)	Stream Name	Type of Impact	Perennial or Intermittent?	Average Stream Width Before Impact	Impact Length (linear feet)	Area of Impact (acres)
2	UT Pigeon River	Culvert	P	3	185	0.0127
Total Stream Impact (by length and acreage)					185	0.0127

5. Individually list all open water impacts (including lakes, ponds, estuaries, sounds, Atlantic Ocean and any other water of the U.S.). Open water impacts include, but are not limited to fill, excavation, dredging, flooding, drainage, bulkheads, etc.

Open Water Impact Site Number (indicate on map)	Name of Waterbody (if applicable)	Type of Impact	Type of Waterbody (lake, pond, estuary, sound, bay, ocean, etc.)	Area of Impact (acres)
No OW impacts.				
Total Open Water Impact (acres)				0

6. List the cumulative impact to all Waters of the U.S. resulting from the project:

Stream Impact (acres):	0.0127
Wetland Impact (acres):	0.45
Open Water Impact (acres):	0
Total Impact to Waters of the U.S. (acres)	0.4627
Total Stream Impact (linear feet):	185

7. Isolated Waters
Do any isolated waters exist on the property? ☐ Yes ☒ No
Describe all impacts to isolated waters, and include the type of water (wetland or stream) and the size of the proposed impact (acres or linear feet). Please note that this section only applies to waters that have specifically been determined to be isolated by the USACE.

_____

_____

8. Pond Creation – **No pond creation.**
If construction of a pond is proposed, associated wetland and stream impacts should be included above in the wetland and stream impact sections. Also, the proposed pond should be described here and illustrated on any maps included with this application.
Pond to be created in (check all that apply): ☐ uplands ☐ stream ☐ wetlands
Describe the method of construction (e.g., dam/embankment, excavation, installation of draw-down valve or spillway, etc.):_____
Proposed use or purpose of pond (e.g., livestock watering, irrigation, aesthetic, trout pond, local stormwater requirement, etc.):_____
Current land use in the vicinity of the pond:_____
Size of watershed draining to pond:_____ Expected pond surface area:_____

VII. Impact Justification (Avoidance and Minimization)

Specifically describe measures taken to avoid the proposed impacts. It may be useful to provide information related to site constraints such as topography, building ordinances, accessibility, and financial viability of the project. The applicant may attach drawings of alternative, lower-impact site layouts, and explain why these design options were not feasible. Also discuss how impacts were minimized once the desired site plan was developed. If applicable, discuss construction techniques to be followed during construction to reduce impacts. There is approximately 250,000 cubic yards of airspace remaining at the existing landfill. It is estimated that this amount of airspace will provide for approximately 2 years worth of waste disposal area. Cell 3 will add approximately 675,000 cubic yards of airspace providing approximately 5.5 years worth of waste disposal area. Cell 4 will add an additional 650,000 cubic yards of airspace providing for an additional 5 years worth of waste disposal area. Landfill expansion is needed in order to contain waste generated by the citizens of western North Carolina.

VIII. Mitigation

DWQ - In accordance with 15A NCAC 2H .0500, mitigation may be required by the NC Division of Water Quality for projects involving greater than or equal to one acre of impacts to freshwater wetlands or greater than or equal to 150 linear feet of total impacts to perennial streams.

USACE – In accordance with the Final Notice of Issuance and Modification of Nationwide Permits, published in the Federal Register on January 15, 2002, mitigation will be required when necessary to ensure that adverse effects to the aquatic environment are minimal. Factors including size and type of proposed impact and function and relative value of the impacted aquatic resource will be considered in determining acceptability of appropriate and practicable mitigation as proposed. Examples of mitigation that may be appropriate and practicable include, but are not limited to: reducing the size of the project; establishing and maintaining wetland and/or upland vegetated buffers to protect open waters such as streams; and replacing losses of aquatic resource functions and values by creating, restoring, enhancing, or preserving similar functions and values, preferable in the same watershed.

If mitigation is required for this project, a copy of the mitigation plan must be attached in order for USACE or DWQ to consider the application complete for processing. Any application lacking a required mitigation plan or NCEEP concurrence shall be placed on hold as incomplete. An applicant may also choose to review the current guidelines for stream restoration in DWQ's Draft Technical Guide for Stream Work in North Carolina, available at http://h2o.enr.state.nc.us/ncwetlands/strmgide.html.

1. Provide a brief description of the proposed mitigation plan. The description should provide as much information as possible, including, but not limited to: site location (attach directions and/or map, if offsite), affected stream and river basin, type and amount (acreage/linear feet) of mitigation proposed (restoration, enhancement, creation, or preservation), a plan view, preservation mechanism (e.g., deed restrictions, conservation easement, etc.), and a description of the current site conditions and proposed method of construction. Please attach a separate sheet if more space is needed.
   Mitigation will be in the form of payment into the NC Ecosystem Enhancement Program (EEP). Haywood County will purchase 185 linear feet of stream credits to offset stream impacts at the site at a ratio of 1:1. The EEP acceptance letter is attached for review (Appendix A). Because of very poor quality, the wetland on site was determined to be non-mitigable. No wetland mitigation is proposed for this project.

2. Mitigation may also be made by payment into the North Carolina Ecosystem Enhancement Program (NCEEP). Please note it is the applicant's responsibility to contact the NCEEP at (919) 715-0476 to determine availability, and written approval from the NCEEP indicating that they are will to accept payment for the mitigation must be attached to this form. For additional information regarding the application process for the NCEEP, check the NCEEP website at http://h2o.enr.state.nc.us/wrp/index.htm. If use of the NCEEP is proposed, please check the appropriate box on page five and provide the following information:

   Amount of stream mitigation requested (linear feet): 185
   Amount of buffer mitigation requested (square feet): 0
   Amount of Riparian wetland mitigation requested (acres): 0
   Amount of Non-riparian wetland mitigation requested (acres): 0
   Amount of Coastal wetland mitigation requested (acres): 0

IX. Environmental Documentation (required by DWQ)

1. Does the project involve an expenditure of public (federal/state/local) funds or the use of public (federal/state) land? Yes ☒ No ☐

2. If yes, does the project require preparation of an environmental document pursuant to the requirements of the National or North Carolina Environmental Policy Act (NEPA/SEPA)? Note: If you are not sure whether a NEPA/SEPA document is required, call the SEPA coordinator at (919) 733-5083 to review current thresholds for environmental documentation. Yes ☐ No ☒

3. If yes, has the document review been finalized by the State Clearinghouse? If so, please attach a copy of the NEPA or SEPA final approval letter. Yes ☐ No ☒

X. Proposed Impacts on Riparian and Watershed Buffers (required by DWQ)

It is the applicant's (or agent's) responsibility to determine, delineate and map all impacts to required state and local buffers associated with the project. The applicant must also provide

justification for these impacts in Section VII above. All proposed impacts must be listed herein, and must be clearly identifiable on the accompanying site plan. All buffers must be shown on a map, whether or not impacts are proposed to the buffers. Correspondence from the DWQ Regional Office may be included as appropriate. Photographs may also be included at the applicant's discretion.

1. Will the project impact protected riparian buffers identified within 15A NCAC 2B .0233 (Neuse), 15A NCAC 2B .0259 (Tar-Pamlico), 15A NCAC 02B .0243 (Catawba) 15A NCAC 2B .0250 (Randleman Rules and Water Supply Buffer Requirements), or other (please identify_____)? Yes ☐ No ☒

2. If "yes", identify the square feet and acreage of impact to each zone of the riparian buffers. If buffer mitigation is required calculate the required amount of mitigation by applying the buffer multipliers.

Zone*	Impact (square feet)	Multiplier	Required Mitigation
1		3 (2 for Catawba)	
2		1.5	
Total			

* Zone 1 extends out 30 feet perpendicular from the top of the near bank of channel; Zone 2 extends an additional 20 feet from the edge of Zone 1.

3. If buffer mitigation is required, please discuss what type of mitigation is proposed (i.e., Donation of Property, Riparian Buffer Restoration / Enhancement, or Payment into the Riparian Buffer Restoration Fund). Please attach all appropriate information as identified within 15A NCAC 2B .0242 or .0244, or .0260. _____

XI. Stormwater (required by DWQ)

Describe impervious acreage (existing and proposed) versus total acreage on the site. Discuss stormwater controls proposed in order to protect surface waters and wetlands downstream from the property. If percent impervious surface exceeds 20%, please provide calculations demonstrating total proposed impervious level. The White Oak Landfill currently has and is operating under a NPDES stormwater permit; permit number NCG120047.

XII. Sewage Disposal (required by DWQ)

Clearly detail the ultimate treatment methods and disposition (non-discharge or discharge) of wastewater generated from the proposed project, or available capacity of the subject facility. Wastewater will not be generated by the proposed landfill expansion.

XIII. Violations (required by DWQ)

Is this site in violation of DWQ Wetland Rules (15A NCAC 2H .0500) or any Buffer Rules?
Yes ☐ No ☒

Is this an after-the-fact permit application? Yes ☐ No ☒

XIV. Cumulative Impacts (required by DWQ)

Will this project (based on past and reasonably anticipated future impacts) result in additional development, which could impact nearby downstream water quality? Yes ☐ No ☒
If yes, please submit a qualitative or quantitative cumulative impact analysis in accordance with the most recent North Carolina Division of Water Quality policy posted on our website at http://h2o.enr.state.nc.us/ncwetlands. If no, please provide a short narrative description: This project will not result in additional development, which could impact nearby downstream water quality.

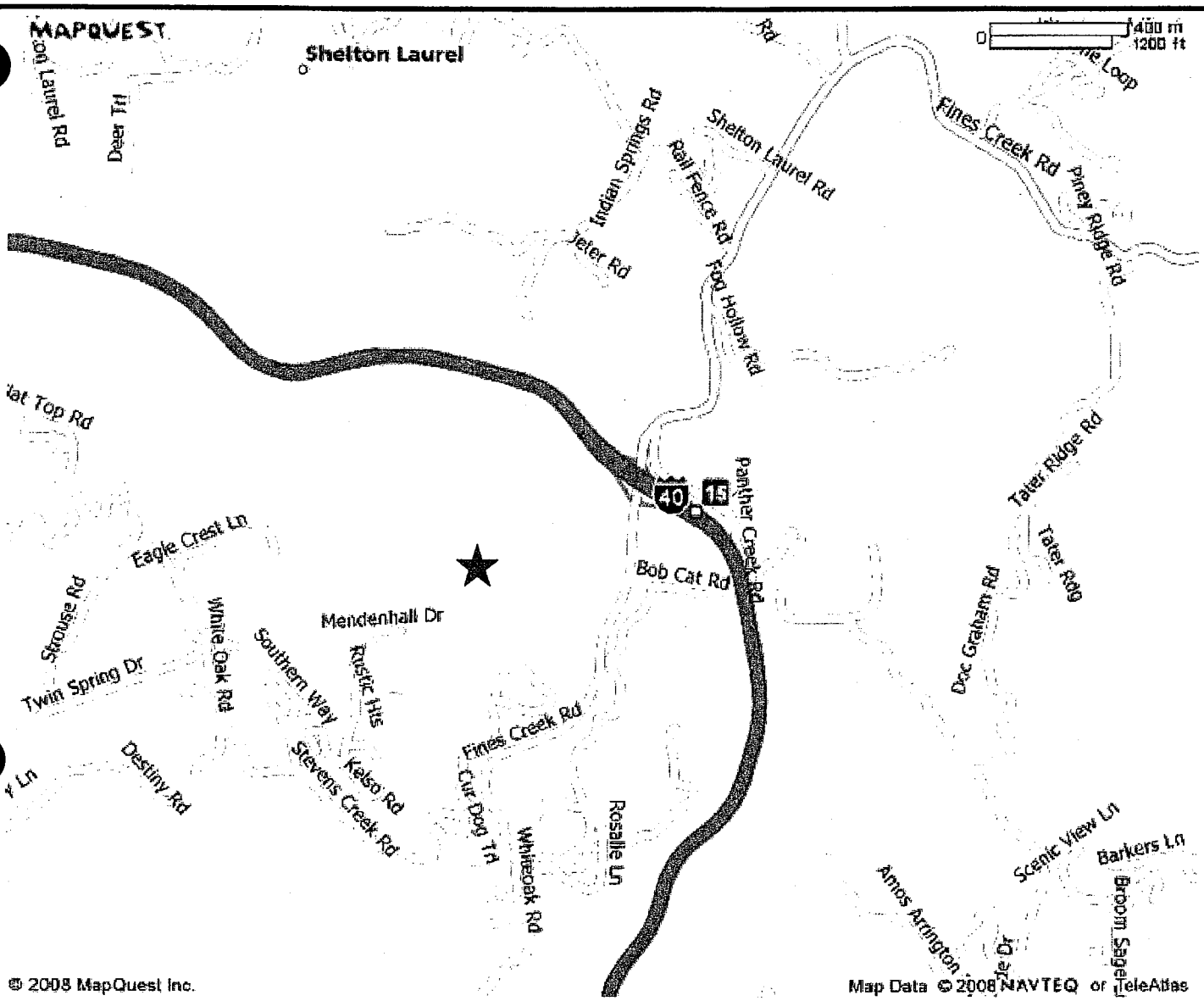
XV. Other Circumstances (Optional):

It is the applicant's responsibility to submit the application sufficiently in advance of desired construction dates to allow processing time for these permits. However, an applicant may choose to list constraints associated with construction or sequencing that may impose limits on work schedules (e.g., draw-down schedules for lakes, dates associated with Endangered and Threatened Species, accessibility problems, or other issues outside of the applicant's control).

R Clemen Riddle 8-15-08

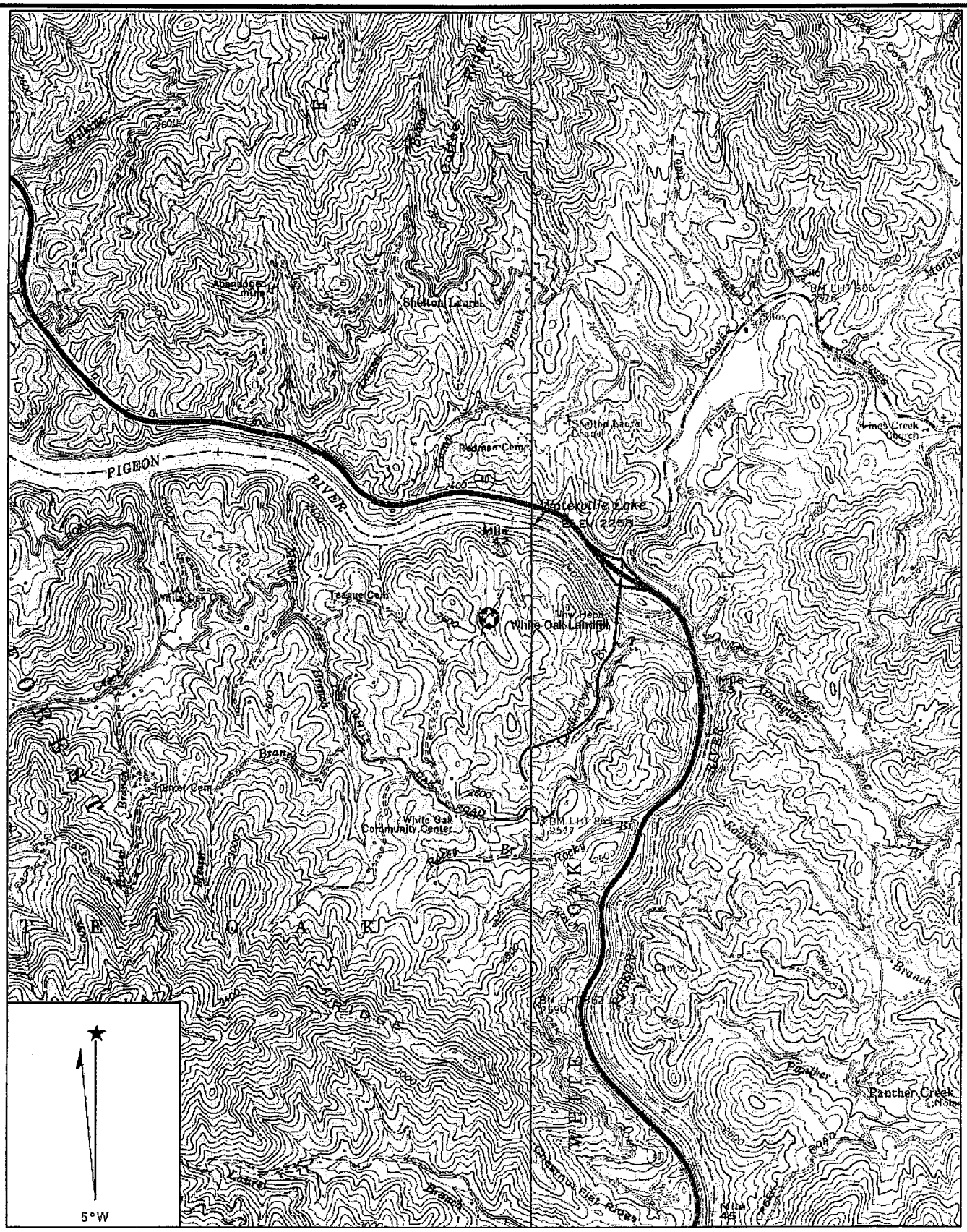
Applicant/Agent's Signature **Date**

(Agent's signature is valid only if an authorization letter from the applicant is provided.)

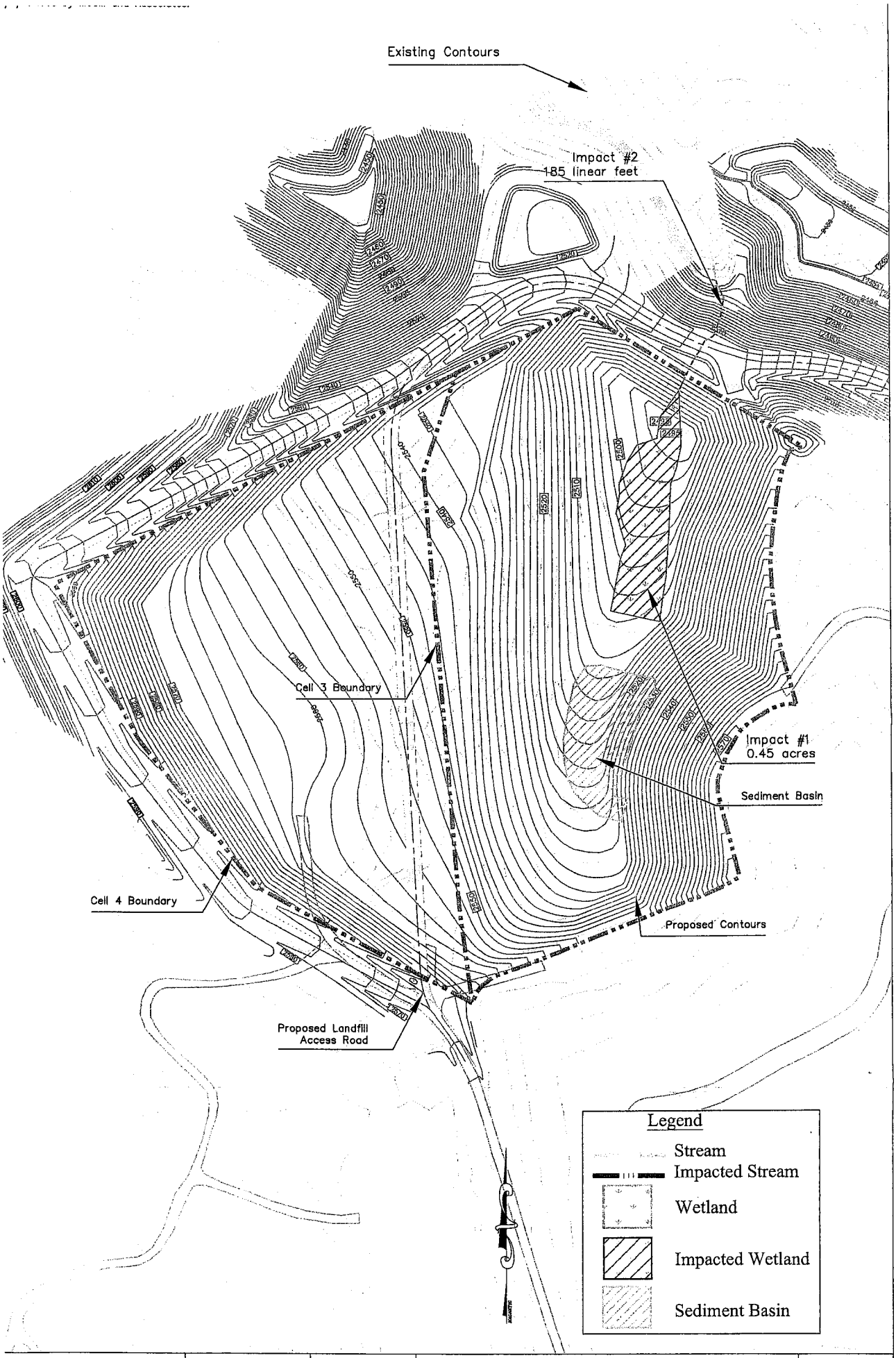


★ - Approximate Site Location

White Oak Landfill Haywood County, North Carolina	**CLEARWATER** Environmental Consultants, Inc. 718 Oakland Street Hendersonville, NC 28791 828-698-9800	Site Vicinity Map MapQuest Figure 1



White Oak Landfill Haywood County, North Carolina	**CLEARWATER** Environmental Consultants, Inc. 718 Oakland Street Hendersonville, NC 28791 828-698-9800	USGS Topographic Map Cove Creek Gap Quad Figure 2



ClearWater
nvironmental Consultants, Inc.

718 Oakland St
Hendersonville NC 28791
Phone: (828) 698-9800
Fax: (828) 698-9003

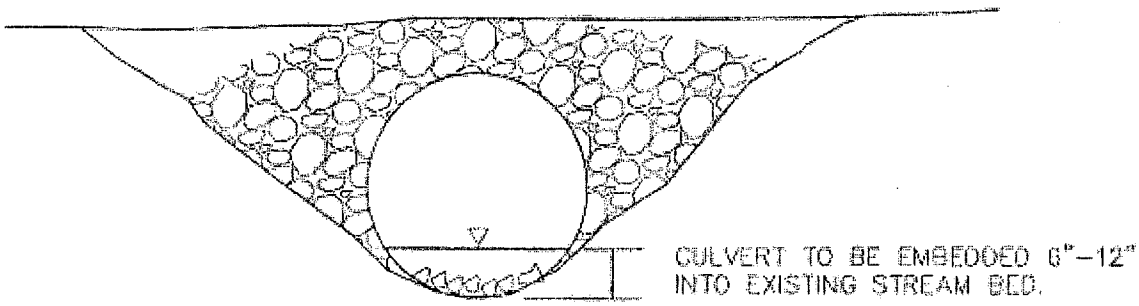
1 inch = 125 feet
DRAWN BY: CEC
DATE: 07.31.08
CEC PROJECT NO.: 563

White Oak Land Fill
Impact Map

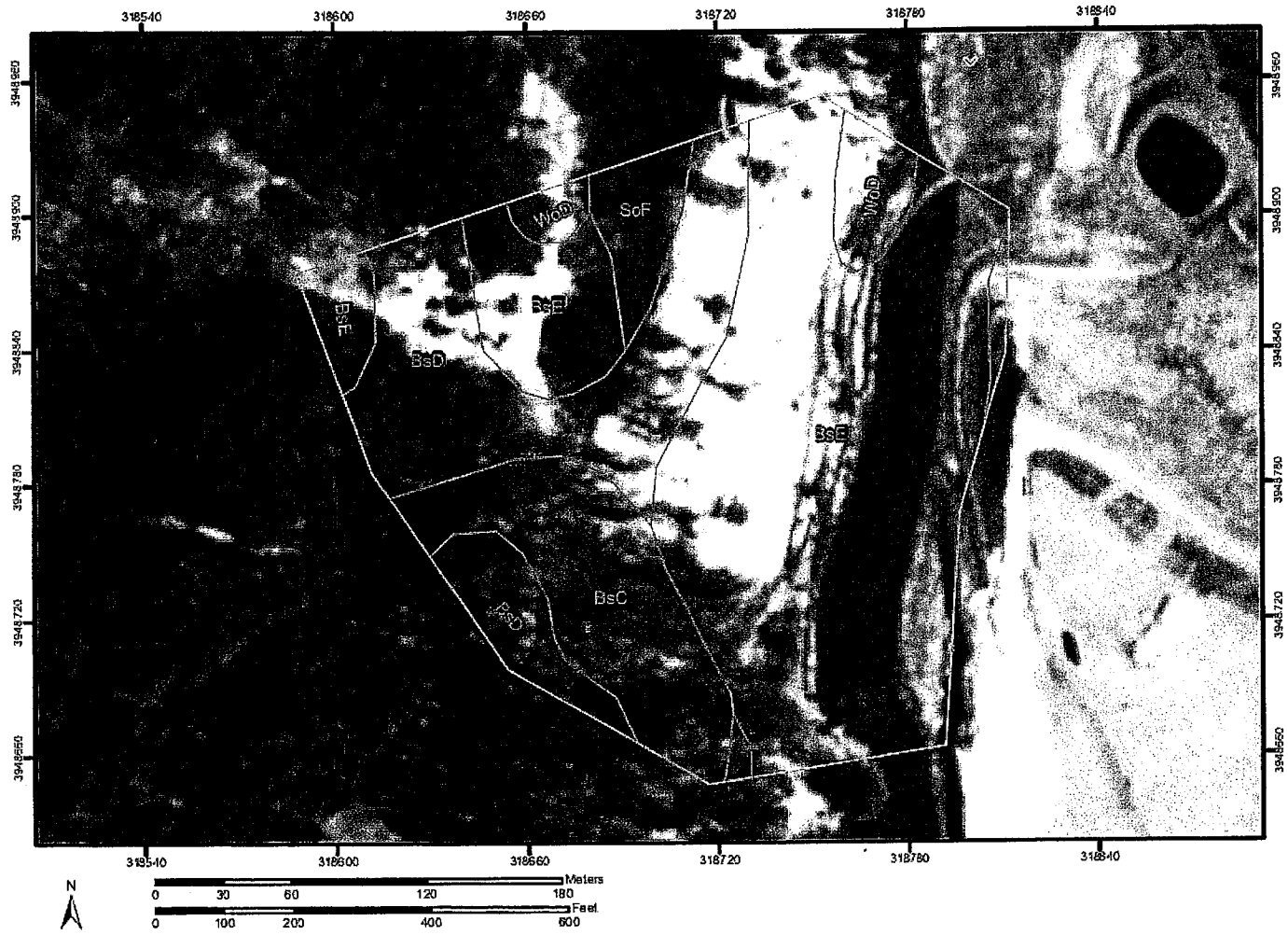
Haywood County

Haywood County

SHEET NO.
FIG. 3



White Oak Landfill Haywood County North Carolina	**CLEARWATER** Environmental Consultants, Inc. 718 Oakland Street Hendersonville, NC 28791 828-698-9800	Culvert Typical Figure 4



White Oak Landfill Haywood County, North Carolina	**CLEARWATER** Environmental Consultants, Inc. 718 Oakland Street Hendersonville, NC 28791 828-698-9800	Soils Map USDA Web Soil Survey Figure 5a

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features

Municipalities
- Cities
- Urban Areas

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails

Roads
- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 17N

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Haywood County Area, North Carolina
Survey Area Data: Version 7, Mar 16, 2007

Date(s) aerial images were photographed: 4/5/1999

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

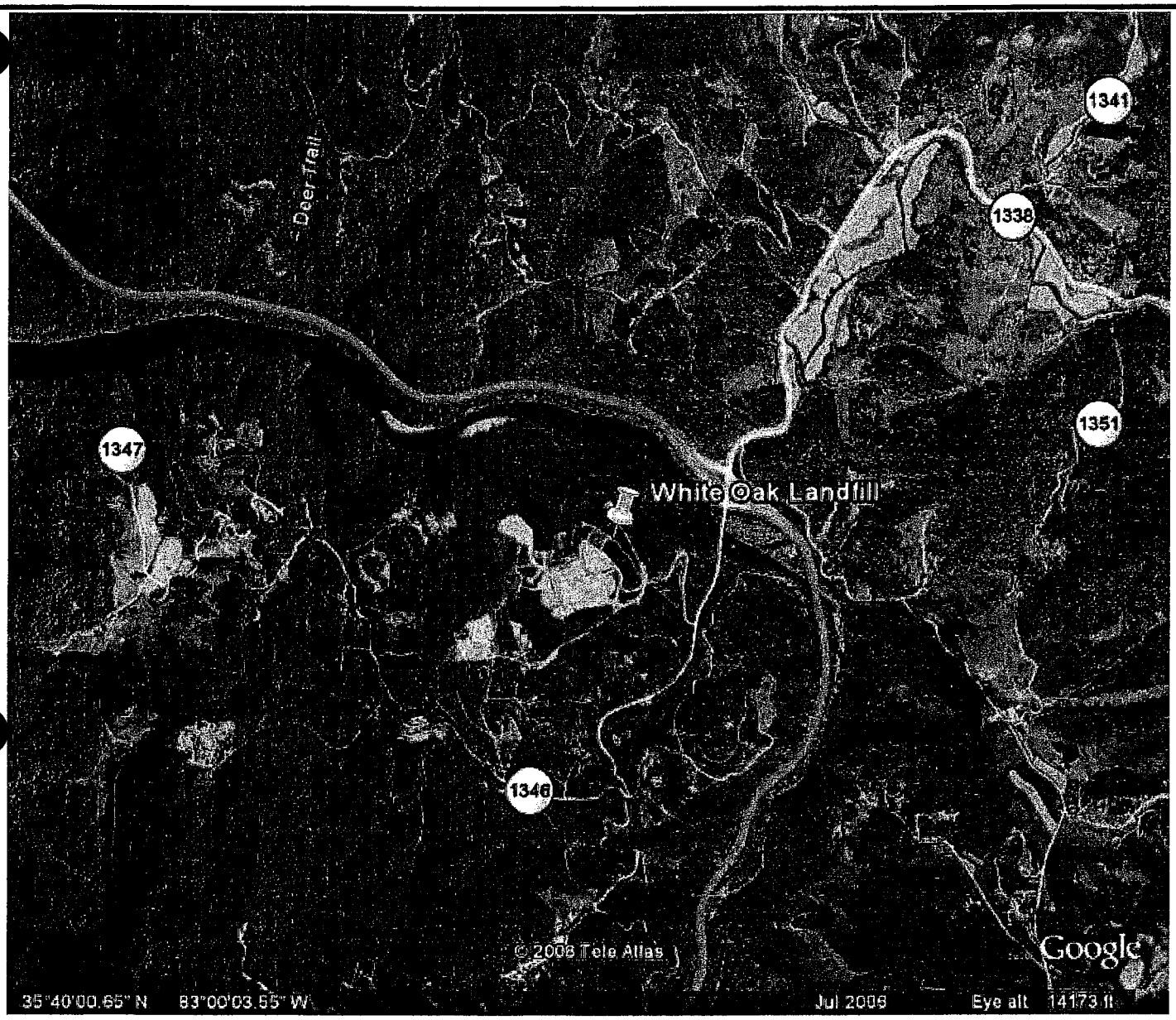
Map Unit Legend

Haywood County Area, North Carolina (NC606)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
BsC	Brasstown-Junaluska complex, 8 to 15 percent slopes	2.2	13.2%
BsD	Brasstown-Junaluska complex, 15 to 30 percent slopes	4.0	24.2%
BsE	Brasstown-Junaluska complex, 30 to 50 percent slopes	9.1	55.2%
SoF	Soco-Stecoah complex, 50 to 95 percent slopes	0.6	3.4%
WoD	Whiteoak cobbly loam, 15 to 30 percent slopes, stony	0.6	3.9%
Totals for Area of Interest (AOI)		16.4	100.0%

White Oak Landfill
Haywood County,
North Carolina

CLEARWATER
Environmental Consultants, Inc.
718 Oakland Street
Hendersonville, NC 28791
828-698-9800

Soils Legend
USDA Web Soil Survey
Figure 5b



White Oak Landfill Haywood County, North Carolina	**CLEARWATER** Environmental Consultants, Inc. 718 Oakland Street Hendersonville, NC 28791 828-698-9800	Aerial Map Google Earth Figure 6

Appendix A
EEP Acceptance Letter
(dated August 7, 2008)

Ecosystem Enhancement PROGRAM

August 7, 2008

Mark Shumpert
Haywood County
1233 N. Main St. Box 2
Waynesville, NC 28786

Expiration of Acceptance: February 7, 2009

Project: White Oak Landfill **County: Haywood**

The purpose of this letter is to notify you that the North Carolina Ecosystem Enhancement Program (NCEEP) is willing to accept payment for impacts associated with the above referenced project. Please note that this decision does not assure that the payment will be approved by the permit issuing agencies as mitigation for project impacts. It is the responsibility of the applicant to contact these agencies to determine if payment to the NCEEP will be approved.

This acceptance is valid for six months from the date of this letter and is not transferable. **If we have not received a copy of the issued 404 Permit/401 Certification/CAMA permit within this time frame, this acceptance will expire.** It is the applicant's responsibility to send copies of the permits to NCEEP. Once NCEEP receives a copy of the permit(s) an invoice will be issued based on the required mitigation in that permit and payment must be made prior to conducting the authorized work. The amount of the In Lieu Fee to be paid to NCEEP by an applicant is calculated based upon the Fee Schedule and policies listed at www.nceep.net.

Based on the information supplied by you the impacts that may require compensatory mitigation are summarized in the following table.

	River Basin	CU Location	Stream (feet)			Wetlands (acres)			Buffer I (Sq. Ft.)	Buffer II (Sq. Ft.)
			Cold	Cool	Warm	Riparian	Non-Riparian	Coastal Marsh		
Impacts	French Broad	06010106	185	0	0	.45	0	0	0	0
Credits	French Broad	06010106	370	0	0	0.9	0	0	0	0

Upon receipt of payment, EEP will take responsibility for providing the compensatory mitigation. If the regulatory agencies require mitigation credits greater than indicated above, and the applicant wants NCEEP to be responsible for the additional mitigation, the applicant will need to submit a mitigation request to NCEEP for approval prior to permit issuance. The mitigation will be performed in accordance with the Memorandum of Understanding between the N. C. Department of Environment and Natural Resources and the U. S. Army Corps of Engineers dated November 4, 1998.

If you have any questions or need additional information, please contact Valerie Mitchener at (919) 715-1973.

Sincerely,

James B. Stanfield Jr

William D. Gilmore, PE
Director

cc: Cyndi Karoly, NCDWQ Wetlands/401 Unit
Lori Beckwith, USACE-Asheville
Kevin Barnett, NCDWQ-Asheville
Rebekah Newton, agent
File

Restoring... Enhancing... Protecting Our State

NCDENR

Jurisdictional Determination Information

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	White Oak Landfill	**Project No:**	543	**Date:**	03/03/08
Applicant/Owner:	Haywood County			**County:**	Haywood
Investigators:	David Nestor, Scott Taylor			**State:**	NC
				Plot ID:	

Do Normal Circumstances exist on the site?	Yes	**Community ID:**	Upland
Is the site significantly disturbed (Atypical Situation:)?	No	**Transect ID:**	
Is the area a potential Problem Area?	No	**Field Location:**	Adjacent to Wetland
(If needed, explain on the reverse side)			

VEGETATION

Dominant Plant Species (Latin/Common)	Stratum	Indicator	Plant Species (Latin/Common)	Stratum	Indicator
Liriodendron tulipifera/tulip poplar	Tree	FAC			
Robinia pseudoacacia/black locust	Tree	UPL			
Rubus argutus/serrate-leaf blackberry	Herb	FACU+			

Percent of Dominant Species that are OBL, FACW or FAC:					**FAC Neutral**	/ =	%
(excluding FAC-)	**1/3**	=		**33%**	**Numeric Index:**	/ =	%

Remarks: Upland area is on a hill above the wetland.

HYDROLOGY

_____ **Recorded Data (Describe in Remarks):**

_____ **Stream,Lake or Tide Gauge**

_____ **Aerial Photographs**

_____ **Other**

_____ **No Recorded Data**

Field Observations

Depth of Surface Water: 0 (in.)>

Depth to Free Water in Pit: >12 (in.)>

Depth to Saturated Soil: >12 (in.)>

Wetland Hydrology Indicators

Primary Indicators

_____ **Inundated**

_____ **Saturated in Upper 12 Inches**

_____ **Water Marks**

_____ **Drift Lines**

_____ **Sediment Deposits**

_____ **Drainage Patterns in Wetlands**

Secondary Indicators (2 or more required):

_____ **Oxidized Root Channels in Upper 12 Inches**

_____ **Water Stained Leaves**

_____ **Local Soil Survey Data**

_____ **FAC-Neutral Test**

Other (Explain in Remarks)

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	White Oak Landfill	**Project No:**	543	**Date:**	03/03/08
Applicant/Owner:	Haywood County			**County:**	Haywood
Investigators:	David Nestor, Scott Taylor			**State:**	NC
				Plot ID:	

Remarks:

SOILS

Map Unit Name (Series and Phase): Not Available
Map Symbol: N/A **Drainage Class:** N/A **Mapped Hydric Inclusions?** N/A
Taxonomy (Subgroup): Not Available **Field Observations Confirm Mapped Type?** Yes No

Profile Description

Depth (Inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Color (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-4		10 YR 4/4			Loam
4-12		10 YR 3/4			Loam

Hydric soil Indicators

- ____ **Histosol**
- ____ **Histic Epipedon**
- ____ **Sulfidic Odor**
- ____ **Aquic Moisture Regime**
- ____ **Reducing Conditions**
- ____ **Gleyed or Low Chroma Colors**
- ____ **Concretions**
- ____ **High Organic Content in Surface Layer in Sandy Soils**
- ____ **Organic Streaking in Sandy Soils**
- ____ **Listed on Local Hydric Soils List**
- ____ **Listed on National Hydric Soils List**
- ____ **Other: (Explain in Remarks)**

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present? No **Is the Sampling Point within the Wetland?** No
Wetland Hydrology Present? No
Hydric Soils Present? No

Remarks:
This area does not meet the 1987 Corps of Engineers Wetlands Delineation Manual's criteria for jurisdictional wetlands.
This area is not a wetland

Explanation for response to: Normal Circumstances? Atypical Situation? Potential Problem Area?

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	White Oak Landfill	**Project No:**	543	**Date:**	03/03/08
Applicant/Owner:	Haywood County			**County:**	Haywood
Investigators:	Scott Taylor, David Nestor			**State:**	NC
				Plot ID:	

Do Normal Circumstances exist on the site?	Yes	**Community ID:**	Wetland
Is the site significantly disturbed (Atypical Situation:)?	No	**Transect ID:**	
Is the area a potential Problem Area?	No	**Field Location:**	Wetland
(If needed, explain on the reverse side)			

VEGETATION

Dominant Plant Species (Latin/Common)	Stratum	Indicator	Plant Species (Latin/Common)	Stratum	Indicator
Salix nigra/black willow	Tree	OBL	*Scirpus cyperinus*/wool-grass	Herb	OBL
Platanus occidentalis/American sycamore	Tree	FACW-	*Mimulus alatus*/sharp-wing monkey flower	Herb	OBL
Rubus argutus/serrate leaf blackberry	Shrub	FACU+	*Ranunculus recurvatus*/hooked buttercup	Herb	FAC
Andropogon virginicus/broom sedge	Herb	FAC-	*Aster nova-angliae*/New England aster	Herb	FACW
Typhus latifolia/cattail	Herb	OBL	*Epilobium coloratum*/purple leaf willow herb	Herb	OBL

Percent of Dominant Species that are OBL, FACW or FAC:					**FAC Neutral**	/ =	%
(excluding FAC-)	7/9	=	78%	%	**Numeric Index:**	/ =	%

Remarks: Wetland is being feed by discharge pipe from a sediment basin.

HYDROLOGY

____ **Recorded Data (Describe in Remarks):**	**Wetland Hydrology Indicators**
____ **Stream,Lake or Tide Gauge**	**Primary Indicators**
____ **Aerial Photographs**	x **Inundated**
____ **Other**	x **Saturated in Upper 12 Inches**
	x **Water Marks**
x **No Recorded Data**	x **Drift Lines**
	x **Sediment Deposits**
Field Observations	x **Drainage Patterns in Wetlands**
Depth of Surface Water: 0-2" (in.)>	**Secondary Indicators (2 or more required):**
Depth to Free Water in Pit: 0->12" (in.)>	____ **Oxidized Root Channels in Upper 12 Inches**
Depth to Saturated Soil: 0-9" (in.)>	x **Water Stained Leaves**
	____ **Local Soil Survey Data**
	x **FAC-Neutral Test**
	Other (Explain in Remarks)

DATA FORM
ROUTINE WETLAND DETERMINATION
(1987 COE Wetlands Delineation Manual)

Project/Site:	White Oak Landfill	**Project No:**	543	**Date:**	03/03/08
Applicant/Owner:	Haywood County			**County:**	Haywood
Investigators:	Scott Taylor, David Nestor			**State:**	NC
				Plot ID:	

Remarks:

SOILS

Map Unit Name (Series and Phase): Not Available
Map Symbol: N/A **Drainage Class:** N/A **Mapped Hydric Inclusions?** N/A
Taxonomy (Subgroup): Not Available **Field Observations Confirm Mapped Type?** Yes No

Profile Description

Depth (Inches)	Horizon	Matrix Color (Munsell Moist)	Mottle Color (Munsell Moist)	Mottle Abundance/Contrast	Texture, Concretions, Structure, etc.
0-5"		10 YR 4/4			Clay
5-12"		2.5 Y 5/2	7.5 YR 5/8	Few/distinct	Clay

Hydric soil Indicators

____	**Histosol**	____	**Concretions**
____	**Histic Epipedon**	____	**High Organic Content in Surface Layer in Sandy Soils**
____	**Sulfidic Odor**	____	**Organic Streaking in Sandy Soils**
x	**Aquic Moisture Regime**	____	**Listed on Local Hydric Soils List**
x	**Reducing Conditions**	____	**Listed on National Hydric Soils List**
x	**Gleyed or Low Chroma Colors**	____	**Other: (Explain in Remarks)**

Remarks:

WETLAND DETERMINATION

Hydrophytic Vegetation Present?	Yes	**Is the Sampling Point within the Wetland?**	Yes
Wetland Hydrology Present?	Yes		
Hydric Soils Present?	Yes		

Remarks:
This area meets the 1987 Corps of Engineers Wetlands Delineation Manual's criteria for jurisdictional wetlands. This area is a wetland.

Explanation for response to: Normal Circumstances? Atypical Situation? Potential Problem Area?

APPROVED JURISDICTIONAL DETERMINATION FORM
U.S. Army Corps of Engineers

This form should be completed by following the instructions provided in Section IV of the JD Form Instructional Guidebook.

SECTION I: BACKGROUND INFORMATION

A. REPORT COMPLETION DATE FOR APPROVED JURISDICTIONAL DETERMINATION (JD):

B. DISTRICT OFFICE, FILE NAME, AND NUMBER:

C. PROJECT LOCATION AND BACKGROUND INFORMATION:

State: NC County/parish/borough: Haywood City: Fine's Creek
Center coordinates of site (lat/long in degree decimal format): Lat. 35.665597° Pick List, Long. 83.002427° Pick List.
Universal Transverse Mercator:
Name of nearest waterbody: UT Pigeon River
Name of nearest Traditional Navigable Water (TNW) into which the aquatic resource flows: Pigeon River
Name of watershed or Hydrologic Unit Code (HUC): 06010106 Pigeon

- ☒ Check if map/diagram of review area and/or potential jurisdictional areas is/are available upon request.
- ☐ Check if other sites (e.g., offsite mitigation sites, disposal sites, etc…) are associated with this action and are recorded on a different JD form.

D. REVIEW PERFORMED FOR SITE EVALUATION (CHECK ALL THAT APPLY):

- ☐ Office (Desk) Determination. Date:
- ☐ Field Determination. Date(s):

SECTION II: SUMMARY OF FINDINGS

A. RHA SECTION 10 DETERMINATION OF JURISDICTION.

There Pick List "*navigable waters of the U.S.*" within Rivers and Harbors Act (RHA) jurisdiction (as defined by 33 CFR part 329) in the review area. [*Required*]

- ☐ Waters subject to the ebb and flow of the tide.
- ☐ Waters are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Explain: .

B. CWA SECTION 404 DETERMINATION OF JURISDICTION.

There Are "*waters of the U.S.*" within Clean Water Act (CWA) jurisdiction (as defined by 33 CFR part 328) in the review area. [*Required*]

1. **Waters of the U.S.**
   a. **Indicate presence of waters of U.S. in review area (check all that apply):** [1]
   - ☐ TNWs, including territorial seas
   - ☐ Wetlands adjacent to TNWs
   - ☒ Relatively permanent waters[2] (RPWs) that flow directly or indirectly into TNWs
   - ☐ Non-RPWs that flow directly or indirectly into TNWs
   - ☒ Wetlands directly abutting RPWs that flow directly or indirectly into TNWs
   - ☐ Wetlands adjacent to but not directly abutting RPWs that flow directly or indirectly into TNWs
   - ☐ Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs
   - ☐ Impoundments of jurisdictional waters
   - ☐ Isolated (interstate or intrastate) waters, including isolated wetlands

   b. **Identify (estimate) size of waters of the U.S. in the review area:**
   Non-wetland waters: 385 linear feet: 3 width (ft) and/or 0.03 acres.
   Wetlands: 0.45 acres.

   c. **Limits (boundaries) of jurisdiction** based on: **1987 Delineation Manual**
   Elevation of established OHWM (if known): .

2. **Non-regulated waters/wetlands (check if applicable):**[3]
   - ☐ Potentially jurisdictional waters and/or wetlands were assessed within the review area and determined to be not jurisdictional. Explain: .

---

[1] Boxes checked below shall be supported by completing the appropriate sections in Section III below.
[2] For purposes of this form, an RPW is defined as a tributary that is not a TNW and that typically flows year-round or has continuous flow at least "seasonally" (e.g., typically 3 months).

SECTION III: CWA ANALYSIS

A. TNWs AND WETLANDS ADJACENT TO TNWs

The agencies will assert jurisdiction over TNWs and wetlands adjacent to TNWs. If the aquatic resource is a TNW, complete Section III.A.1 and Section III.D.1. only; if the aquatic resource is a wetland adjacent to a TNW, complete Sections III.A.1 and 2 and Section III.D.1.; otherwise, see Section III.B below.

1. **TNW**
   Identify TNW: .

   Summarize rationale supporting determination: .

2. **Wetland adjacent to TNW**
   Summarize rationale supporting conclusion that wetland is "adjacent": .

B. CHARACTERISTICS OF TRIBUTARY (THAT IS NOT A TNW) AND ITS ADJACENT WETLANDS (IF ANY):

This section summarizes information regarding characteristics of the tributary and its adjacent wetlands, if any, and it helps determine whether or not the standards for jurisdiction established under *Rapanos* have been met.

The agencies will assert jurisdiction over non-navigable tributaries of TNWs where the tributaries are "relatively permanent waters" (RPWs), i.e. tributaries that typically flow year-round or have continuous flow at least seasonally (e.g., typically 3 months). A wetland that directly abuts an RPW is also jurisdictional. If the aquatic resource is not a TNW, but has year-round (perennial) flow, skip to Section III.D.2. If the aquatic resource is a wetland directly abutting a tributary with perennial flow, skip to Section III.D.4.

A wetland that is adjacent to but that does not directly abut an RPW requires a significant nexus evaluation. Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

If the waterbody[4] is not an RPW, or a wetland directly abutting an RPW, a JD will require additional data to determine if the waterbody has a significant nexus with a TNW. If the tributary has adjacent wetlands, the significant nexus evaluation must consider the tributary in combination with all of its adjacent wetlands. This significant nexus evaluation that combines, for analytical purposes, the tributary and all of its adjacent wetlands is used whether the review area identified in the JD request is the tributary, or its adjacent wetlands, or both. If the JD covers a tributary with adjacent wetlands, complete Section III.B.1 for the tributary, Section III.B.2 for any onsite wetlands, and Section III.B.3 for all wetlands adjacent to that tributary, both onsite and offsite. The determination whether a significant nexus exists is determined in Section III.C below.

1. **Characteristics of non-TNWs that flow directly or indirectly into TNW**

   (i) **General Area Conditions:**
   Watershed size: **Pick List**
   Drainage area: **Pick List**
   Average annual rainfall: inches
   Average annual snowfall: inches

   (ii) **Physical Characteristics:**
   (a) Relationship with TNW:
   ☐ Tributary flows directly into TNW.
   ☐ Tributary flows through **Pick List** tributaries before entering TNW.

   Project waters are **Pick List** river miles from TNW.
   Project waters are **Pick List** river miles from RPW.
   Project waters are **Pick List** aerial (straight) miles from TNW.
   Project waters are **Pick List** aerial (straight) miles from RPW.
   Project waters cross or serve as state boundaries. Explain: .

   Identify flow route to TNW[5]: .
   Tributary stream order, if known: .

---

[4] Note that the Instructional Guidebook contains additional information regarding swales, ditches, washes, and erosional features generally and in the arid West.

[5] Flow route can be described by identifying, e.g., tributary a, which flows through the review area, to flow into tributary b, which then flows into TNW.

(b) General Tributary Characteristics (check all that apply):

Tributary is:
- ☐ Natural
- ☐ Artificial (man-made). Explain: .
- ☐ Manipulated (man-altered). Explain: .

Tributary properties with respect to top of bank (estimate):
Average width: feet
Average depth: feet
Average side slopes: **Pick List.**

Primary tributary substrate composition (check all that apply):
- ☐ Silts
- ☐ Cobbles
- ☐ Bedrock
- ☐ Other. Explain: .
- ☐ Sands
- ☐ Gravel
- ☐ Vegetation. Type/% cover:
- ☐ Concrete
- ☐ Muck

Tributary condition/stability [e.g., highly eroding, sloughing banks]. Explain: .
Presence of run/riffle/pool complexes. Explain: .
Tributary geometry: **Pick List**
Tributary gradient (approximate average slope): %

(c) Flow:
Tributary provides for: **Pick List**
Estimate average number of flow events in review area/year: **Pick List**
Describe flow regime: .
Other information on duration and volume: .

Surface flow is: **Pick List.** Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .
- ☐ Dye (or other) test performed: .

Tributary has (check all that apply):
- ☐ Bed and banks
- ☐ OHWM[6] (check all indicators that apply):
  - ☐ clear, natural line impressed on the bank
  - ☐ changes in the character of soil
  - ☐ shelving
  - ☐ vegetation matted down, bent, or absent
  - ☐ leaf litter disturbed or washed away
  - ☐ sediment deposition
  - ☐ water staining
  - ☐ other (list):
  - ☐ the presence of litter and debris
  - ☐ destruction of terrestrial vegetation
  - ☐ the presence of wrack line
  - ☐ sediment sorting
  - ☐ scour
  - ☐ multiple observed or predicted flow events
  - ☐ abrupt change in plant community
- ☐ Discontinuous OHWM.[7] Explain: .

If factors other than the OHWM were used to determine lateral extent of CWA jurisdiction (check all that apply):
- ☐ High Tide Line indicated by:
  - ☐ oil or scum line along shore objects
  - ☐ fine shell or debris deposits (foreshore)
  - ☐ physical markings/characteristics
  - ☐ tidal gauges
  - ☐ other (list):
- ☐ Mean High Water Mark indicated by:
  - ☐ survey to available datum;
  - ☐ physical markings;
  - ☐ vegetation lines/changes in vegetation types.

(iii) Chemical Characteristics:
Characterize tributary (e.g., water color is clear, discolored, oily film; water quality; general watershed characteristics, etc.).
Explain: .
Identify specific pollutants, if known: .

---

[6] A natural or man-made discontinuity in the OHWM does not necessarily sever jurisdiction (e.g., where the stream temporarily flows underground, or where the OHWM has been removed by development or agricultural practices). Where there is a break in the OHWM that is unrelated to the waterbody's flow regime (e.g., flow over a rock outcrop or through a culvert), the agencies will look for indicators of flow above and below the break.
[7] Ibid.

(iv) Biological Characteristics. Channel supports (check all that apply):

- ☐ Riparian corridor. Characteristics (type, average width): .
- ☐ Wetland fringe. Characteristics: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

2. Characteristics of wetlands adjacent to non-TNW that flow directly or indirectly into TNW

(i) Physical Characteristics:

(a) General Wetland Characteristics:

Properties:

Wetland size: acres

Wetland type. Explain: .

Wetland quality. Explain: .

Project wetlands cross or serve as state boundaries. Explain: .

(b) General Flow Relationship with Non-TNW:

Flow is: **Pick List**. Explain: .

Surface flow is: **Pick List**

Characteristics: .

Subsurface flow: **Pick List**. Explain findings: .

- ☐ Dye (or other) test performed: .

(c) Wetland Adjacency Determination with Non-TNW:

- ☐ Directly abutting
- ☐ Not directly abutting
  - ☐ Discrete wetland hydrologic connection. Explain: .
  - ☐ Ecological connection. Explain: .
  - ☐ Separated by berm/barrier: Explain: .

(d) Proximity (Relationship) to TNW

Project wetlands are **Pick List** river miles from TNW.

Project waters are **Pick List** aerial (straight) miles from TNW.

Flow is from: **Pick List.**

Estimate approximate location of wetland as within the **Pick List** floodplain.

(ii) Chemical Characteristics:

Characterize wetland system (e.g., water color is clear, brown, oil film on surface; water quality; general watershed characteristics; etc.). Explain: .

Identify specific pollutants, if known: .

(iii) Biological Characteristics. Wetland supports (check all that apply):

- ☐ Riparian buffer. Characteristics (type, average width): .
- ☐ Vegetation type/percent cover. Explain: .
- ☐ Habitat for:
  - ☐ Federally Listed species. Explain findings: .
  - ☐ Fish/spawn areas. Explain findings: .
  - ☐ Other environmentally-sensitive species. Explain findings: .
  - ☐ Aquatic/wildlife diversity. Explain findings: .

3. Characteristics of all wetlands adjacent to the tributary (if any)

All wetland(s) being considered in the cumulative analysis: **Pick List**

Approximately ( ) acres in total are being considered in the cumulative analysis.

For each wetland, specify the following:

Directly abuts? (Y/N)	Size (in acres)	Directly abuts? (Y/N)	Size (in acres)

Summarize overall biological, chemical and physical functions being performed: .

C. SIGNIFICANT NEXUS DETERMINATION

A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical, and biological integrity of a TNW. For each of the following situations, a significant nexus exists if the tributary, in combination with all of its adjacent wetlands, has more than a speculative or insubstantial effect on the chemical, physical and/or biological integrity of a TNW. Considerations when evaluating significant nexus include, but are not limited to the volume, duration, and frequency of the flow of water in the tributary and its proximity to a TNW, and the functions performed by the tributary and all its adjacent wetlands. It is not appropriate to determine significant nexus based solely on any specific threshold of distance (e.g. between a tributary and its adjacent wetland or between a tributary and the TNW). Similarly, the fact an adjacent wetland lies within or outside of a floodplain is not solely determinative of significant nexus.

Draw connections between the features documented and the effects on the TNW, as identified in the *Rapanos* Guidance and discussed in the Instructional Guidebook. Factors to consider include, for example:

- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to carry pollutants or flood waters to TNWs, or to reduce the amount of pollutants or flood waters reaching a TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), provide habitat and lifecycle support functions for fish and other species, such as feeding, nesting, spawning, or rearing young for species that are present in the TNW?
- Does the tributary, in combination with its adjacent wetlands (if any), have the capacity to transfer nutrients and organic carbon that support downstream foodwebs?
- Does the tributary, in combination with its adjacent wetlands (if any), have other relationships to the physical, chemical, or biological integrity of the TNW?

Note: the above list of considerations is not inclusive and other functions observed or known to occur should be documented below:

1. **Significant nexus findings for non-RPW that has no adjacent wetlands and flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary itself, then go to Section III.D: .

2. **Significant nexus findings for non-RPW and its adjacent wetlands, where the non-RPW flows directly or indirectly into TNWs.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

3. **Significant nexus findings for wetlands adjacent to an RPW but that do not directly abut the RPW.** Explain findings of presence or absence of significant nexus below, based on the tributary in combination with all of its adjacent wetlands, then go to Section III.D: .

D. DETERMINATIONS OF JURISDICTIONAL FINDINGS. THE SUBJECT WATERS/WETLANDS ARE (CHECK ALL THAT APPLY):

1. **TNWs and Adjacent Wetlands.** Check all that apply and provide size estimates in review area:
   - ☐ TNWs: linear feet width (ft), Or, acres.
   - ☐ Wetlands adjacent to TNWs: acres.

2. **RPWs that flow directly or indirectly into TNWs.**
   - ☒ Tributaries of TNWs where tributaries typically flow year-round are jurisdictional. Provide data and rationale indicating that tributary is perennial: Fed by wetland.
   - ☐ Tributaries of TNW where tributaries have continuous flow "seasonally" (e.g., typically three months each year) are jurisdictional. Data supporting this conclusion is provided at Section III.B. Provide rationale indicating that tributary flows seasonally: .

Provide estimates for jurisdictional waters in the review area (check all that apply):
☒ Tributary waters: **385** linear feet **3** width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

3. **Non-RPWs[8] that flow directly or indirectly into TNWs.**
☐ Waterbody that is not a TNW or an RPW, but flows directly or indirectly into a TNW, and it has a significant nexus with a TNW is jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional waters within the review area (check all that apply):
☐ Tributary waters: linear feet width (ft).
☐ Other non-wetland waters: acres.
Identify type(s) of waters: .

4. **Wetlands directly abutting an RPW that flow directly or indirectly into TNWs.**
☒ Wetlands directly abut RPW and thus are jurisdictional as adjacent wetlands.
☒ Wetlands directly abutting an RPW where tributaries typically flow year-round. Provide data and rationale indicating that tributary is perennial in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: **Wetland flows into tributary.**

☐ Wetlands directly abutting an RPW where tributaries typically flow "seasonally." Provide data indicating that tributary is seasonal in Section III.B and rationale in Section III.D.2, above. Provide rationale indicating that wetland is directly abutting an RPW: .

Provide acreage estimates for jurisdictional wetlands in the review area: **0.45** acres.

5. **Wetlands adjacent to but not directly abutting an RPW that flow directly or indirectly into TNWs.**
☐ Wetlands that do not directly abut an RPW, but when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisidictional. Data supporting this conclusion is provided at Section III.C.

Provide acreage estimates for jurisdictional wetlands in the review area: acres.

6. **Wetlands adjacent to non-RPWs that flow directly or indirectly into TNWs.**
☐ Wetlands adjacent to such waters, and have when considered in combination with the tributary to which they are adjacent and with similarly situated adjacent wetlands, have a significant nexus with a TNW are jurisdictional. Data supporting this conclusion is provided at Section III.C.

Provide estimates for jurisdictional wetlands in the review area: acres.

7. **Impoundments of jurisdictional waters.[9]**
As a general rule, the impoundment of a jurisdictional tributary remains jurisdictional.
☐ Demonstrate that impoundment was created from "waters of the U.S.," or
☐ Demonstrate that water meets the criteria for one of the categories presented above (1-6), or
☐ Demonstrate that water is isolated with a nexus to commerce (see E below).

E. **ISOLATED [INTERSTATE OR INTRA-STATE] WATERS, INCLUDING ISOLATED WETLANDS, THE USE, DEGRADATION OR DESTRUCTION OF WHICH COULD AFFECT INTERSTATE COMMERCE, INCLUDING ANY SUCH WATERS (CHECK ALL THAT APPLY):[10]**
☐ which are or could be used by interstate or foreign travelers for recreational or other purposes.
☐ from which fish or shellfish are or could be taken and sold in interstate or foreign commerce.
☐ which are or could be used for industrial purposes by industries in interstate commerce.
☐ Interstate isolated waters. Explain: .
☐ Other factors. Explain: .

Identify water body and summarize rationale supporting determination: .

---

[8] See Footnote # 3.
[9] To complete the analysis refer to the key in Section III.D.6 of the Instructional Guidebook.
[10] **Prior to asserting or declining CWA jurisdiction based solely on this category, Corps Districts will elevate the action to Corps and EPA HQ for review consistent with the process described in the Corps/EPA *Memorandum Regarding CWA Act Jurisdiction Following Rapanos.***

Provide estimates for jurisdictional waters in the review area (check all that apply):
- ☐ Tributary waters: linear feet width (ft).
- ☐ Other non-wetland waters: acres.
  - Identify type(s) of waters: .
- ☐ Wetlands: acres.

F. NON-JURISDICTIONAL WATERS, INCLUDING WETLANDS (CHECK ALL THAT APPLY):
- ☐ If potential wetlands were assessed within the review area, these areas did not meet the criteria in the 1987 Corps of Engineers Wetland Delineation Manual and/or appropriate Regional Supplements.
- ☐ Review area included isolated waters with no substantial nexus to interstate (or foreign) commerce.
  - ☐ Prior to the Jan 2001 Supreme Court decision in "*SWANCC*," the review area would have been regulated based solely on the "Migratory Bird Rule" (MBR).
- ☐ Waters do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction. Explain: .
- ☐ Other: (explain, if not covered above): .

Provide acreage estimates for non-jurisdictional waters in the review area, where the sole potential basis of jurisdiction is the MBR factors (i.e., presence of migratory birds, presence of endangered species, use of water for irrigated agriculture), using best professional judgment (check all that apply):
- ☐ Non-wetland waters (i.e., rivers, streams): linear feet width (ft).
- ☐ Lakes/ponds: acres.
- ☐ Other non-wetland waters: acres. List type of aquatic resource: .
- ☐ Wetlands: acres.

Provide acreage estimates for non-jurisdictional waters in the review area that do not meet the "Significant Nexus" standard, where such a finding is required for jurisdiction (check all that apply):
- ☐ Non-wetland waters (i.e., rivers, streams): linear feet, width (ft).
- ☐ Lakes/ponds: acres.
- ☐ Other non-wetland waters: acres. List type of aquatic resource: .
- ☐ Wetlands: acres.

SECTION IV: DATA SOURCES.

A. SUPPORTING DATA. Data reviewed for JD (check all that apply - checked items shall be included in case file and, where checked and requested, appropriately reference sources below):
- ☒ Maps, plans, plots or plat submitted by or on behalf of the applicant/consultant: .
- ☒ Data sheets prepared/submitted by or on behalf of the applicant/consultant.
  - ☐ Office concurs with data sheets/delineation report.
  - ☐ Office does not concur with data sheets/delineation report.
- ☐ Data sheets prepared by the Corps: .
- ☐ Corps navigable waters' study: .
- ☐ U.S. Geological Survey Hydrologic Atlas: .
  - ☐ USGS NHD data.
  - ☐ USGS 8 and 12 digit HUC maps.
- ☒ U.S. Geological Survey map(s). Cite scale & quad name:Cove Creek Gap 1:24,000.
- ☐ USDA Natural Resources Conservation Service Soil Survey. Citation: .
- ☐ National wetlands inventory map(s). Cite name: .
- ☐ State/Local wetland inventory map(s): .
- ☐ FEMA/FIRM maps: .
- ☐ 100-year Floodplain Elevation is: (National Geodectic Vertical Datum of 1929)
- ☐ Photographs: ☐ Aerial (Name & Date): .
  - or ☐ Other (Name & Date): .
- ☐ Previous determination(s). File no. and date of response letter: .
- ☐ Applicable/supporting case law: .
- ☐ Applicable/supporting scientific literature: .
- ☐ Other information (please specify): .

B. ADDITIONAL COMMENTS TO SUPPORT JD: .

Section 13 - Permit to Construct Drawings

SECTION 13 PERMIT TO CONSTRUCT DRAWINGS TO FOLLOW UNDER SEPARATE COVER.