PERMIT APPLICATION

FOR

PHASE 5 CONSTRUCTION PERMIT

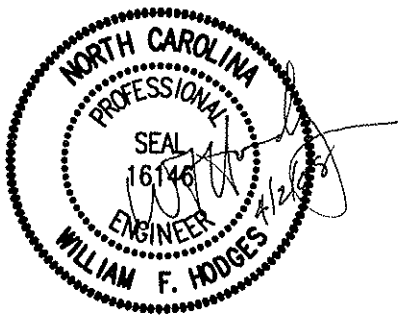
EAST CAROLINA REGIONAL LANDFILL
BERTIE COUNTY, NORTH CAROLINA

FOR

REPUBLIC SERVICES OF NORTH CAROLINA, LLC
dba
EAST CAROLINA ENVIRONMENTAL

APRIL 2008

VOLUME 2 OF 2



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PERMIT APPLICATION
FOR
EAST CAROLINA REGIONAL LANDFILL
PHASE 5 CONSTRUCTION PERMIT

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EAST CAROLINA REGIONAL LANDFILL – PHASE 5
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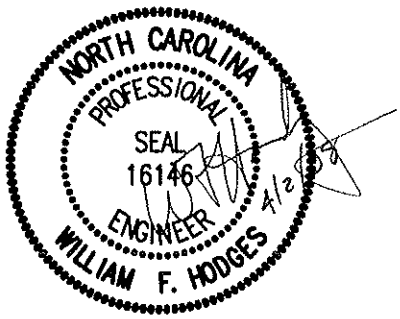

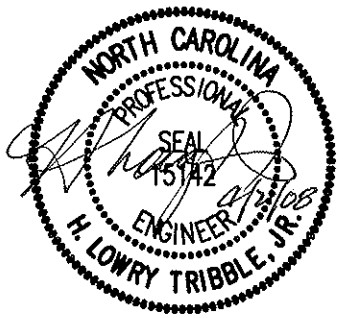

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5. APPENDIX

a. Location Map

1. STORMWATER MANAGEMENT CALCULATIONS

a. General

The East Carolina Regional MSW Landfill (MSWLF) is an existing municipal solid waste landfill located in Bertie County, North Carolina. Approximately 82 acres of the landfill footprint is currently constructed. The proposed Phase 5 development of the landfill will disturb approximately 31 acres. Of this disturbed area, approximately 25 acres will represent the actual footprint of the waste disposal cells and the remaining 6 acres will represent areas for access road, buildings, support facilities, forebays, wet detention basins, and outside slopes along cut and fill areas around the landfill.

Disturbed areas will be stabilized using erosion control measures. Stormwater which comes from off-site and undisturbed areas on the site will be diverted around the MSWLF. Precipitation which falls onto the MSWLF will be diverted to and transported by stormwater conveyance channels (SCC's) to one of three wet detention basins. These basins are designed to protect water quality by reducing the stormwater runoff rate, and removing total suspended solids (TSS) from stormwater runoff. These basins, as well as a timely application of various erosion and sedimentation practices, will minimize the time that soils are exposed, control stormwater runoff, protect soils from erosive forces, protect surrounding property and preserve water quality.

The best way to control sediment is to minimize erosion of soil at its source. One way to minimize erosion is to control stormwater through the use of stormwater management structures in areas of concentrated water flows. In the design of a landfill, stormwater should be controlled, collected and transported from the top of the landfill to the point where it leaves the property. Stormwater which falls onto the top of a landfill or along its sideslopes, will be collected by a series of sideslope diversion berms and sideslope downdrain pipes. Sideslope diversion berms are vegetated earthen structures constructed across the landfill sideslope. These are spaced every 20 - 40 vertical feet on the landfill sideslope. The sideslope diversion berms are constructed at least 2' high and at a 2% slope along the stormwater pathway. The purpose of the sideslope diversion berm is to reduce the slope length that stormwater runoff will travel as sheet flow, and transport the stormwater to a sideslope downdrain pipe.

All landfill sideslopes and sideslope earthen berms will be grassed. Berms will be covered with a temporary liner, such as Excelsior Matting for temporary protection prior to permanent vegetation being established. The sideslope downdrain pipes will be used to transport runoff from points on top of the landfill to the bottom of the landfill. These pipes will be 24" diameter corrugated HDPE pipe and will be sized to carry the runoff collected behind each berm while not exceeding 60% of the capacity of the 24" diameter pipe. The downdrain pipes will discharge into a stabilized open stormwater conveyance channel (SCC) system or directly into a drop inlet structure. A rip-rap apron will be placed at the outlet of each downdrain system to reduce the velocity of the concentrated pipe flow, and prevent erosion at the outlet as it enters the stabilized SCC system at the toe of the waste footprint.

The SCC system around the waste footprint collects all of the stormwater runoff from the outside edge of the access road around the landfill to the top of the landfill. These SCCs are at least 2' wide at the bottom, 4' deep and have 2:1 sideslopes. All SCCs will be grassed. If velocities exceed 2 feet per second (i.e. scour velocity), temporary and/or permanent protective measures will be used to prevent scouring. These measures include temporary liners which are used to protect the SCC until the grass has time to grow and mature, and permanent SCC liners, such as stone rip-rap, concrete or special geotextile materials. These liners are discussed further in Section (e) of this document.

The stormwater runoff has now been taken from areas on top of the landfill, along grassed diversion berms, through the downdrain pipe systems to the SCC system. The SCC system transports the stormwater by gravity to wet detention basins. The stormwater is collected in drop inlets and transported across the access road and into the wet detention basins through drainage pipes. The inlets and pipes are sized to handle the 25-year, 24-hour storm event. Temporary drop inlet protections in the forms of sediment traps and silt fences are used around the drop inlet to collect sediment from upstream SCCs. These protections help keep sediment out of the drainage pipe system. The outlet of each drainage pipe entering the wet detention basins is also protected from soil scouring with a stone rip-rap apron.

Three wet detention basins are to be used for final trapping and settlement of sediment. The basins are designed generally in accordance with the NCDENR Stormwater Best Management Practices Manual. Design specifications for each basin are included in this document.

Based on the topography of the site and the design of the landfill, there are areas that will be disturbed and the stormwater runoff from these areas cannot be diverted to one of the wet detention basins. These areas include the outside cut and fill slopes on access roads and the wet detention basins. In order to control stormwater runoff and control erosion and sedimentation, all of these areas will be protected by the installation of silt fencing as well as being mulched and vegetated. Mulch helps to reduce runoff and erosion, conserve soil moisture, and prevent soil compaction and crusting. Each of these areas will be stabilized by using temporary and permanent grassing along with slope protective materials, such as Excelsior Matting, permanent erosion control pre-seeded blankets, channel liners, other types of erosion control blankets and mats, or a sprayed-on synthetic polyacrylamide polyamine "Silt Stop", if required. The polyamine chemically binds to the fine clay particles and prevents the particles from going into solution. In addition to the use of mulch, grassing and slope protective materials, all areas downhill of a disturbed area will be protected with silt fencing. Silt fencing will capture sediment and prevent it from leaving the site and entering any drainageways.

Erosion and sedimentation control measures will be inspected routinely and after any significant rainfall events. Any damage observed will be repaired. Cleanout of sediment control structures will occur regularly to maintain the effectiveness of the structures. Sediment removed from these structures will be used as cover soils for the landfill waste. Silt fencing and drop inlet protection will remain in place until sediment contributing areas are stabilized.

The site manager of the MSWLF will be responsible for the facility stormwater, erosion and sedimentation control program. The address and telephone number of the manager is listed below:

Mr. Bill Cooksey
Republic Services of North Carolina, LLC
East Carolina Regional Landfill
1922 Republican Road
Aulander, NC 27805
Phone: 252-348-3322

b. Design Assumptions

The following assumptions are used to size all downdrains, sideslope berms, stormwater conveyance channels (SCC), and storm piping.

1) It is assumed that the surface of the landfill is 50% impervious. This fairly represents the observed amount of runoff from many closed landfills in the southeastern United States.

2) Downdrains are designed to flow approximately 60% full during the 25-year, 24-hour storm event. All proposed downdrain pipes are 24" diameter and all risers are 18" – 24" diameter.

3) Downdrain calculations are based on corrugated plastic pipe.

4) Storm drainage flows were calculated using HYDRAFLOW and the SCS Method.

5) The Curve Number CN = 74

6) Estimated velocities of storm water:

5% slope on top of landfill	= 1.5 fps
along sideslope berms	= 3.0 fps
in downdrain pipes	= 12 fps
down 3.5:1 sideslopes	= 3.9 fps

7) Sideslope drainage berms shall be 24" deep and designed with an average of 2% slope.

8) Perimeter SCC shall be designed with a 2' minimum bottom width, 2:1 sideslopes and 4' deep.

9) SCC with greater than 2.0 fps velocity shall be designed with SCC stabilization.

10) Shear stress for temporary ground cover in SCCs where the velocity exceeds 2.0 fps, shall be calculated to determine the type of SCC stabilization to be used.

$T = y \times d \times s$

$y = 62.4$ #/s.f.

d = depth of flow

s = slope of SCC, ft./ft.

11) Drop inlets shall be designed with a 4 foot square minimum inside dimension and 18" high opening on all 4 sides.

12) Manning's "n" for corrugated plastic downdrain pipe is:

12" - 0.018	21" - 0.020
15" - 0.018	24" - 0.020
18" - 0.020	

13) Manning's "n" for concrete pipe is 0.013.

14) Manning "n" for corrugated metal pipe is 0.023.

15) See "Erosion Control Plan" sheet in the Phase 5 Engineering Plans for Drainage Structure Locations.

16) The 25-year, 24-hour stormwater event is used to design all stormwater controls unless otherwise noted.

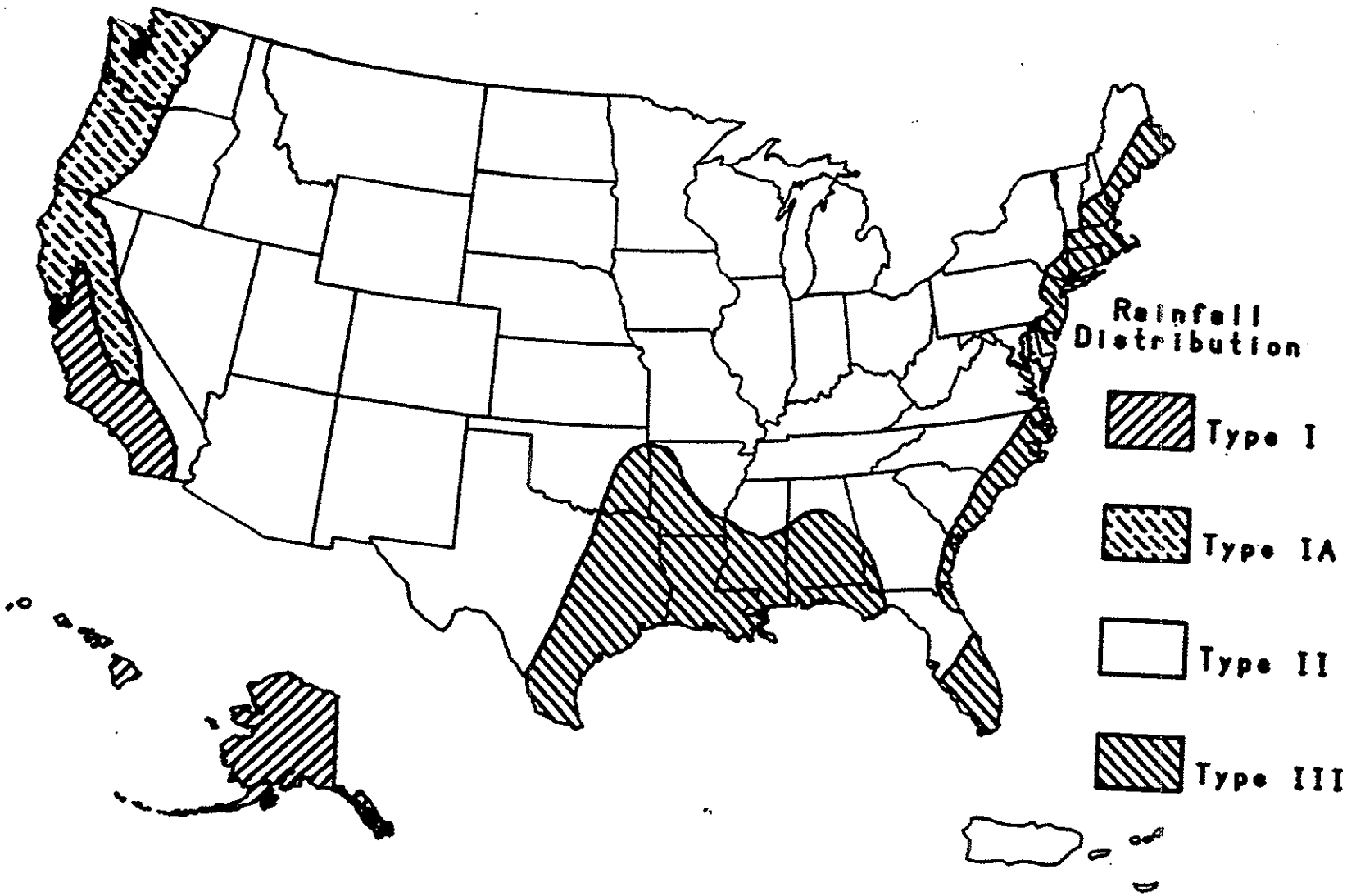

Figure B-2.—Approximate geographic boundaries for SCS rainfall distributions.

SCS Peak Discharge Method

The peak discharge method of calculating runoff was developed by the USDA Soil Conservation Service and is contained in SCS Technical Release No. 55 (TR-55) entitled Urban Hydrology for Small Watersheds, Second Ed.; June 1986. This method of runoff calculation yields a total runoff volume as well as a peak discharge. Use of the SCS method is illustrated in Sample Problem 8.03b and in Chapter 7, Sample Erosion and Sedimentation Control Plan.

Step 1. Measure the drainage area (in acres); the hydraulic length (distance from most remote point to design point, in feet); and the average slope (percent) of the watershed.

Step 2. Calculate a curve number, CN, for the drainage area.

The curve number, CN, is an empirical value, which establishes a relationship between rainfall and runoff based upon characteristics of the drainage area. Table 8.03b contains CN values for different land uses, cover conditions, and hydrologic soil groups. Hydrologic group assignments for most common soils in North Carolina are given in Appendix 8.01. If the soil name is not known, judge the soils based on the group description below:

- **Soil Group A**—Represents soil having a low runoff potential due to high infiltration rates. These soils consist primarily of deep, well-drained sands and gravels.
- **Soil Group B**—Represents soils having a moderately low runoff potential due to moderate infiltration rates. These soils consist primarily of moderately deep to deep, moderately well-drained to well-drained soils with moderately fine to moderately coarse textures.
- **Soil Group C**—Represents soils having a moderately high runoff potential due to slow infiltration rates. These soils consist primarily of soils in which a layer exists near the surface that impedes the downward movement of water, or soils with moderately fine to fine texture.
- **Soil Group D**—Represents soils having a high runoff potential due to very slow infiltration rates. These soils consist primarily of soils with high water tables, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious parent material.

If the watershed is homogeneous (i.e., uniform land use and soils) the CN value can be determined directly from Table 8.03b. Curve numbers for nonhomogeneous watersheds may be determined by dividing the watershed into homogeneous subareas and computing a weighted average.

Step 3. Select design storm and determine runoff depth and volume for erosion and sediment control using the 10-yr, 24-hr storm.

a. Determine rainfall amount, in inches, from Figures 8.03h through 8.03m for the selected design storm. (The design storm is based on an SCS Type II, 24-hr rainfall distribution.)

Sample Problem 8.03b
Determination of peak runoff rate using the SCS method.

Given:

Location: Raleigh, N.C.

Land use by soil group:

Commercial area: soil group B	8 acres
Newly graded area: soil group C	20 acres
Wooded land: (good stand—good ground cover) soil group B	12 acres
Total area	40 acres

Avg. watershed slope: 5%

Ratio of drainage area to ponded area (2 acres wooded, ponded area near center of watershed) 20:1

Hydraulic length: 2,000 ft

% hydraulic length modified: none

% impervious area: (8 acres commercial, 85% impervious) 17%

Find:

Peak rate of runoff for the 10-yr frequency, 24-hr storm - $Q_{p\ 10,\ 24}$

Solution:

(1) Drainage area = 40 acres (given)
hydraulic length = 2,000 ft
average slope = 5%

(2) Calculate average curve number (CN) using Table 8.03b.

	% drainage area	x CN		
Commercial area	20%	x 92	=	1840
Newly graded area	50%	x 93	=	4650
Wooded land	30%	x 55	=	1650
	100%			8140

CN $\frac{8140}{100} = 81.4$ Use 82

(3) Determine runoff depth
a. Rainfall amount for 10-yr, 24-hr storm; Raleigh, NC = 5.6 inches (Figure 8.03j)
b. Runoff depth = 3.63 inches (Table 8.03c by double interpolation)

(4) Determine peak rate of runoff for the design storm by adjusting for watershed shape.
a. Equivalent drainage area = 46 acres (Figure 8.03n; hydraulic length = 2,000 ft)
b. Q_1 = 40 cfs/inch x 3.63 inches = 145 cfs (Figure 8.03p; 3% to 8% slope; CN = 82)
c. $Q_2 = 145 \times \frac{40}{46} = 126$ cfs

(5) Adjust peak discharge rate Q_2 for percent impervious area and percent hydraulic length modified
a. Impervious factor = 1.08 (Figure 8.03r ; 17% impervious)
b. Hydraulic length modification factor - omit (no channel improvement made)
c. $Q_3 = 126 \times 1.08 = 136$ cfs

(6) Adjust peak discharge for avg. watershed slope
a. Adjustment factor for watershed slope = 1.07 (Table 8.03d; 5% avg. slope)
b. $Q_4 = 136 \times 1.07 = 146$ cfs

(7) Adjust peak discharge for surface ponding
a. Adjustment factor for surface ponding = 0.68 (Table 8.03e; ratio 20:1; center of watershed; 10-yr)
b. $Q_{p\ 10,24} = 146 \times 0.68 = 99$ cfs at design point.

Table 8.03b
Runoff Curve Numbers (CN)

Land Use/Cover		Hydrologic Soil Group A	B	C	D
Cultivated land					
without conservation		72	81	88	91
with conservation		62	71	78	81
Pasture land					
poor condition		68	79	86	89
fair condition		49	69	79	84
good condition		39	61	74	80
Meadow					
good condition		30	58	71	78
Wood or forest land					
Thin stand - poor cover, no mulch		45	66	77	83
Good stand - good cover		25	55	70	77
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
good condition:					
grass cover on 75%					
or more of the area		39	61	74	80
fair condition:					
grass cover on 50					
to 75% of the area		49	69	79	84
Commercial and business					
areas (85% impervious)		89	92	94	95
Industrial districts					
(72% impervious)		81	88	91	93
Residential:[1] Development completed and vegetation established					
Average lot size	Average % Impervious				
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acre	15	47	66	77	81
Paved parking lots, roofs,					
driveways, etc.		98	98	98	98
Streets and roads					
paved with curbs and					
storm sewers		98	98	98	98
gravel		76	85	89	91
dirt		72	82	87	89
Newly graded area		81	89	93	95
Residential: Development underway and no vegetation					
Lot sizes of 1/4 acre		88	93	95	97
Lot sizes of 1/2 acre		85	91	94	96
Lot sizes of 1 acre		82	90	93	95
Lot sizes of 2 acres		81	89	92	94

[1]Curve numbers are computed assuming the runoff from the house and driveway is directed toward the street.

source: USDA-SCS

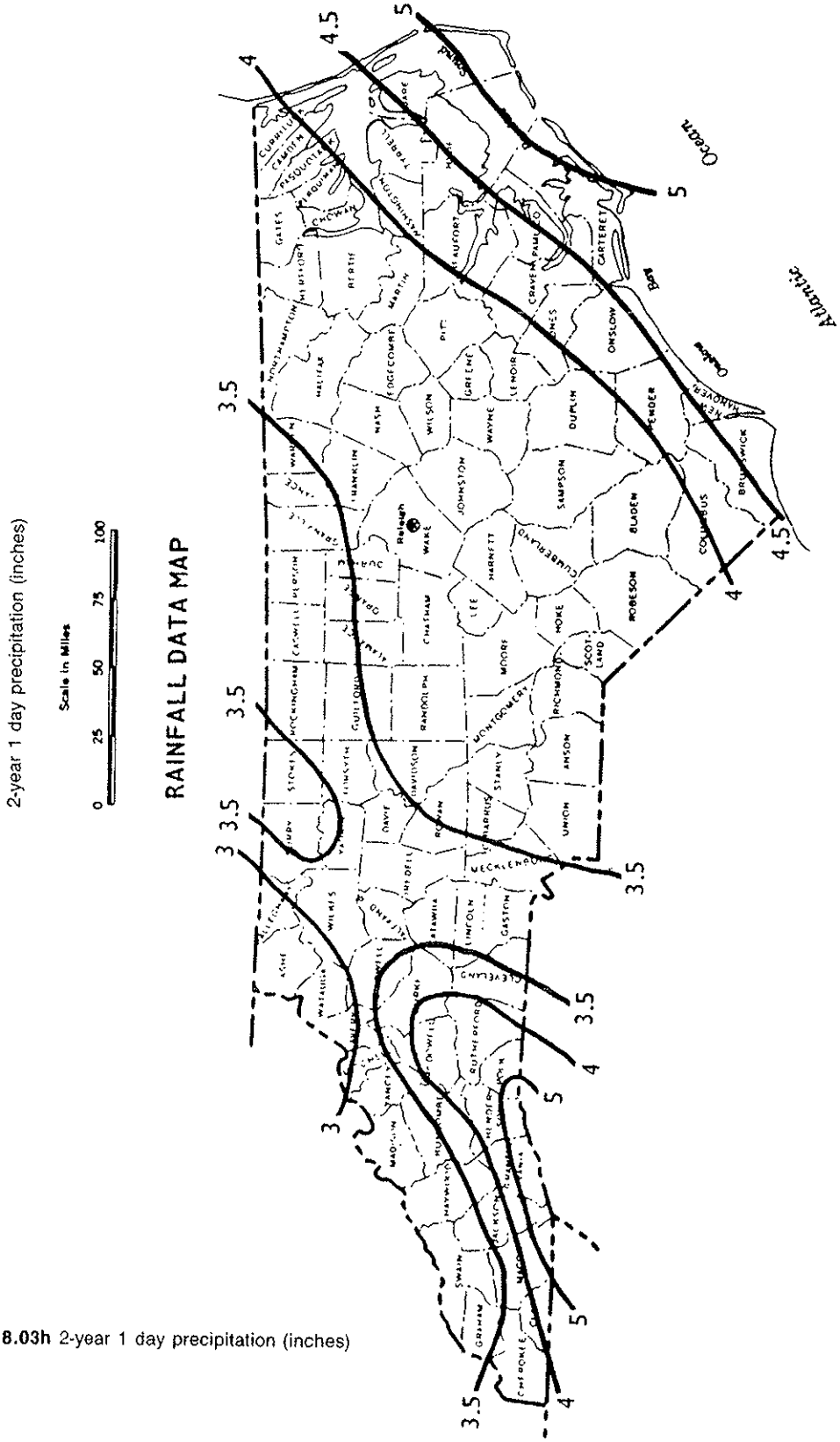

Figure 8.03h 2-year 1 day precipitation (inches)

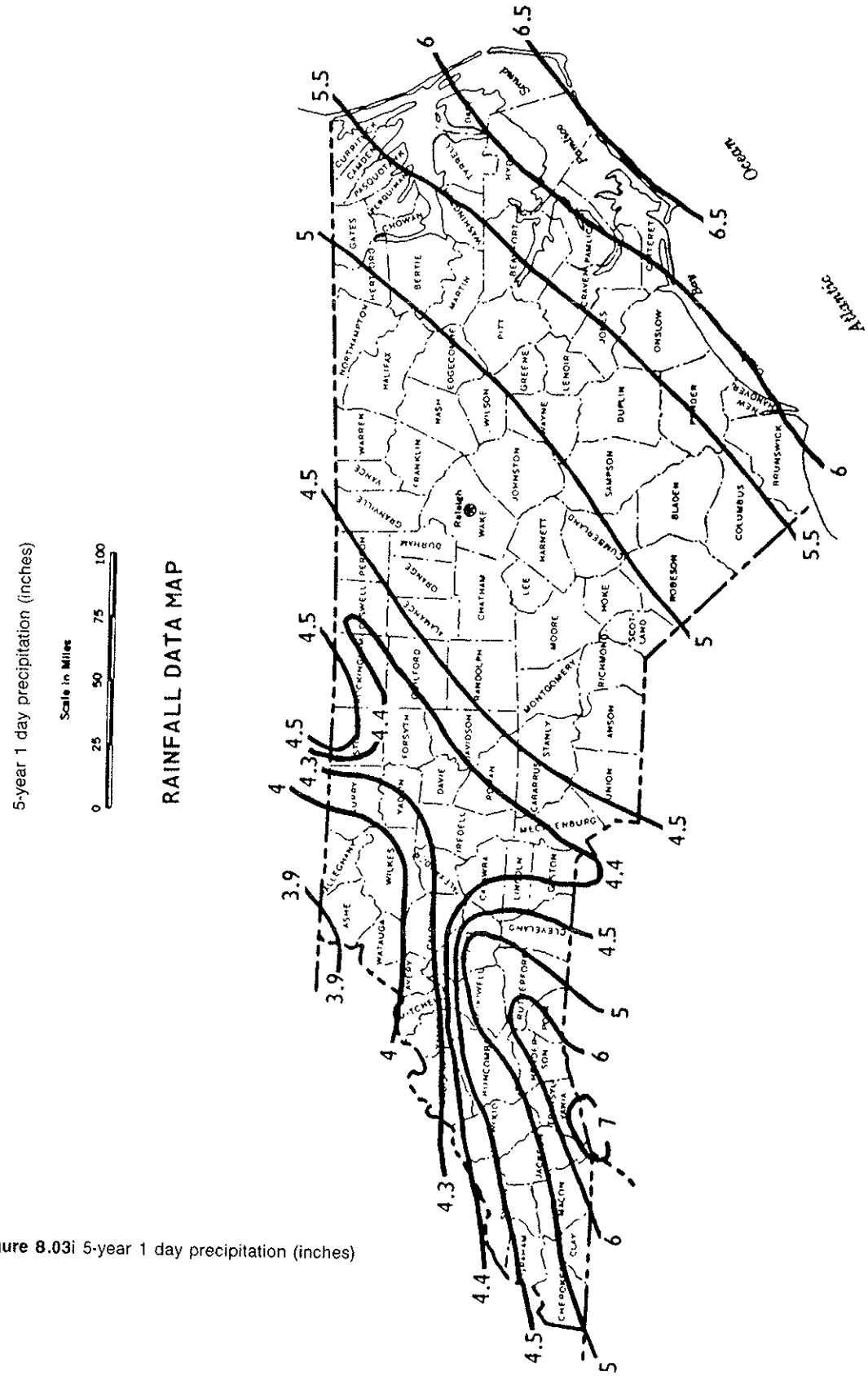

Figure 8.03i 5-year 1 day precipitation (inches)

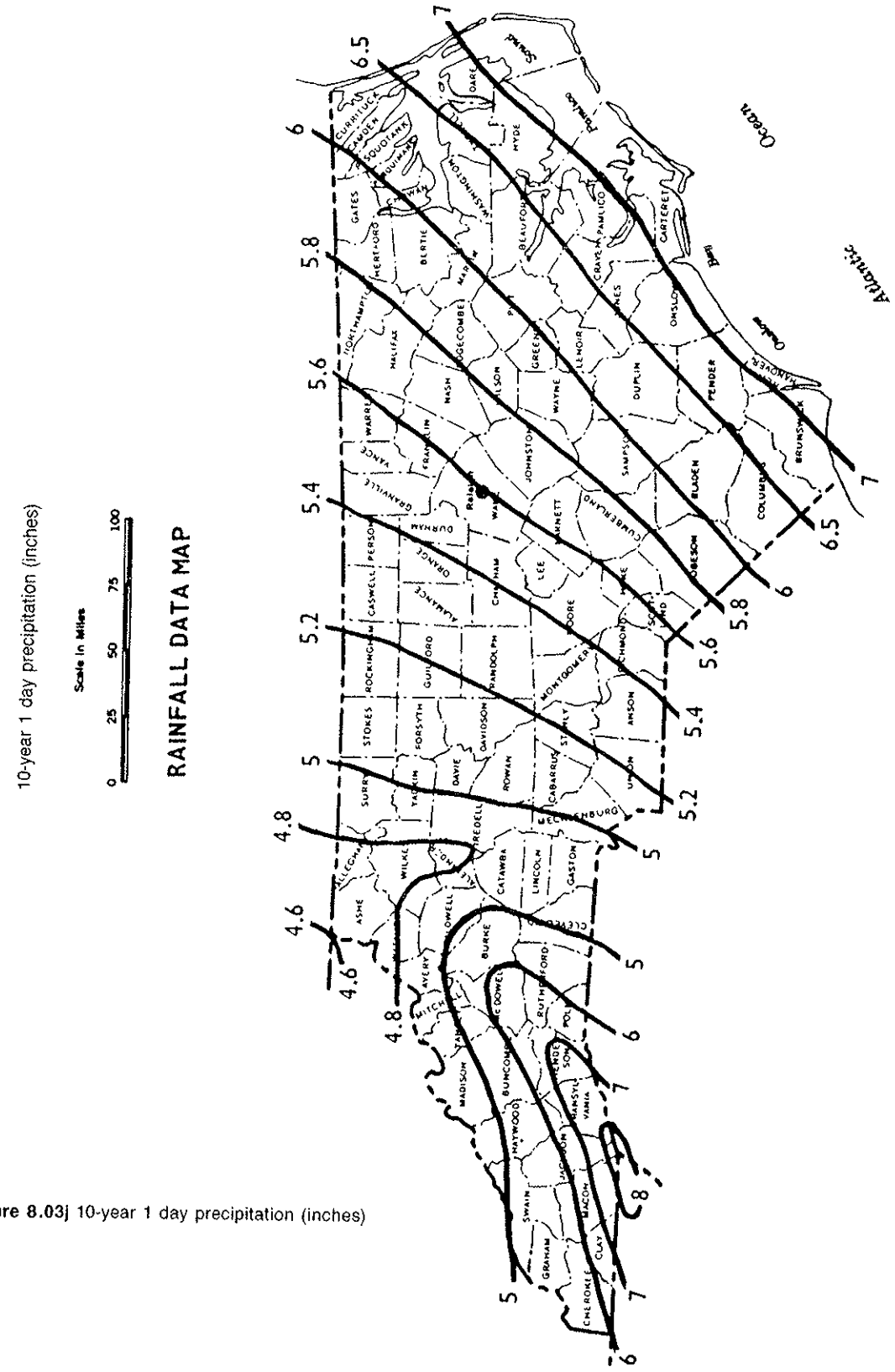

Figure 8.03j 10-year 1 day precipitation (inches)

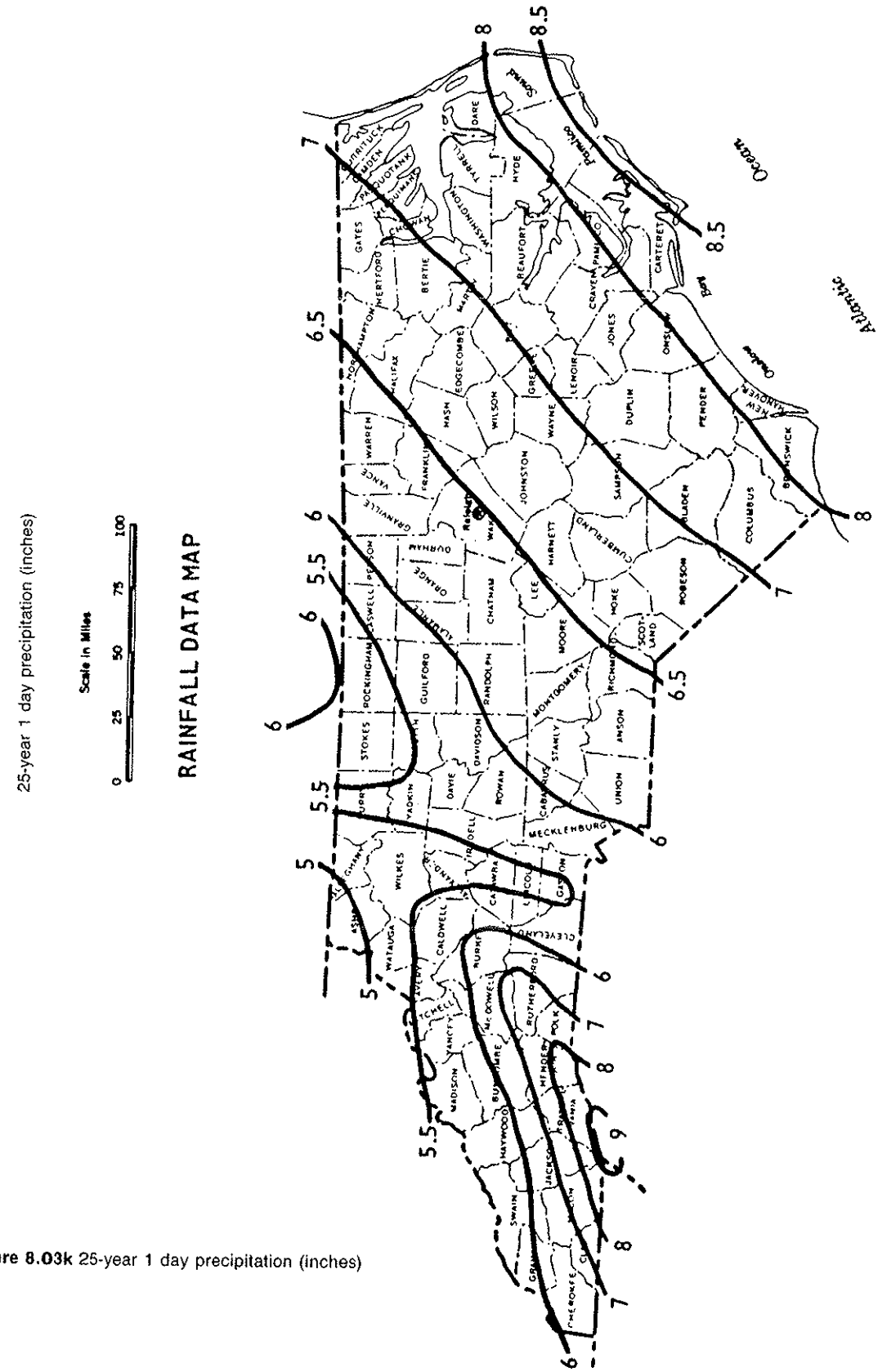

Figure 8.03k 25-year 1 day precipitation (inches)

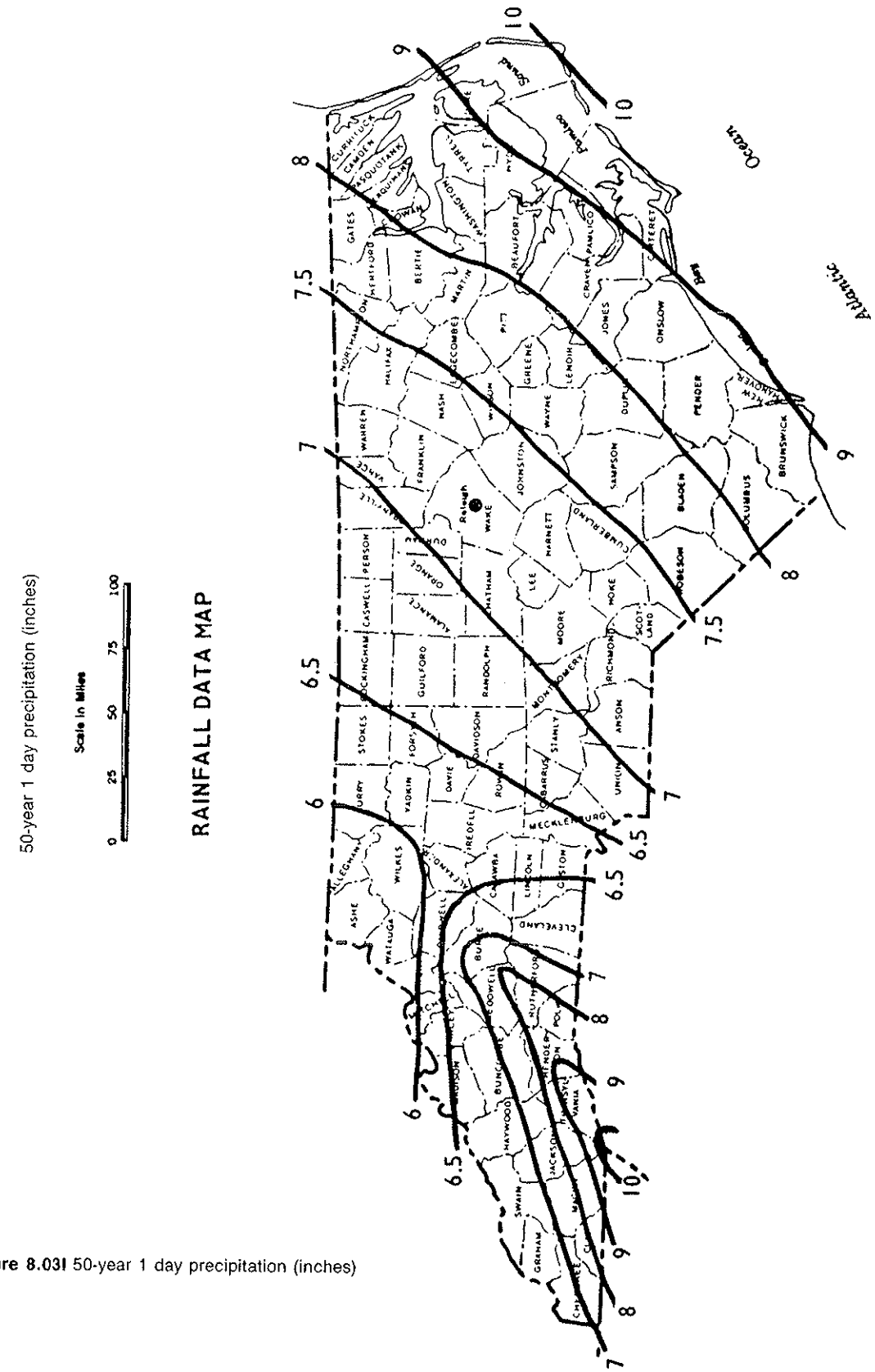

Figure 8.03I 50-year 1 day precipitation (inches)

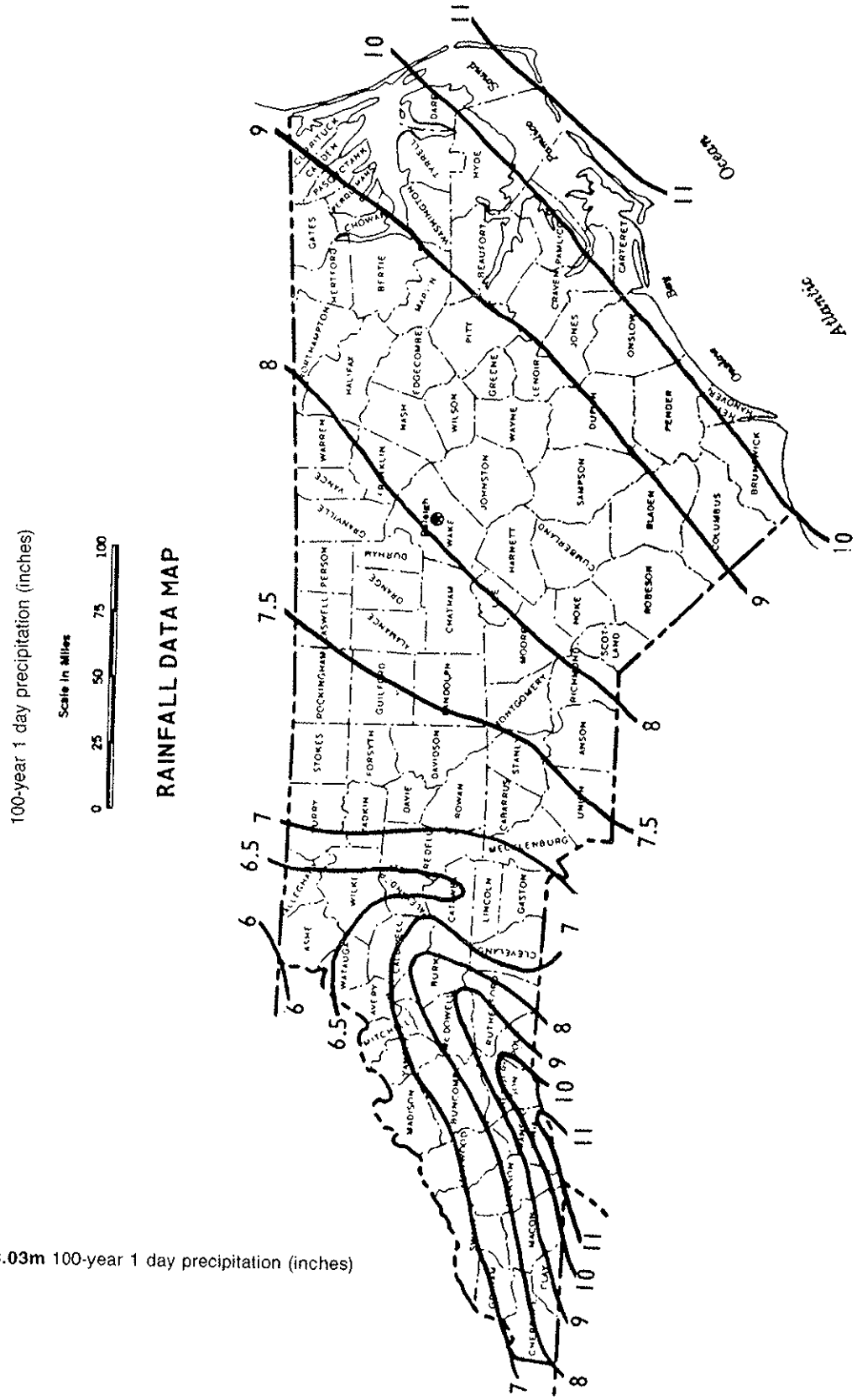

Figure 8.03m 100-year 1 day precipitation (inches)

c. **Hydrograph Summary Reports for 2 Year, 5 Year, 10 Year, 25 Year, 50 Year and 100 Year Return Periods**

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	2.193	1	723	6,011	----	------	------	Area to DD No. 1
2	SCS Runoff	2.734	1	730	10,550	----	------	------	Area to DD No. 2
3	Combine	4.516	1	725	16,561	1, 2	------	------	DD No. 2
4	SCS Runoff	2.806	1	727	9,507	----	------	------	Area to DD No. 3
5	Combine	7.302	1	726	26,068	3, 4	------	------	DD No. 3
6	SCS Runoff	1.791	1	717	3,356	----	------	------	Area to DD No. 4
7	SCS Runoff	2.070	1	718	4,163	----	------	------	Area to DD No. 5
8	SCS Runoff	2.401	1	720	5,460	----	------	------	Area to DD No. 6
9	Combine	4.371	1	719	9,623	7, 8	------	------	DD No. 6
10	SCS Runoff	1.765	1	719	3,731	----	------	------	Area to DD No. 7
11	Combine	6.136	1	719	13,354	9, 10	------	------	DD No. 7
12	SCS Runoff	3.045	1	721	7,443	----	------	------	Area to DD No. 8
13	SCS Runoff	3.195	1	720	7,263	----	------	------	Area to DD No. 9
14	Combine	6.225	1	720	14,706	12, 13	------	------	DD No. 9
15	SCS Runoff	1.288	1	725	3,912	----	------	------	Area to DD No. 10
	Combine	7.327	1	720	18,618	14, 15	------	------	DD No. 10
17	SCS Runoff	1.255	1	725	3,813	----	------	------	Area to DD No. 11
18	Combine	8.444	1	721	22,431	16, 17	------	------	DD No. 11
19	SCS Runoff	0.929	1	725	2,823	----	------	------	Area to DD No. 12
20	SCS Runoff	1.476	1	720	3,356	----	------	------	Area to DD No. 13
21	Combine	2.272	1	720	6,178	19, 20	------	------	DD No. 13
22	SCS Runoff	1.652	1	724	4,818	----	------	------	Area to DD No. 14
23	Combine	3.841	1	722	10,996	21, 22	------	------	DD No. 14
24	SCS Runoff	1.840	1	726	5,910	----	------	------	Area to DD No. 15
25	Combine	5.539	1	723	16,907	23, 24	------	------	DD No. 15
26	SCS Runoff	2.224	1	727	7,535	----	------	------	Area to DD No. 16
27	Combine	7.595	1	724	24,441	25, 26	------	------	DD No. 16
28	SCS Runoff	1.864	1	722	4,783	----	------	------	Area to DD No. 17
29	Combine	9.398	1	723	29,224	27, 28	------	------	DD No. 17
30	SCS Runoff	1.937	1	723	5,309	----	------	------	Area to DD No. 18

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	11.34	1	723	34,533	29, 30	------	------	DD No. 18
32	SCS Runoff	1.878	1	724	5,477	----	------	------	Area to DD No. 19
33	Combine	13.21	1	723	40,010	31, 32	------	------	DD No. 19
34	SCS Runoff	1.965	1	724	5,731	----	------	------	Area to DD No. 20
35	Combine	15.17	1	723	45,741	33, 34	------	------	DD No. 20
36	SCS Runoff	2.093	1	720	4,758	----	------	------	Area to DD No. 21
37	SCS Runoff	2.169	1	721	5,302	----	------	------	Area to DD No. 22
38	Combine	4.251	1	720	10,060	36, 37	------	------	DD No. 22
39	SCS Runoff	2.604	1	726	8,365	----	------	------	Area to DD No. 23
40	Combine	6.450	1	721	18,425	38, 39	------	------	DD No. 23
41	SCS Runoff	2.534	1	720	5,760	----	------	------	Area to DD No. 24
42	Combine	8.897	1	721	24,185	40, 41	------	------	DD No. 24
43	SCS Runoff	2.010	1	723	5,510	----	------	------	Area to DD No. 25
44	Combine	10.86	1	721	29,695	42, 43	------	------	DD No. 25
45	SCS Runoff	2.046	1	723	5,610	----	------	------	Area to DD No. 26
	Combine	12.86	1	721	35,305	44, 45	------	------	DD No. 26
47	SCS Runoff	2.156	1	723	5,910	----	------	------	Area to DD No. 27
48	Combine	14.97	1	721	41,215	46, 47	------	------	DD No. 27
49	SCS Runoff	2.104	1	724	6,136	----	------	------	Area to DD No. 28
50	Combine	16.96	1	722	47,351	48, 49	------	------	DD No. 28

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	1.132	1	720	2,575	----	-------	-------	Area to DD No. 29
2	SCS Runoff	1.456	1	719	3,077	----	-------	-------	Area to DD No. 30
3	Combine	2.580	1	719	5,651	1, 2	-------	-------	DD No. 30
4	SCS Runoff	1.937	1	723	5,309	----	-------	-------	Area to DD No. 31
5	Combine	4.342	1	720	10,960	3, 4	-------	-------	DD No. 31
6	SCS Runoff	1.924	1	725	5,843	----	-------	-------	Area to DD No. 32
7	Combine	6.025	1	721	16,804	5, 6	-------	-------	DD No. 32
8	SCS Runoff	2.030	1	727	6,877	----	-------	-------	Area to DD No. 33
9	Combine	7.715	1	722	23,681	7, 8	-------	-------	DD No. 33
10	SCS Runoff	4.385	1	723	12,021	----	-------	-------	Area to DD No. 34
11	SCS Runoff	5.581	1	724	16,279	----	-------	-------	Area to DD No. 35
12	Combine	9.955	1	723	28,300	10, 11	-------	-------	DD No. 35
13	SCS Runoff	5.998	1	724	17,496	----	-------	-------	Area to DD No. 36
14	Combine	15.94	1	723	45,796	12, 13	-------	-------	DD No. 36
15	SCS Runoff	4.885	1	724	14,251	----	-------	-------	Area to DD No. 37
	SCS Runoff	5.178	1	727	17,548	----	-------	-------	Area to DD No. 38
17	Combine	9.884	1	725	31,798	15, 16	-------	-------	DD No. 38
18	SCS Runoff	3.619	1	725	10,993	----	-------	-------	Area to DD No. 39
19	Combine	13.50	1	725	42,791	17, 18	-------	-------	DD No. 39
20	SCS Runoff	2.370	1	726	7,613	----	-------	-------	Area to DD No. 40
21	Combine	15.87	1	725	50,405	19, 20	-------	-------	DD No. 40
22	SCS Runoff	2.524	1	730	9,742	----	-------	-------	Area to DD No. 41
23	Combine	18.13	1	725	60,147	21, 22	-------	-------	DD No. 41
24	SCS Runoff	5.559	1	725	16,886	----	-------	-------	Area to DD No. 42
25	SCS Runoff	4.940	1	725	15,004	----	-------	-------	Area to DD No. 43
26	Combine	10.50	1	725	31,890	24, 25	-------	-------	DD No. 43
27	SCS Runoff	5.999	1	725	18,223	----	-------	-------	Area to DD No. 44
28	Combine	16.50	1	725	50,113	26, 27	-------	-------	DD No. 44
29	SCS Runoff	3.880	1	725	11,785	----	-------	-------	Area to DD No. 45
30	SCS Runoff	2.789	1	728	9,779	----	-------	-------	Area to DD No. 46

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	6.558	1	725	21,565	29, 30	------	------	DD No. 46
32	SCS Runoff	3.189	1	722	8,185	----	------	------	Area to DD No. 47
33	Combine	9.427	1	724	29,749	31, 32	------	------	DD No. 47
34	SCS Runoff	2.959	1	722	7,593	----	------	------	Area to DD No. 48
35	SCS Runoff	2.710	1	720	6,161	----	------	------	Area to DD No. 49
36	Combine	5.592	1	720	13,754	34, 35	------	------	DD No. 49
37	SCS Runoff	2.962	1	721	7,239	----	------	------	Area to DD No. 50
38	Combine	8.539	1	720	20,993	36, 37	------	------	DD No. 50
39	SCS Runoff	3.036	1	722	7,790	----	------	------	Area to DD No. 51
40	Combine	11.57	1	721	28,783	38, 39	------	------	DD No. 51
41	SCS Runoff	3.408	1	724	9,940	----	------	------	Area to DD No. 52
42	Combine	14.78	1	721	38,723	40, 41	------	------	DD No. 52

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	1.992	1	723	5,460	----	-------	------	Area to DD No. 53
2	SCS Runoff	3.087	1	721	7,545	----	-------	------	Area to DD No. 54
3	Combine	5.032	1	721	13,005	1, 2	------	------	DD No. 54
4	SCS Runoff	3.150	1	720	7,163	----	------	------	Area to DD No. 55
5	Combine	8.088	1	720	20,167	3, 4	------	------	DD No. 55
6	SCS Runoff	2.920	1	721	7,137	----	------	------	Area to DD No. 56
7	Combine	11.00	1	721	27,305	5, 6	------	------	DD No. 56
8	SCS Runoff	2.555	1	722	6,558	----	------	------	Area to DD No. 57
9	Combine	13.55	1	721	33,863	7, 8	------	------	DD No. 57
10	SCS Runoff	2.671	1	722	6,853	----	------	------	Area to DD No. 58
11	Combine	16.22	1	721	40,716	9, 10	------	------	DD No. 58
12	SCS Runoff	1.251	1	721	3,059	----	------	------	Area to DD No. 59
13	SCS Runoff	2.149	1	719	4,542	----	------	------	Area to DD No. 60
14	Combine	3.352	1	719	7,601	12, 13	------	------	DD No. 60
15	SCS Runoff	2.613	1	722	6,705	----	------	------	Area to DD No. 61
	Combine	5.848	1	720	14,306	14, 15	------	------	DD No. 61
17	SCS Runoff	2.382	1	722	6,114	----	------	------	Area to DD No. 62
18	Combine	8.169	1	720	20,420	16, 17	------	------	DD No. 62
19	SCS Runoff	3.942	1	721	9,636	----	------	------	Area to DD No. 63
20	Combine	12.09	1	720	30,056	18, 19	------	------	DD No. 63
21	SCS Runoff	4.098	1	720	9,316	----	------	------	Area to DD No. 64
22	Combine	16.19	1	720	39,372	20, 21	------	------	DD No. 64
23	SCS Runoff	4.088	1	721	9,993	----	------	------	Area to DD No. 65
24	SCS Runoff	2.628	1	721	6,424	----	------	------	Area to DD No. 66
25	Combine	6.716	1	721	16,416	23, 24	------	------	DD No. 66
26	SCS Runoff	2.286	1	722	5,867	----	------	------	Area to DD No. 67
27	Combine	9.000	1	721	22,284	25, 26	------	------	DD No. 67

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	3.321	1	724	9,686	----	------	------	SCC No. 1 Area
2	Manual	16.50	1	725	50,113	----	------	------	DD No. 44
3	Manual	9.427	1	724	29,749	----	------	------	DD No. 47
4	Combine	29.24	1	724	89,548	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	1.158	1	718	2,330	----	------	------	SCC No. 2 Area
6	Combine	29.69	1	724	91,878	4, 5	------	------	SCC No. 2
7	Manual	14.78	1	721	38,723	----	------	------	DD No. 52
8	SCS Runoff	1.843	1	724	5,376	----	------	------	SCC No. 3 Area
9	Combine	45.57	1	723	135,977	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	0.643	1	716	1,118	----	------	------	SCC No. 4 Area
11	Combine	45.67	1	723	137,094	9, 10	------	------	SCC No. 4
12	SCS Runoff	0.749	1	717	1,402	----	------	------	SCC No. 6
13	Manual	16.22	1	721	40,716	----	------	------	DD No. 58
14	SCS Runoff	2.704	1	728	9,481	----	------	------	SCC No. 5 Area
15	Combine	18.76	1	721	51,600	12, 13, 14	------	------	SCC No. 5
	Combine	64.03	1	722	188,694	11, 15	------	------	Pipe No. 400
17	Reservoir	1.393	1	1178	142,721	16	61.41	133,180	Sed. Basin 4-perm pool
18	Reservoir	21.04	1	738	188,681	16	64.27	62,739	Sed. Basin 4-ES
19	SCS Runoff	1.230	1	717	2,304	----	------	------	SCC No. 7
20	SCS Runoff	4.765	1	740	25,472	----	------	------	SCC No. 8 Area
21	Manual	16.19	1	720	39,372	----	------	------	DD No. 64
22	Manual	9.000	1	721	22,284	----	------	------	DD No. 67
23	Combine	27.97	1	720	89,431	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	1.960	1	722	5,029	----	------	------	SCC No. 9 Area
25	Manual	7.302	1	726	26,068	----	------	------	DD No. 3
26	Combine	36.26	1	721	120,528	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	2.311	1	719	4,884	----	------	------	SCC No. 10 Area
28	SCS Runoff	1.791	1	717	3,356	----	------	------	Area to DD No. 4
29	Combine	39.36	1	720	128,768	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	2.056	1	719	4,346	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	8.444	1	721	22,431	----	------	------	DD No. 11
32	SCS Runoff	1.107	1	716	1,925	----	------	------	SCC No. 12 Area
33	Combine	10.88	1	720	28,703	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	2.644	1	720	6,011	----	------	------	SCC No. 11 Area
35	Manual	6.136	1	719	13,354	----	------	------	DD No. 7
36	Combine	19.61	1	719	48,067	33, 34, 35	------	------	SCC No. 11
37	Combine	58.81	1	720	176,834	29, 36	------	------	Pipe No. 200
38	Reservoir	1.770	1	1046	102,412	37	52.10	117,530	Ex. Sed. Basin No. 2
39	Reservoir	15.20	1	744	176,825	37	57.66	58,277	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	3.096	1	719	6,544	----	------	------	SCC No. 14
2	Manual	15.17	1	723	45,741	----	------	------	DD No. 20
3	Combine	17.46	1	722	52,285	1, 2	------	------	Pipe No. 300
4	SCS Runoff	1.390	1	717	2,605	----	------	------	SCC No. 15
5	SCS Runoff	2.530	1	718	5,088	----	------	------	SCC No. 21
6	SCS Runoff	1.600	1	718	3,218	----	------	------	SCC No. 20 Area
7	Combine	4.130	1	718	8,306	5, 6	------	------	SCC No. 20
8	SCS Runoff	2.448	1	726	7,864	----	------	------	SCC No. 19 Area
9	Combine	5.797	1	718	16,170	7, 8	------	------	SCC No. 19
10	Manual	18.13	1	725	60,147	----	------	------	DD No. 41
11	Manual	15.94	1	723	45,796	----	------	------	DD No. 36
12	SCS Runoff	2.651	1	731	10,541	----	------	------	SSC No. 18 Area
13	Combine	40.03	1	724	132,654	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	7.715	1	722	23,681	----	------	------	DD No. 33
15	SCS Runoff	3.049	1	725	9,260	----	------	------	SCC No. 17 Area
	Combine	50.56	1	723	165,594	13, 14, 15	------	------	SCC No. 17
17	Manual	16.96	1	722	47,351	----	------	------	DD No. 28
18	SCS Runoff	3.373	1	724	9,838	----	------	------	SCC No. 16 Area
19	Combine	70.56	1	723	222,785	16, 17, 18	------	------	SCC No. 16
20	Combine	70.97	1	723	225,389	4, 19	------	------	Pipe No. 301
21	Combine	88.30	1	722	277,674	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	2.803	1	1042	173,449	21	56.41	182,292	Ex. Sed. Basin No. 3
23	Reservoir	40.23	1	736	277,669	21	61.22	78,837	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	3.824	1	722	10,299	----	------	------	Area to DD No. 1
2	SCS Runoff	4.815	1	729	18,077	----	------	------	Area to DD No. 2
3	Combine	7.968	1	725	28,376	1, 2	------	------	DD No. 2
4	SCS Runoff	4.928	1	726	16,290	----	------	------	Area to DD No. 3
5	Combine	12.85	1	725	44,666	3, 4	------	------	DD No. 3
6	SCS Runoff	3.051	1	717	5,750	----	------	------	Area to DD No. 4
7	SCS Runoff	3.542	1	718	7,133	----	------	------	Area to DD No. 5
8	SCS Runoff	4.135	1	719	9,355	----	------	------	Area to DD No. 6
9	Combine	7.542	1	718	16,488	7, 8	------	------	DD No. 6
10	SCS Runoff	3.024	1	719	6,393	----	------	------	Area to DD No. 7
11	Combine	10.56	1	718	22,881	9, 10	------	------	DD No. 7
12	SCS Runoff	5.271	1	720	12,754	----	------	------	Area to DD No. 8
13	SCS Runoff	5.500	1	719	12,444	----	------	------	Area to DD No. 9
14	Combine	10.77	1	720	25,198	12, 13	------	------	DD No. 9
15	SCS Runoff	2.256	1	724	6,703	----	------	------	Area to DD No. 10
	Combine	12.75	1	720	31,901	14, 15	------	------	DD No. 10
17	SCS Runoff	2.199	1	724	6,533	----	------	------	Area to DD No. 11
18	Combine	14.69	1	720	38,434	16, 17	------	------	DD No. 11
19	SCS Runoff	1.628	1	724	4,836	----	------	------	Area to DD No. 12
20	SCS Runoff	2.541	1	719	5,750	----	------	------	Area to DD No. 13
21	Combine	3.974	1	720	10,586	19, 20	------	------	DD No. 13
22	SCS Runoff	2.887	1	723	8,255	----	------	------	Area to DD No. 14
23	Combine	6.715	1	721	18,841	21, 22	------	------	DD No. 14
24	SCS Runoff	3.227	1	725	10,127	----	------	------	Area to DD No. 15
25	Combine	9.711	1	722	28,969	23, 24	------	------	DD No. 15
26	SCS Runoff	3.906	1	726	12,911	----	------	------	Area to DD No. 16
27	Combine	13.35	1	723	41,879	25, 26	------	------	DD No. 16
28	SCS Runoff	3.242	1	721	8,195	----	------	------	Area to DD No. 17
29	Combine	16.47	1	723	50,074	27, 28	------	------	DD No. 17
30	SCS Runoff	3.378	1	722	9,097	----	------	------	Area to DD No. 18

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	19.83	1	723	59,171	29, 30	------	------	DD No. 18
32	SCS Runoff	3.282	1	723	9,385	----	------	------	Area to DD No. 19
33	Combine	23.11	1	723	68,556	31, 32	------	------	DD No. 19
34	SCS Runoff	3.434	1	723	9,819	----	------	------	Area to DD No. 20
35	Combine	26.54	1	723	78,375	33, 34	------	------	DD No. 20
36	SCS Runoff	3.604	1	719	8,153	----	------	------	Area to DD No. 21
37	SCS Runoff	3.754	1	720	9,085	----	------	------	Area to DD No. 22
38	Combine	7.355	1	720	17,238	36, 37	------	------	DD No. 22
39	SCS Runoff	4.567	1	725	14,332	----	------	------	Area to DD No. 23
40	Combine	11.27	1	721	31,570	38, 39	------	------	DD No. 23
41	SCS Runoff	4.362	1	719	9,870	----	------	------	Area to DD No. 24
42	Combine	15.55	1	720	41,440	40, 41	------	------	DD No. 24
43	SCS Runoff	3.505	1	722	9,440	----	------	------	Area to DD No. 25
44	Combine	18.91	1	721	50,881	42, 43	------	------	DD No. 25
45	SCS Runoff	3.569	1	722	9,612	----	------	------	Area to DD No. 26
	Combine	22.43	1	721	60,493	44, 45	------	------	DD No. 26
47	SCS Runoff	3.760	1	722	10,127	----	------	------	Area to DD No. 27
48	Combine	26.13	1	721	70,620	46, 47	------	------	DD No. 27
49	SCS Runoff	3.677	1	723	10,514	----	------	------	Area to DD No. 28
50	Combine	29.65	1	721	81,134	48, 49	------	------	DD No. 28

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	1.950	1	719	4,411	----	------	------	Area to DD No. 29
2	SCS Runoff	2.494	1	719	5,272	----	------	------	Area to DD No. 30
3	Combine	4.443	1	719	9,683	1, 2	------	------	DD No. 30
4	SCS Runoff	3.378	1	722	9,097	----	------	------	Area to DD No. 31
5	Combine	7.536	1	720	18,780	3, 4	------	------	DD No. 31
6	SCS Runoff	3.370	1	724	10,012	----	------	------	Area to DD No. 32
7	Combine	10.50	1	720	28,792	5, 6	------	------	DD No. 32
8	SCS Runoff	3.565	1	726	11,784	----	------	------	Area to DD No. 33
9	Combine	13.54	1	721	40,576	7, 8	------	------	DD No. 33
10	SCS Runoff	7.648	1	722	20,597	----	------	------	Area to DD No. 34
11	SCS Runoff	9.755	1	723	27,893	----	------	------	Area to DD No. 35
12	Combine	17.37	1	723	48,491	10, 11	------	------	DD No. 35
13	SCS Runoff	10.48	1	723	29,979	----	------	------	Area to DD No. 36
14	Combine	27.85	1	723	78,470	12, 13	------	------	DD No. 36
15	SCS Runoff	8.539	1	723	24,418	----	------	------	Area to DD No. 37
	SCS Runoff	9.096	1	726	30,067	----	------	------	Area to DD No. 38
17	Combine	17.32	1	724	54,484	15, 16	------	------	DD No. 38
18	SCS Runoff	6.339	1	724	18,836	----	------	------	Area to DD No. 39
19	Combine	23.66	1	724	73,320	17, 18	------	------	DD No. 39
20	SCS Runoff	4.157	1	725	13,045	----	------	------	Area to DD No. 40
21	Combine	27.78	1	725	86,366	19, 20	------	------	DD No. 40
22	SCS Runoff	4.446	1	729	16,693	----	------	------	Area to DD No. 41
23	Combine	31.87	1	725	103,059	21, 22	------	------	DD No. 41
24	SCS Runoff	9.737	1	724	28,933	----	------	------	Area to DD No. 42
25	SCS Runoff	8.652	1	724	25,709	----	------	------	Area to DD No. 43
26	Combine	18.39	1	724	54,642	24, 25	------	------	DD No. 43
27	SCS Runoff	10.51	1	724	31,224	----	------	------	Area to DD No. 44
28	Combine	28.90	1	724	85,865	26, 27	------	------	DD No. 44
29	SCS Runoff	6.796	1	724	20,194	----	------	------	Area to DD No. 45
30	SCS Runoff	4.904	1	727	16,756	----	------	------	Area to DD No. 46

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	11.53	1	725	36,950	29, 30	------	------	DD No. 46
32	SCS Runoff	5.548	1	721	14,024	----	------	------	Area to DD No. 47
33	Combine	16.52	1	723	50,974	31, 32	------	------	DD No. 47
34	SCS Runoff	5.147	1	721	13,010	----	------	------	Area to DD No. 48
35	SCS Runoff	4.666	1	719	10,556	----	------	------	Area to DD No. 49
36	Combine	9.716	1	720	23,566	34, 35	------	------	DD No. 49
37	SCS Runoff	5.126	1	720	12,404	----	------	------	Area to DD No. 50
38	Combine	14.84	1	720	35,971	36, 37	------	------	DD No. 50
39	SCS Runoff	5.280	1	721	13,348	----	------	------	Area to DD No. 51
40	Combine	20.03	1	720	49,319	38, 39	------	------	DD No. 51
41	SCS Runoff	5.956	1	723	17,031	----	------	------	Area to DD No. 52
42	Combine	25.72	1	721	66,350	40, 41	------	------	DD No. 52

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	3.474	1	722	9,355	----	------	------	Area to DD No. 53
2	SCS Runoff	5.343	1	720	12,929	----	------	------	Area to DD No. 54
3	Combine	8.752	1	721	22,283	1, 2	------	------	DD No. 54
4	SCS Runoff	5.424	1	719	12,273	----	------	------	Area to DD No. 55
5	Combine	14.07	1	720	34,556	3, 4	------	------	DD No. 55
6	SCS Runoff	5.054	1	720	12,230	----	------	------	Area to DD No. 56
7	Combine	19.12	1	720	46,786	5, 6	------	------	DD No. 56
8	SCS Runoff	4.445	1	721	11,236	----	------	------	Area to DD No. 57
9	Combine	23.49	1	720	58,022	7, 8	------	------	DD No. 57
10	SCS Runoff	4.645	1	721	11,743	----	------	------	Area to DD No. 58
11	Combine	28.09	1	721	69,764	9, 10	------	------	DD No. 58
12	SCS Runoff	2.166	1	720	5,241	----	------	------	Area to DD No. 59
13	SCS Runoff	3.681	1	719	7,782	----	------	------	Area to DD No. 60
14	Combine	5.792	1	719	13,023	12, 13	------	------	DD No. 60
15	SCS Runoff	4.545	1	721	11,489	----	------	------	Area to DD No. 61
	Combine	10.13	1	720	24,513	14, 15	------	------	DD No. 61
17	SCS Runoff	4.144	1	721	10,476	----	------	------	Area to DD No. 62
18	Combine	14.20	1	720	34,988	16, 17	------	------	DD No. 62
19	SCS Runoff	6.823	1	720	16,510	----	------	------	Area to DD No. 63
20	Combine	21.02	1	720	51,499	18, 19	------	------	DD No. 63
21	SCS Runoff	7.055	1	719	15,963	----	------	------	Area to DD No. 64
22	Combine	28.07	1	720	67,462	20, 21	------	------	DD No. 64
23	SCS Runoff	7.076	1	720	17,122	----	------	------	Area to DD No. 65
24	SCS Runoff	4.549	1	720	11,007	----	------	------	Area to DD No. 66
25	Combine	11.62	1	720	28,128	23, 24	------	------	DD No. 66
26	SCS Runoff	3.977	1	721	10,053	----	------	------	Area to DD No. 67
27	Combine	15.58	1	721	38,182	25, 26	------	------	DD No. 67

Hydrograph Summary Report

Hyd. o.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	5.804	1	723	16,597	----	------	------	SCC No. 1 Area
2	Manual	28.90	1	724	85,865	----	------	------	DD No. 44
3	Manual	16.52	1	723	50,974	----	------	------	DD No. 47
4	Combine	51.18	1	724	153,436	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	1.982	1	718	3,992	----	------	------	SCC No. 2 Area
6	Combine	51.93	1	724	157,428	4, 5	------	------	SCC No. 2
7	Manual	25.72	1	721	66,350	----	------	------	DD No. 52
8	SCS Runoff	3.221	1	723	9,211	----	------	------	SCC No. 3 Area
9	Combine	79.73	1	722	232,989	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	1.089	1	716	1,915	----	------	------	SCC No. 4 Area
11	Combine	79.94	1	722	234,904	9, 10	------	------	SCC No. 4
12	SCS Runoff	1.275	1	717	2,403	----	------	------	SCC No. 6
13	Manual	28.09	1	721	69,764	----	------	------	DD No. 58
14	SCS Runoff	4.754	1	727	16,246	----	------	------	SCC No. 5 Area
15	Combine	32.66	1	721	88,413	12, 13, 14	------	------	SCC No. 5
	Combine	111.96	1	722	323,317	11, 15	------	------	Pipe No. 400
17	Reservoir	2.604	1	1099	232,987	16	62.40	230,246	Sed. Basin 4-perm pool
18	Reservoir	44.71	1	735	323,304	16	64.66	106,321	Sed. Basin 4-ES
19	SCS Runoff	2.095	1	717	3,948	----	------	------	SCC No. 7
20	SCS Runoff	8.454	1	740	43,644	----	------	------	SCC No. 8 Area
21	Manual	28.07	1	720	67,462	----	------	------	DD No. 64
22	Manual	15.58	1	721	38,182	----	------	------	DD No. 67
23	Combine	48.95	1	720	153,236	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	3.409	1	721	8,617	----	------	------	SCC No. 9 Area
25	Manual	12.85	1	725	44,666	----	------	------	DD No. 3
26	Combine	63.52	1	721	206,518	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	3.958	1	719	8,368	----	------	------	SCC No. 10 Area
28	SCS Runoff	3.051	1	717	5,750	----	------	------	Area to DD No. 4
29	Combine	69.11	1	720	220,636	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	3.523	1	719	7,447	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd.).	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	14.69	1	720	38,434	----	------	------	DD No. 11
32	SCS Runoff	1.876	1	716	3,299	----	------	------	SCC No. 12 Area
33	Combine	18.95	1	719	49,180	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	4.552	1	719	10,299	----	------	------	SCC No. 11 Area
35	Manual	10.56	1	718	22,881	----	------	------	DD No. 7
36	Combine	34.03	1	719	82,360	33, 34, 35	------	------	SCC No. 11
37	Combine	102.63	1	720	302,996	29, 36	------	------	Pipe No. 200
38	Reservoir	3.141	1	975	227,527	37	52.84	199,327	Ex. Sed. Basin No. 2
39	Reservoir	33.26	1	736	302,987	37	57.97	98,297	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd.).	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	5.304	1	719	11,213	----	------	------	SCC No. 14
2	Manual	26.54	1	723	78,375	----	------	------	DD No. 20
3	Combine	30.56	1	721	89,587	1, 2	------	------	Pipe No. 300
4	SCS Runoff	2.368	1	717	4,463	----	------	------	SCC No. 15
5	SCS Runoff	4.328	1	718	8,718	----	------	------	SCC No. 21
6	SCS Runoff	2.738	1	718	5,514	----	------	------	SCC No. 20 Area
7	Combine	7.066	1	718	14,232	5, 6	------	------	SCC No. 20
8	SCS Runoff	4.294	1	725	13,474	----	------	------	SCC No. 19 Area
9	Combine	10.15	1	718	27,706	7, 8	------	------	SCC No. 19
10	Manual	31.87	1	725	103,059	----	------	------	DD No. 41
11	Manual	27.85	1	723	78,470	----	------	------	DD No. 36
12	SCS Runoff	4.673	1	730	18,061	----	------	------	SSC No. 18 Area
13	Combine	70.39	1	723	227,295	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	13.54	1	721	40,576	----	------	------	DD No. 33
15	SCS Runoff	5.340	1	724	15,866	----	------	------	SCC No. 17 Area
	Combine	88.93	1	723	283,737	13, 14, 15	------	------	SCC No. 17
17	Manual	29.65	1	721	81,134	----	------	------	DD No. 28
18	SCS Runoff	5.895	1	723	16,858	----	------	------	SCC No. 16 Area
19	Combine	123.72	1	722	381,729	16, 17, 18	------	------	SCC No. 16
20	Combine	124.65	1	722	386,192	4, 19	------	------	Pipe No. 301
21	Combine	155.19	1	722	475,779	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	4.714	1	995	367,102	21	57.99	315,999	Ex. Sed. Basin No. 3
23	Reservoir	84.11	1	734	475,775	21	61.67	129,069	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	5.025	1	722	13,508	----	------	------	Area to DD No. 1
2	SCS Runoff	6.359	1	729	23,710	----	------	------	Area to DD No. 2
3	Combine	10.51	1	725	37,218	1, 2	------	------	DD No. 2
4	SCS Runoff	6.498	1	726	21,366	----	------	------	Area to DD No. 3
5	Combine	16.96	1	725	58,583	3, 4	------	------	DD No. 3
6	SCS Runoff	3.967	1	717	7,542	----	------	------	Area to DD No. 4
7	SCS Runoff	4.614	1	718	9,356	----	------	------	Area to DD No. 5
8	SCS Runoff	5.417	1	719	12,270	----	------	------	Area to DD No. 6
9	Combine	9.874	1	718	21,626	7, 8	------	------	DD No. 6
10	SCS Runoff	3.955	1	718	8,385	----	------	------	Area to DD No. 7
11	Combine	13.83	1	718	30,011	9, 10	------	------	DD No. 7
12	SCS Runoff	6.914	1	720	16,728	----	------	------	Area to DD No. 8
13	SCS Runoff	7.206	1	719	16,322	----	------	------	Area to DD No. 9
14	Combine	14.09	1	720	33,050	12, 13	------	------	DD No. 9
15	SCS Runoff	2.969	1	724	8,792	----	------	------	Area to DD No. 10
	Combine	16.74	1	720	41,841	14, 15	------	------	DD No. 10
17	SCS Runoff	2.894	1	724	8,569	----	------	------	Area to DD No. 11
18	Combine	19.31	1	720	50,410	16, 17	------	------	DD No. 11
19	SCS Runoff	2.142	1	724	6,343	----	------	------	Area to DD No. 12
20	SCS Runoff	3.329	1	719	7,542	----	------	------	Area to DD No. 13
21	Combine	5.225	1	720	13,885	19, 20	------	------	DD No. 13
22	SCS Runoff	3.798	1	723	10,827	----	------	------	Area to DD No. 14
23	Combine	8.838	1	721	24,712	21, 22	------	------	DD No. 14
24	SCS Runoff	4.251	1	725	13,283	----	------	------	Area to DD No. 15
25	Combine	12.79	1	722	37,995	23, 24	------	------	DD No. 15
26	SCS Runoff	5.150	1	726	16,933	----	------	------	Area to DD No. 16
27	Combine	17.60	1	723	54,929	25, 26	------	------	DD No. 16
28	SCS Runoff	4.254	1	721	10,748	----	------	------	Area to DD No. 17
29	Combine	21.69	1	722	65,677	27, 28	------	------	DD No. 17
30	SCS Runoff	4.438	1	722	11,932	----	------	------	Area to DD No. 18

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	26.13	1	722	77,609	29, 30	------	------	DD No. 18
32	SCS Runoff	4.318	1	723	12,309	----	------	------	Area to DD No. 19
33	Combine	30.40	1	722	89,918	31, 32	------	------	DD No. 19
34	SCS Runoff	4.517	1	723	12,879	----	------	------	Area to DD No. 20
35	Combine	34.91	1	723	102,796	33, 34	------	------	DD No. 20
36	SCS Runoff	4.721	1	719	10,694	----	------	------	Area to DD No. 21
37	SCS Runoff	4.925	1	720	11,916	----	------	------	Area to DD No. 22
38	Combine	9.627	1	720	22,609	36, 37	------	------	DD No. 22
39	SCS Runoff	6.017	1	725	18,798	----	------	------	Area to DD No. 23
40	Combine	14.82	1	721	41,408	38, 39	------	------	DD No. 23
41	SCS Runoff	5.715	1	719	12,945	----	------	------	Area to DD No. 24
42	Combine	20.45	1	720	54,353	40, 41	------	------	DD No. 24
43	SCS Runoff	4.606	1	722	12,382	----	------	------	Area to DD No. 25
44	Combine	24.86	1	720	66,735	42, 43	------	------	DD No. 25
45	SCS Runoff	4.690	1	722	12,607	----	------	------	Area to DD No. 26
	Combine	29.45	1	721	79,342	44, 45	------	------	DD No. 26
47	SCS Runoff	4.941	1	722	13,283	----	------	------	Area to DD No. 27
48	Combine	34.33	1	721	92,625	46, 47	------	------	DD No. 27
49	SCS Runoff	4.837	1	723	13,791	----	------	------	Area to DD No. 28
50	Combine	38.99	1	721	106,415	48, 49	------	------	DD No. 28

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	2.554	1	719	5,786	----	-------	-------	Area to DD No. 29
2	SCS Runoff	3.261	1	718	6,914	----	-------	-------	Area to DD No. 30
3	Combine	5.805	1	719	12,700	1, 2	------	------	DD No. 30
4	SCS Runoff	4.438	1	722	11,932	----	------	------	Area to DD No. 31
5	Combine	9.876	1	720	24,632	3, 4	------	------	DD No. 31
6	SCS Runoff	4.434	1	724	13,132	----	------	------	Area to DD No. 32
7	Combine	13.83	1	720	37,764	5, 6	------	------	DD No. 32
8	SCS Runoff	4.701	1	726	15,456	----	------	------	Area to DD No. 33
9	Combine	17.85	1	721	53,220	7, 8	------	------	DD No. 33
10	SCS Runoff	10.05	1	722	27,016	----	------	------	Area to DD No. 34
11	SCS Runoff	12.83	1	723	36,585	----	------	------	Area to DD No. 35
12	Combine	22.81	1	723	63,601	10, 11	------	------	DD No. 35
13	SCS Runoff	13.79	1	723	39,320	----	------	------	Area to DD No. 36
14	Combine	36.60	1	723	102,921	12, 13	------	------	DD No. 36
15	SCS Runoff	11.23	1	723	32,026	----	------	------	Area to DD No. 37
16	SCS Runoff	11.99	1	726	39,436	----	-------	-------	Area to DD No. 38
17	Combine	22.84	1	724	71,462	15, 16	------	------	DD No. 38
18	SCS Runoff	8.343	1	724	24,705	----	-------	-------	Area to DD No. 39
19	Combine	31.18	1	724	96,167	17, 18	-------	-------	DD No. 39
20	SCS Runoff	5.476	1	725	17,110	----	------	------	Area to DD No. 40
21	Combine	36.62	1	724	113,277	19, 20	------	------	DD No. 40
22	SCS Runoff	5.872	1	729	21,895	----	------	------	Area to DD No. 41
23	Combine	41.98	1	725	135,172	21, 22	------	------	DD No. 41
24	SCS Runoff	12.81	1	724	37,948	----	------	------	Area to DD No. 42
25	SCS Runoff	11.39	1	724	33,720	----	-------	-------	Area to DD No. 43
26	Combine	24.20	1	724	71,668	24, 25	-------	-------	DD No. 43
27	SCS Runoff	13.83	1	724	40,953	----	------	------	Area to DD No. 44
28	Combine	38.03	1	724	112,621	26, 27	------	------	DD No. 44
29	SCS Runoff	8.944	1	724	26,486	----	------	------	Area to DD No. 45
30	SCS Runoff	6.468	1	727	21,977	----	------	------	Area to DD No. 46

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	15.20	1	725	48,463	29, 30	------	------	DD No. 46
32	SCS Runoff	7.280	1	721	18,394	----	------	------	Area to DD No. 47
33	Combine	21.77	1	723	66,857	31, 32	------	------	DD No. 47
34	SCS Runoff	6.754	1	721	17,064	----	------	------	Area to DD No. 48
35	SCS Runoff	6.112	1	719	13,845	----	------	------	Area to DD No. 49
36	Combine	12.74	1	720	30,910	34, 35	------	------	DD No. 49
37	SCS Runoff	6.724	1	720	16,270	----	------	------	Area to DD No. 50
38	Combine	19.47	1	720	47,179	36, 37	------	------	DD No. 50
39	SCS Runoff	6.929	1	721	17,507	----	------	------	Area to DD No. 51
40	Combine	26.29	1	720	64,687	38, 39	------	------	DD No. 51
41	SCS Runoff	7.836	1	723	22,339	----	------	------	Area to DD No. 52
42	Combine	33.75	1	721	87,025	40, 41	------	------	DD No. 52

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	4.564	1	722	12,270	----	------	------	Area to DD No. 53
2	SCS Runoff	7.009	1	720	16,957	----	------	------	Area to DD No. 54
3	Combine	11.48	1	721	29,227	1, 2	------	------	DD No. 54
4	SCS Runoff	7.106	1	719	16,097	----	------	------	Area to DD No. 55
5	Combine	18.46	1	720	45,323	3, 4	------	------	DD No. 55
6	SCS Runoff	6.630	1	720	16,041	----	------	------	Area to DD No. 56
7	Combine	25.09	1	720	61,364	5, 6	------	------	DD No. 56
8	SCS Runoff	5.833	1	721	14,737	----	------	------	Area to DD No. 57
9	Combine	30.83	1	720	76,101	7, 8	------	------	DD No. 57
10	SCS Runoff	6.096	1	721	15,402	----	------	------	Area to DD No. 58
11	Combine	36.84	1	720	91,503	9, 10	------	------	DD No. 58
12	SCS Runoff	2.841	1	720	6,875	----	------	------	Area to DD No. 59
13	SCS Runoff	4.814	1	718	10,207	----	------	------	Area to DD No. 60
14	Combine	7.576	1	719	17,081	12, 13	------	------	DD No. 60
15	SCS Runoff	5.965	1	721	15,070	----	------	------	Area to DD No. 61
	Combine	13.27	1	720	32,151	14, 15	------	------	DD No. 61
17	SCS Runoff	5.438	1	721	13,740	----	------	------	Area to DD No. 62
18	Combine	18.62	1	720	45,891	16, 17	------	------	DD No. 62
19	SCS Runoff	8.950	1	720	21,655	----	------	------	Area to DD No. 63
20	Combine	27.57	1	720	67,546	18, 19	------	------	DD No. 63
21	SCS Runoff	9.243	1	719	20,937	----	------	------	Area to DD No. 64
22	Combine	36.78	1	720	88,483	20, 21	------	------	DD No. 64
23	SCS Runoff	9.282	1	720	22,457	----	------	------	Area to DD No. 65
24	SCS Runoff	5.967	1	720	14,436	----	------	------	Area to DD No. 66
25	Combine	15.25	1	720	36,893	23, 24	------	------	DD No. 66
26	SCS Runoff	5.219	1	721	13,186	----	------	------	Area to DD No. 67
27	Combine	20.39	1	721	50,079	25, 26	------	------	DD No. 67

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Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	7.636	1	723	21,769	----	------	------	SCC No. 1 Area
2	Manual	38.03	1	724	112,621	----	------	------	DD No. 44
3	Manual	21.77	1	723	66,857	----	------	------	DD No. 47
4	Combine	67.32	1	724	201,247	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	2.582	1	718	5,235	----	------	------	SCC No. 2 Area
6	Combine	68.39	1	723	206,483	4, 5	------	------	SCC No. 2
7	Manual	33.75	1	721	87,025	----	------	------	DD No. 52
8	SCS Runoff	4.238	1	723	12,081	----	------	------	SCC No. 3 Area
9	Combine	105.00	1	722	305,589	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	1.413	1	716	2,512	----	------	------	SCC No. 4 Area
11	Combine	105.27	1	722	308,100	9, 10	------	------	SCC No. 4
12	SCS Runoff	1.658	1	717	3,152	----	------	------	SCC No. 6
13	Manual	36.84	1	720	91,503	----	------	------	DD No. 58
14	SCS Runoff	6.271	1	727	21,308	----	------	------	SCC No. 5 Area
15	Combine	42.87	1	721	115,963	12, 13, 14	------	------	SCC No. 5
	Combine	147.20	1	722	424,063	11, 15	------	------	Pipe No. 400
17	Reservoir	3.854	1	1015	315,341	16	63.00	292,101	Sed. Basin 4-perm pool
18	Reservoir	57.08	1	735	424,051	16	64.96	139,660	Sed. Basin 4-ES
19	SCS Runoff	2.724	1	717	5,178	----	------	------	SCC No. 7
20	SCS Runoff	11.18	1	740	57,244	----	------	------	SCC No. 8 Area
21	Manual	36.78	1	720	88,483	----	------	------	DD No. 64
22	Manual	20.39	1	721	50,079	----	------	------	DD No. 67
23	Combine	64.39	1	720	200,984	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	4.473	1	721	11,302	----	------	------	SCC No. 9 Area
25	Manual	16.96	1	725	58,583	----	------	------	DD No. 3
26	Combine	83.58	1	721	270,870	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	5.176	1	718	10,975	----	------	------	SCC No. 10 Area
28	SCS Runoff	3.967	1	717	7,542	----	------	------	Area to DD No. 4
29	Combine	91.02	1	720	289,387	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	4.607	1	718	9,768	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	19.31	1	720	50,410	----	------	------	DD No. 11
32	SCS Runoff	2.435	1	716	4,327	----	------	------	SCC No. 12 Area
33	Combine	24.90	1	719	64,505	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	5.963	1	719	13,508	----	------	------	SCC No. 11 Area
35	Manual	13.83	1	718	30,011	----	------	------	DD No. 7
36	Combine	44.60	1	719	108,024	33, 34, 35	------	------	SCC No. 11
37	Combine	134.83	1	720	397,410	29, 36	------	------	Pipe No. 200
38	Reservoir	3.923	1	975	319,158	37	53.44	266,889	Ex. Sed. Basin No. 2
39	Reservoir	48.39	1	734	397,401	37	58.19	126,944	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	6.936	1	718	14,707	----	------	------	SCC No. 14
2	Manual	34.91	1	723	102,796	----	------	------	DD No. 20
3	Combine	40.27	1	721	117,503	1, 2	------	------	Pipe No. 300
4	SCS Runoff	3.079	1	717	5,853	----	------	------	SCC No. 15
5	SCS Runoff	5.639	1	718	11,434	----	------	------	SCC No. 21
6	SCS Runoff	3.567	1	718	7,232	----	------	------	SCC No. 20 Area
7	Combine	9.205	1	718	18,666	5, 6	------	------	SCC No. 20
8	SCS Runoff	5.657	1	725	17,673	----	------	------	SCC No. 19 Area
9	Combine	13.36	1	718	36,339	7, 8	------	------	SCC No. 19
10	Manual	41.98	1	725	135,172	----	------	------	DD No. 41
11	Manual	36.60	1	723	102,921	----	------	------	DD No. 36
12	SCS Runoff	6.173	1	730	23,688	----	------	------	SSC No. 18 Area
13	Combine	92.83	1	723	298,120	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	17.85	1	721	53,220	----	------	------	DD No. 33
15	SCS Runoff	7.027	1	724	20,810	----	------	------	SCC No. 17 Area
	Combine	117.20	1	723	372,150	13, 14, 15	------	------	SCC No. 17
17	Manual	38.99	1	721	106,415	----	------	------	DD No. 28
18	SCS Runoff	7.756	1	723	22,111	----	------	------	SCC No. 16 Area
19	Combine	163.12	1	722	500,676	16, 17, 18	------	------	SCC No. 16
20	Combine	164.31	1	722	506,529	4, 19	------	------	Pipe No. 301
21	Combine	204.46	1	722	624,034	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	5.706	1	1012	506,096	21	59.12	425,912	Ex. Sed. Basin No. 3
23	Reservoir	119.16	1	732	624,029	21	61.98	162,859	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	6.258	1	722	16,850	----	------	------	Area to DD No. 1
2	SCS Runoff	7.950	1	729	29,577	----	------	------	Area to DD No. 2
3	Combine	13.14	1	724	46,427	1, 2	------	------	DD No. 2
4	SCS Runoff	8.114	1	726	26,652	----	------	------	Area to DD No. 3
5	Combine	21.20	1	725	73,079	3, 4	------	------	DD No. 3
6	SCS Runoff	4.902	1	717	9,408	----	------	------	Area to DD No. 4
7	SCS Runoff	5.710	1	718	11,671	----	------	------	Area to DD No. 5
8	SCS Runoff	6.731	1	719	15,306	----	------	------	Area to DD No. 6
9	Combine	12.26	1	718	26,977	7, 8	------	------	DD No. 6
10	SCS Runoff	4.909	1	718	10,460	----	------	------	Area to DD No. 7
11	Combine	17.17	1	718	37,437	9, 10	------	------	DD No. 7
12	SCS Runoff	8.600	1	720	20,867	----	------	------	Area to DD No. 8
13	SCS Runoff	8.954	1	719	20,361	----	------	------	Area to DD No. 9
14	Combine	17.50	1	720	41,228	12, 13	------	------	DD No. 9
15	SCS Runoff	3.702	1	724	10,967	----	------	------	Area to DD No. 10
	Combine	20.82	1	720	52,195	14, 15	------	------	DD No. 10
17	SCS Runoff	3.608	1	724	10,689	----	------	------	Area to DD No. 11
18	Combine	24.06	1	720	62,884	16, 17	------	------	DD No. 11
19	SCS Runoff	2.671	1	724	7,913	----	------	------	Area to DD No. 12
20	SCS Runoff	4.137	1	719	9,408	----	------	------	Area to DD No. 13
21	Combine	6.510	1	720	17,321	19, 20	------	------	DD No. 13
22	SCS Runoff	4.734	1	723	13,506	----	------	------	Area to DD No. 14
23	Combine	11.02	1	721	30,827	21, 22	------	------	DD No. 14
24	SCS Runoff	5.305	1	725	16,569	----	------	------	Area to DD No. 15
25	Combine	15.96	1	722	47,397	23, 24	------	------	DD No. 15
26	SCS Runoff	6.431	1	726	21,123	----	------	------	Area to DD No. 16
27	Combine	21.97	1	723	68,520	25, 26	------	------	DD No. 16
28	SCS Runoff	5.293	1	721	13,408	----	------	------	Area to DD No. 17
29	Combine	27.08	1	722	81,928	27, 28	------	------	DD No. 17
30	SCS Runoff	5.527	1	722	14,884	----	------	------	Area to DD No. 18

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	32.61	1	722	96,812	29, 30	------	------	DD No. 18
32	SCS Runoff	5.382	1	723	15,355	----	------	------	Area to DD No. 19
33	Combine	37.94	1	722	112,167	31, 32	------	------	DD No. 19
34	SCS Runoff	5.631	1	723	16,066	----	------	------	Area to DD No. 20
35	Combine	43.52	1	722	128,232	33, 34	------	------	DD No. 20
36	SCS Runoff	5.866	1	719	13,340	----	------	------	Area to DD No. 21
37	SCS Runoff	6.126	1	720	14,864	----	------	------	Area to DD No. 22
38	Combine	11.96	1	720	28,204	36, 37	------	------	DD No. 22
39	SCS Runoff	7.508	1	725	23,450	----	------	------	Area to DD No. 23
40	Combine	18.46	1	721	51,654	38, 39	------	------	DD No. 23
41	SCS Runoff	7.101	1	719	16,148	----	------	------	Area to DD No. 24
42	Combine	25.47	1	720	67,802	40, 41	------	------	DD No. 24
43	SCS Runoff	5.736	1	722	15,446	----	------	------	Area to DD No. 25
44	Combine	30.99	1	720	83,248	42, 43	------	------	DD No. 25
45	SCS Runoff	5.840	1	722	15,727	----	------	------	Area to DD No. 26
	Combine	36.66	1	721	98,974	44, 45	------	------	DD No. 26
47	SCS Runoff	6.153	1	722	16,569	----	------	------	Area to DD No. 27
48	Combine	42.75	1	721	115,544	46, 47	------	------	DD No. 27
49	SCS Runoff	6.030	1	723	17,203	----	------	------	Area to DD No. 28
50	Combine	48.58	1	721	132,746	48, 49	------	------	DD No. 28

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	3.174	1	719	7,217	----	-------	------	Area to DD No. 29
2	SCS Runoff	4.048	1	718	8,625	----	-------	------	Area to DD No. 30
3	Combine	7.198	1	719	15,843	1, 2	-------	------	DD No. 30
4	SCS Runoff	5.527	1	722	14,884	----	-------	------	Area to DD No. 31
5	Combine	12.28	1	720	30,727	3, 4	-------	------	DD No. 31
6	SCS Runoff	5.529	1	724	16,381	----	-------	------	Area to DD No. 32
7	Combine	17.24	1	720	47,108	5, 6	-------	------	DD No. 32
8	SCS Runoff	5.870	1	726	19,280	----	-------	------	Area to DD No. 33
9	Combine	22.28	1	721	66,388	7, 8	-------	------	DD No. 33
10	SCS Runoff	12.52	1	722	33,700	----	-------	------	Area to DD No. 34
11	SCS Runoff	16.00	1	723	45,637	----	-------	------	Area to DD No. 35
12	Combine	28.40	1	723	79,338	10, 11	-------	------	DD No. 35
13	SCS Runoff	17.19	1	723	49,050	----	-------	------	Area to DD No. 36
14	Combine	45.59	1	723	128,387	12, 13	-------	------	DD No. 36
15	SCS Runoff	14.00	1	723	39,951	----	-------	------	Area to DD No. 37
	SCS Runoff	14.98	1	726	49,193	----	-------	------	Area to DD No. 38
17	Combine	28.52	1	724	89,144	15, 16	-------	------	DD No. 38
18	SCS Runoff	10.40	1	724	30,818	----	-------	------	Area to DD No. 39
19	Combine	38.92	1	724	119,962	17, 18	-------	------	DD No. 39
20	SCS Runoff	6.833	1	725	21,343	----	-------	------	Area to DD No. 40
21	Combine	45.71	1	724	141,306	19, 20	-------	------	DD No. 40
22	SCS Runoff	7.341	1	729	27,312	----	-------	------	Area to DD No. 41
23	Combine	52.39	1	725	168,618	21, 22	-------	------	DD No. 41
24	SCS Runoff	15.98	1	724	47,338	----	-------	------	Area to DD No. 42
25	SCS Runoff	14.20	1	724	42,063	----	-------	------	Area to DD No. 43
26	Combine	30.17	1	724	89,401	24, 25	-------	------	DD No. 43
27	SCS Runoff	17.24	1	724	51,086	----	-------	------	Area to DD No. 44
28	Combine	47.42	1	724	140,488	26, 27	-------	------	DD No. 44
29	SCS Runoff	11.15	1	724	33,040	----	-------	------	Area to DD No. 45
30	SCS Runoff	8.077	1	727	27,415	----	-------	------	Area to DD No. 46

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	18.97	1	725	60,455	29, 30	------	------	DD No. 46
32	SCS Runoff	9.058	1	721	22,945	----	------	------	Area to DD No. 47
33	Combine	27.17	1	723	83,400	31, 32	------	------	DD No. 47
34	SCS Runoff	8.403	1	721	21,286	----	------	------	Area to DD No. 48
35	SCS Runoff	7.595	1	719	17,271	----	------	------	Area to DD No. 49
36	Combine	15.84	1	720	38,558	34, 35	------	------	DD No. 49
37	SCS Runoff	8.364	1	720	20,295	----	------	------	Area to DD No. 50
38	Combine	24.21	1	720	58,853	36, 37	------	------	DD No. 50
39	SCS Runoff	8.621	1	721	21,839	----	------	------	Area to DD No. 51
40	Combine	32.72	1	720	80,693	38, 39	------	------	DD No. 51
41	SCS Runoff	9.767	1	723	27,866	----	------	------	Area to DD No. 52
42	Combine	41.98	1	721	108,558	40, 41	------	------	DD No. 52

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	5.684	1	722	15,306	----	------	------	Area to DD No. 53
2	SCS Runoff	8.718	1	720	21,153	----	------	------	Area to DD No. 54
3	Combine	14.28	1	721	36,458	1, 2	------	------	DD No. 54
4	SCS Runoff	8.830	1	719	20,080	----	------	------	Area to DD No. 55
5	Combine	22.96	1	720	56,538	3, 4	------	------	DD No. 55
6	SCS Runoff	8.246	1	720	20,010	----	------	------	Area to DD No. 56
7	Combine	31.21	1	720	76,548	5, 6	------	------	DD No. 56
8	SCS Runoff	7.257	1	721	18,384	----	------	------	Area to DD No. 57
9	Combine	38.37	1	720	94,931	7, 8	------	------	DD No. 57
10	SCS Runoff	7.585	1	721	19,213	----	------	------	Area to DD No. 58
11	Combine	45.86	1	720	114,144	9, 10	------	------	DD No. 58
12	SCS Runoff	3.534	1	720	8,576	----	------	------	Area to DD No. 59
13	SCS Runoff	5.976	1	718	12,732	----	------	------	Area to DD No. 60
14	Combine	9.404	1	719	21,308	12, 13	------	------	DD No. 60
15	SCS Runoff	7.421	1	721	18,798	----	------	------	Area to DD No. 61
	Combine	16.48	1	719	40,106	14, 15	------	------	DD No. 61
17	SCS Runoff	6.766	1	721	17,140	----	------	------	Area to DD No. 62
18	Combine	23.16	1	720	57,246	16, 17	------	------	DD No. 62
19	SCS Runoff	11.13	1	720	27,013	----	------	------	Area to DD No. 63
20	Combine	34.29	1	720	84,259	18, 19	------	------	DD No. 63
21	SCS Runoff	11.49	1	719	26,118	----	------	------	Area to DD No. 64
22	Combine	45.70	1	720	110,377	20, 21	------	------	DD No. 64
23	SCS Runoff	11.54	1	720	28,013	----	------	------	Area to DD No. 65
24	SCS Runoff	7.422	1	720	18,009	----	------	------	Area to DD No. 66
25	Combine	18.97	1	720	46,022	23, 24	------	------	DD No. 66
26	SCS Runoff	6.493	1	721	16,449	----	------	------	Area to DD No. 67
27	Combine	25.38	1	720	62,470	25, 26	------	------	DD No. 67

Hydrograph Summary Report

Hyd. o.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	9.518	1	723	27,155	----	------	------	SCC No. 1 Area
2	Manual	47.42	1	724	140,488	----	------	------	DD No. 44
3	Manual	27.17	1	723	83,400	----	------	------	DD No. 47
4	Combine	83.90	1	724	251,043	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	3.195	1	718	6,531	----	------	------	SCC No. 2 Area
6	Combine	85.35	1	723	257,573	4, 5	------	------	SCC No. 2
7	Manual	41.98	1	721	108,558	----	------	------	DD No. 52
8	SCS Runoff	5.282	1	723	15,070	----	------	------	SCC No. 3 Area
9	Combine	130.98	1	722	381,202	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	1.748	1	715	3,133	----	------	------	SCC No. 4 Area
11	Combine	131.32	1	722	384,335	9, 10	------	------	SCC No. 4
12	SCS Runoff	2.049	1	717	3,932	----	------	------	SCC No. 6
13	Manual	45.86	1	720	114,144	----	------	------	DD No. 58
14	SCS Runoff	7.831	1	727	26,580	----	------	------	SCC No. 5 Area
15	Combine	53.43	1	720	144,656	12, 13, 14	------	------	SCC No. 5
16	Combine	183.50	1	721	528,991	11, 15	------	------	Pipe No. 400
17	Reservoir	5.335	1	957	401,061	16	63.68	362,330	Sed. Basin 4-perm pool
18	Reservoir	63.13	1	736	528,978	16	65.31	179,288	Sed. Basin 4-ES
19	SCS Runoff	3.366	1	717	6,459	----	------	------	SCC No. 7
20	SCS Runoff	13.99	1	740	71,408	----	------	------	SCC No. 8 Area
21	Manual	45.70	1	720	110,376	----	------	------	DD No. 64
22	Manual	25.38	1	720	62,470	----	------	------	DD No. 67
23	Combine	80.25	1	720	250,715	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	5.566	1	721	14,099	----	------	------	SCC No. 9 Area
25	Manual	21.20	1	725	73,079	----	------	------	DD No. 3
26	Combine	104.21	1	721	337,892	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	6.425	1	718	13,691	----	------	------	SCC No. 10 Area
28	SCS Runoff	4.902	1	717	9,408	----	------	------	Area to DD No. 4
29	Combine	113.54	1	720	360,991	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	5.719	1	718	12,185	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd. o.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	24.06	1	720	62,884	----	------	------	DD No. 11
32	SCS Runoff	3.011	1	715	5,397	----	------	------	SCC No. 12 Area
33	Combine	31.01	1	719	80,466	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	7.410	1	719	16,850	----	------	------	SCC No. 11 Area
35	Manual	17.17	1	718	37,437	----	------	------	DD No. 7
36	Combine	55.43	1	719	134,753	33, 34, 35	------	------	SCC No. 11
37	Combine	167.89	1	720	495,743	29, 36	------	------	Pipe No. 200
38	Reservoir	4.614	1	983	409,705	37	54.09	339,799	Ex. Sed. Basin No. 2
39	Reservoir	57.33	1	734	495,735	37	58.43	158,749	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	8.610	1	718	18,346	----	------	------	SCC No. 14
2	Manual	43.52	1	722	128,232	----	------	------	DD No. 20
3	Combine	50.25	1	721	146,578	1, 2	------	------	Pipe No. 300
4	SCS Runoff	3.805	1	717	7,302	----	------	------	SCC No. 15
5	SCS Runoff	6.978	1	718	14,263	----	------	------	SCC No. 21
6	SCS Runoff	4.414	1	718	9,021	----	------	------	SCC No. 20 Area
7	Combine	11.39	1	718	23,285	5, 6	------	------	SCC No. 20
8	SCS Runoff	7.058	1	725	22,046	----	------	------	SCC No. 19 Area
9	Combine	16.66	1	718	45,330	7, 8	------	------	SCC No. 19
10	Manual	52.39	1	725	168,618	----	------	------	DD No. 41
11	Manual	45.59	1	723	128,387	----	------	------	DD No. 36
12	SCS Runoff	7.718	1	730	29,550	----	------	------	SSC No. 18 Area
13	Combine	115.91	1	723	371,885	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	22.28	1	721	66,388	----	------	------	DD No. 33
15	SCS Runoff	8.762	1	724	25,960	----	------	------	SCC No. 17 Area
	Combine	146.28	1	723	464,233	13, 14, 15	------	------	SCC No. 17
17	Manual	48.58	1	721	132,746	----	------	------	DD No. 28
18	SCS Runoff	9.667	1	723	27,582	----	------	------	SCC No. 16 Area
19	Combine	203.66	1	722	624,561	16, 17, 18	------	------	SCC No. 16
20	Combine	205.11	1	722	631,862	4, 19	------	------	Pipe No. 301
21	Combine	255.14	1	722	778,441	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	6.585	1	1032	636,329	21	60.31	544,418	Ex. Sed. Basin No. 3
23	Reservoir	154.31	1	732	778,436	21	62.26	196,453	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	7.580	1	722	20,485	----	------	------	Area to DD No. 1
2	SCS Runoff	9.661	1	729	35,957	----	------	------	Area to DD No. 2
3	Combine	15.97	1	724	56,442	1, 2	------	------	DD No. 2
4	SCS Runoff	9.850	1	726	32,402	----	------	------	Area to DD No. 3
5	Combine	25.75	1	725	88,843	3, 4	------	------	DD No. 3
6	SCS Runoff	5.909	1	716	11,437	----	------	------	Area to DD No. 4
7	SCS Runoff	6.886	1	717	14,189	----	------	------	Area to DD No. 5
8	SCS Runoff	8.139	1	719	18,607	----	------	------	Area to DD No. 6
9	Combine	14.82	1	718	32,796	7, 8	------	------	DD No. 6
10	SCS Runoff	5.931	1	718	12,716	----	------	------	Area to DD No. 7
11	Combine	20.76	1	718	45,512	9, 10	------	------	DD No. 7
12	SCS Runoff	10.41	1	720	25,368	----	------	------	Area to DD No. 8
13	SCS Runoff	10.83	1	719	24,753	----	------	------	Area to DD No. 9
14	Combine	21.15	1	720	50,121	12, 13	------	------	DD No. 9
15	SCS Runoff	4.488	1	724	13,333	----	------	------	Area to DD No. 10
	Combine	25.20	1	720	63,454	14, 15	------	------	DD No. 10
17	SCS Runoff	4.375	1	724	12,995	----	------	------	Area to DD No. 11
18	Combine	29.16	1	720	76,449	16, 17	------	------	DD No. 11
19	SCS Runoff	3.238	1	724	9,620	----	------	------	Area to DD No. 12
20	SCS Runoff	5.003	1	719	11,437	----	------	------	Area to DD No. 13
21	Combine	7.890	1	720	21,057	19, 20	------	------	DD No. 13
22	SCS Runoff	5.739	1	723	16,420	----	------	------	Area to DD No. 14
23	Combine	13.36	1	721	37,477	21, 22	------	------	DD No. 14
24	SCS Runoff	6.437	1	725	20,144	----	------	------	Area to DD No. 15
25	Combine	19.37	1	722	57,621	23, 24	------	------	DD No. 15
26	SCS Runoff	7.807	1	726	25,680	----	------	------	Area to DD No. 16
27	Combine	26.66	1	723	83,301	25, 26	------	------	DD No. 16
28	SCS Runoff	6.407	1	721	16,300	----	------	------	Area to DD No. 17
29	Combine	32.88	1	722	99,601	27, 28	------	------	DD No. 17
30	SCS Runoff	6.696	1	722	18,095	----	------	------	Area to DD No. 18

Hydrograph Summary Report

Hyd. ›.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	39.57	1	722	117,696	29, 30	------	------	DD No. 18
32	SCS Runoff	6.524	1	723	18,667	----	------	------	Area to DD No. 19
33	Combine	46.05	1	722	136,363	31, 32	------	------	DD No. 19
34	SCS Runoff	6.826	1	723	19,531	----	------	------	Area to DD No. 20
35	Combine	52.83	1	722	155,894	33, 34	------	------	DD No. 20
36	SCS Runoff	7.093	1	719	16,217	----	------	------	Area to DD No. 21
37	SCS Runoff	7.413	1	720	18,071	----	------	------	Area to DD No. 22
38	Combine	14.45	1	720	34,288	36, 37	------	------	DD No. 22
39	SCS Runoff	9.109	1	725	28,508	----	------	------	Area to DD No. 23
40	Combine	22.37	1	721	62,796	38, 39	------	------	DD No. 23
41	SCS Runoff	8.587	1	719	19,631	----	------	------	Area to DD No. 24
42	Combine	30.86	1	720	82,428	40, 41	------	------	DD No. 24
43	SCS Runoff	6.949	1	722	18,778	----	------	------	Area to DD No. 25
44	Combine	37.57	1	720	101,206	42, 43	------	------	DD No. 25
45	SCS Runoff	7.075	1	722	19,119	----	------	------	Area to DD No. 26
	Combine	44.40	1	720	120,325	44, 45	------	------	DD No. 26
47	SCS Runoff	7.454	1	722	20,144	----	------	------	Area to DD No. 27
48	Combine	51.79	1	721	140,469	46, 47	------	------	DD No. 27
49	SCS Runoff	7.310	1	723	20,914	----	------	------	Area to DD No. 28
50	Combine	58.88	1	721	161,382	48, 49	------	------	DD No. 28

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	3.838	1	719	8,774	----	------	------	Area to DD No. 29
2	SCS Runoff	4.891	1	718	10,486	----	------	------	Area to DD No. 30
3	Combine	8.690	1	719	19,260	1, 2	------	------	DD No. 30
4	SCS Runoff	6.696	1	722	18,095	----	------	------	Area to DD No. 31
5	Combine	14.87	1	719	37,355	3, 4	------	------	DD No. 31
6	SCS Runoff	6.704	1	724	19,915	----	------	------	Area to DD No. 32
7	Combine	20.91	1	720	57,270	5, 6	------	------	DD No. 32
8	SCS Runoff	7.126	1	726	23,440	----	------	------	Area to DD No. 33
9	Combine	27.04	1	721	80,710	7, 8	------	------	DD No. 33
10	SCS Runoff	15.16	1	722	40,970	----	------	------	Area to DD No. 34
11	SCS Runoff	19.39	1	723	55,482	----	------	------	Area to DD No. 35
12	Combine	34.41	1	722	96,452	10, 11	------	------	DD No. 35
13	SCS Runoff	20.84	1	723	59,630	----	------	------	Area to DD No. 36
14	Combine	55.23	1	723	156,083	12, 13	------	------	DD No. 36
15	SCS Runoff	16.97	1	723	48,569	----	------	------	Area to DD No. 37
	SCS Runoff	18.18	1	726	59,805	----	------	------	Area to DD No. 38
17	Combine	34.62	1	724	108,374	15, 16	------	------	DD No. 38
18	SCS Runoff	12.61	1	724	37,467	----	------	------	Area to DD No. 39
19	Combine	47.23	1	724	145,841	17, 18	------	------	DD No. 39
20	SCS Runoff	8.291	1	725	25,948	----	------	------	Area to DD No. 40
21	Combine	55.48	1	724	171,788	19, 20	------	------	DD No. 40
22	SCS Runoff	8.921	1	729	33,204	----	------	------	Area to DD No. 41
23	Combine	63.56	1	725	204,992	21, 22	------	------	DD No. 41
24	SCS Runoff	19.37	1	724	57,550	----	------	------	Area to DD No. 42
25	SCS Runoff	17.21	1	724	51,137	----	------	------	Area to DD No. 43
26	Combine	36.59	1	724	108,687	24, 25	------	------	DD No. 43
27	SCS Runoff	20.91	1	724	62,107	----	------	------	Area to DD No. 44
28	Combine	57.50	1	724	170,794	26, 27	------	------	DD No. 44
29	SCS Runoff	13.52	1	724	40,167	----	------	------	Area to DD No. 45
30	SCS Runoff	9.808	1	727	33,329	----	------	------	Area to DD No. 46

Hydrograph Summary Report

Hyd. ›.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	23.02	1	725	73,496	29, 30	-------	------	DD No. 46
32	SCS Runoff	10.96	1	721	27,895	----	-------	------	Area to DD No. 47
33	Combine	32.98	1	723	101,391	31, 32	-------	------	DD No. 47
34	SCS Runoff	10.17	1	721	25,878	----	-------	------	Area to DD No. 48
35	SCS Runoff	9.184	1	719	20,997	----	-------	------	Area to DD No. 49
36	Combine	19.17	1	720	46,875	34, 35	-------	------	DD No. 49
37	SCS Runoff	10.12	1	720	24,673	----	-------	------	Area to DD No. 50
38	Combine	29.29	1	720	71,549	36, 37	-------	------	DD No. 50
39	SCS Runoff	10.44	1	721	26,550	----	-------	------	Area to DD No. 51
40	Combine	39.61	1	720	98,099	38, 39	-------	------	DD No. 51
41	SCS Runoff	11.84	1	723	33,877	----	-------	------	Area to DD No. 52
42	Combine	50.81	1	721	131,976	40, 41	-------	------	DD No. 52

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	6.885	1	722	18,607	----	------	------	Area to DD No. 53
2	SCS Runoff	10.55	1	720	25,716	----	------	------	Area to DD No. 54
3	Combine	17.28	1	721	44,323	1, 2	------	------	DD No. 54
4	SCS Runoff	10.68	1	719	24,411	----	------	------	Area to DD No. 55
5	Combine	27.79	1	720	68,734	3, 4	------	------	DD No. 55
6	SCS Runoff	9.980	1	720	24,326	----	------	------	Area to DD No. 56
7	Combine	37.77	1	720	93,060	5, 6	------	------	DD No. 56
8	SCS Runoff	8.784	1	721	22,349	----	------	------	Area to DD No. 57
9	Combine	46.45	1	720	115,410	7, 8	------	------	DD No. 57
10	SCS Runoff	9.181	1	721	23,358	----	------	------	Area to DD No. 58
11	Combine	55.53	1	720	138,768	9, 10	------	------	DD No. 58
12	SCS Runoff	4.277	1	720	10,425	----	------	------	Area to DD No. 59
13	SCS Runoff	7.220	1	718	15,479	----	------	------	Area to DD No. 60
14	Combine	11.36	1	719	25,904	12, 13	------	------	DD No. 60
15	SCS Runoff	8.983	1	721	22,854	----	------	------	Area to DD No. 61
16	Combine	19.96	1	719	48,758	14, 15	------	------	DD No. 61
17	SCS Runoff	8.190	1	721	20,837	----	------	------	Area to DD No. 62
18	Combine	28.02	1	720	69,595	16, 17	------	------	DD No. 62
19	SCS Runoff	13.47	1	720	32,840	----	------	------	Area to DD No. 63
20	Combine	41.49	1	720	102,435	18, 19	------	------	DD No. 63
21	SCS Runoff	13.89	1	719	31,752	----	------	------	Area to DD No. 64
22	Combine	55.27	1	720	134,187	20, 21	------	------	DD No. 64
23	SCS Runoff	13.97	1	720	34,056	----	------	------	Area to DD No. 65
24	SCS Runoff	8.982	1	720	21,893	----	------	------	Area to DD No. 66
25	Combine	22.95	1	720	55,950	23, 24	------	------	DD No. 66
26	SCS Runoff	7.860	1	721	19,997	----	------	------	Area to DD No. 67
27	Combine	30.73	1	720	75,947	25, 26	------	------	DD No. 67

Hydrograph Summary Report

Hyd. o.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	11.54	1	723	33,013	----	------	------	SCC No. 1 Area
2	Manual	57.50	1	724	170,794	----	------	------	DD No. 44
3	Manual	32.98	1	723	101,391	----	------	------	DD No. 47
4	Combine	101.72	1	723	305,197	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	3.853	1	717	7,940	----	------	------	SCC No. 2 Area
6	Combine	103.58	1	723	313,137	4, 5	------	------	SCC No. 2
7	Manual	50.81	1	721	131,976	----	------	------	DD No. 52
8	SCS Runoff	6.403	1	723	18,321	----	------	------	SCC No. 3 Area
9	Combine	158.89	1	722	463,434	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	2.107	1	715	3,809	----	------	------	SCC No. 4 Area
11	Combine	159.29	1	722	467,244	9, 10	------	------	SCC No. 4
12	SCS Runoff	2.469	1	716	4,780	----	------	------	SCC No. 6
13	Manual	55.53	1	720	138,768	----	------	------	DD No. 58
14	SCS Runoff	9.509	1	727	32,314	----	------	------	SCC No. 5 Area
15	Combine	64.78	1	720	175,862	12, 13, 14	------	------	SCC No. 5
	Combine	222.68	1	721	643,104	11, 15	------	------	Pipe No. 400
17	Reservoir	13.43	1	806	510,544	16	64.01	397,259	Sed. Basin 4-perm pool
18	Reservoir	68.02	1	737	643,092	16	65.72	225,187	Sed. Basin 4-ES
19	SCS Runoff	4.057	1	716	7,853	----	------	------	SCC No. 7
20	SCS Runoff	17.03	1	739	86,813	----	------	------	SCC No. 8 Area
21	Manual	55.27	1	720	134,187	----	------	------	DD No. 64
22	Manual	30.73	1	720	75,947	----	------	------	DD No. 67
23	Combine	97.28	1	720	304,798	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	6.737	1	721	17,140	----	------	------	SCC No. 9 Area
25	Manual	25.75	1	725	88,843	----	------	------	DD No. 3
26	Combine	126.46	1	720	410,782	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	7.763	1	718	16,644	----	------	------	SCC No. 10 Area
28	SCS Runoff	5.909	1	716	11,437	----	------	------	Area to DD No. 4
29	Combine	137.74	1	720	438,863	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	6.909	1	718	14,813	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd. o.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	29.16	1	720	76,449	----	------	------	DD No. 11
32	SCS Runoff	3.630	1	715	6,562	----	------	------	SCC No. 12 Area
33	Combine	37.57	1	719	97,824	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	8.960	1	719	20,485	----	------	------	SCC No. 11 Area
35	Manual	20.76	1	718	45,512	----	------	------	DD No. 7
36	Combine	67.05	1	719	163,821	33, 34, 35	------	------	SCC No. 11
37	Combine	203.42	1	719	602,685	29, 36	------	------	Pipe No. 200
38	Reservoir	6.122	1	949	504,184	37	54.70	412,403	Ex. Sed. Basin No. 2
39	Reservoir	60.22	1	737	602,675	37	58.74	199,710	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd. o.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	10.40	1	718	22,303	----	------	------	SCC No. 14
2	Manual	52.83	1	722	155,894	----	------	------	DD No. 20
3	Combine	60.98	1	721	178,197	1, 2	------	------	Pipe No. 300
4	SCS Runoff	4.586	1	716	8,877	----	------	------	SCC No. 15
5	SCS Runoff	8.415	1	717	17,340	----	------	------	SCC No. 21
6	SCS Runoff	5.323	1	717	10,967	----	------	------	SCC No. 20 Area
7	Combine	13.74	1	717	28,308	5, 6	------	------	SCC No. 20
8	SCS Runoff	8.564	1	725	26,801	----	------	------	SCC No. 19 Area
9	Combine	20.19	1	718	55,109	7, 8	------	------	SCC No. 19
10	Manual	63.56	1	725	204,992	----	------	------	DD No. 41
11	Manual	55.23	1	723	156,083	----	------	------	DD No. 36
12	SCS Runoff	9.379	1	730	35,924	----	------	------	SSC No. 18 Area
13	Combine	140.73	1	723	452,108	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	27.04	1	721	80,710	----	------	------	DD No. 33
15	SCS Runoff	10.62	1	724	31,560	----	------	------	SCC No. 17 Area
	Combine	177.52	1	723	564,377	13, 14, 15	------	------	SCC No. 17
17	Manual	58.88	1	721	161,382	----	------	------	DD No. 28
18	SCS Runoff	11.72	1	723	33,531	----	------	------	SCC No. 16 Area
19	Combine	247.22	1	722	759,291	16, 17, 18	------	------	SCC No. 16
20	Combine	248.96	1	722	768,168	4, 19	------	------	Pipe No. 301
21	Combine	309.58	1	722	946,364	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	18.58	1	814	794,041	21	60.81	599,398	Ex. Sed. Basin No. 3
23	Reservoir	186.05	1	732	946,360	21	62.57	233,533	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	8.916	1	722	24,203	----	------	------	Area to DD No. 1
2	SCS Runoff	11.39	1	729	42,483	----	------	------	Area to DD No. 2
3	Combine	18.84	1	724	66,686	1, 2	------	------	DD No. 2
4	SCS Runoff	11.61	1	726	38,283	----	------	------	Area to DD No. 3
5	Combine	30.36	1	725	104,968	3, 4	------	------	DD No. 3
6	SCS Runoff	6.930	1	716	13,513	----	------	------	Area to DD No. 4
7	SCS Runoff	8.082	1	717	16,764	----	------	------	Area to DD No. 5
8	SCS Runoff	9.559	1	719	21,984	----	------	------	Area to DD No. 6
9	Combine	17.41	1	718	38,749	7, 8	------	------	DD No. 6
10	SCS Runoff	6.961	1	718	15,024	----	------	------	Area to DD No. 7
11	Combine	24.37	1	718	53,773	9, 10	------	------	DD No. 7
12	SCS Runoff	12.23	1	720	29,973	----	------	------	Area to DD No. 8
13	SCS Runoff	12.72	1	719	29,245	----	------	------	Area to DD No. 9
14	Combine	24.83	1	720	59,218	12, 13	------	------	DD No. 9
15	SCS Runoff	5.283	1	724	15,753	----	------	------	Area to DD No. 10
	Combine	29.63	1	720	74,971	14, 15	------	------	DD No. 10
17	SCS Runoff	5.150	1	724	15,354	----	------	------	Area to DD No. 11
18	Combine	34.31	1	720	90,324	16, 17	------	------	DD No. 11
19	SCS Runoff	3.812	1	724	11,366	----	------	------	Area to DD No. 12
20	SCS Runoff	5.876	1	719	13,513	----	------	------	Area to DD No. 13
21	Combine	9.284	1	720	24,879	19, 20	------	------	DD No. 13
22	SCS Runoff	6.754	1	723	19,400	----	------	------	Area to DD No. 14
23	Combine	15.73	1	721	44,279	21, 22	------	------	DD No. 14
24	SCS Runoff	7.581	1	725	23,800	----	------	------	Area to DD No. 15
25	Combine	22.81	1	722	68,079	23, 24	------	------	DD No. 15
26	SCS Runoff	9.199	1	726	30,341	----	------	------	Area to DD No. 16
27	Combine	31.41	1	723	98,420	25, 26	------	------	DD No. 16
28	SCS Runoff	7.531	1	721	19,258	----	------	------	Area to DD No. 17
29	Combine	38.74	1	722	117,678	27, 28	------	------	DD No. 17
30	SCS Runoff	7.876	1	722	21,379	----	------	------	Area to DD No. 18

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	46.61	1	722	139,058	29, 30	------	------	DD No. 18
32	SCS Runoff	7.678	1	723	22,055	----	------	------	Area to DD No. 19
33	Combine	54.25	1	722	161,112	31, 32	------	------	DD No. 19
34	SCS Runoff	8.034	1	723	23,076	----	------	------	Area to DD No. 20
35	Combine	62.23	1	722	184,188	33, 34	------	------	DD No. 20
36	SCS Runoff	8.332	1	719	19,161	----	------	------	Area to DD No. 21
37	SCS Runoff	8.713	1	720	21,350	----	------	------	Area to DD No. 22
38	Combine	16.96	1	720	40,511	36, 37	------	------	DD No. 22
39	SCS Runoff	10.73	1	725	33,682	----	------	------	Area to DD No. 23
40	Combine	26.32	1	721	74,194	38, 39	------	------	DD No. 23
41	SCS Runoff	10.09	1	719	23,194	----	------	------	Area to DD No. 24
42	Combine	36.31	1	720	97,388	40, 41	------	------	DD No. 24
43	SCS Runoff	8.173	1	722	22,186	----	------	------	Area to DD No. 25
44	Combine	44.22	1	720	119,574	42, 43	------	------	DD No. 25
45	SCS Runoff	8.322	1	722	22,589	----	------	------	Area to DD No. 26
	Combine	52.28	1	720	142,164	44, 45	------	------	DD No. 26
47	SCS Runoff	8.768	1	722	23,800	----	------	------	Area to DD No. 27
48	Combine	60.91	1	721	165,963	46, 47	------	------	DD No. 27
49	SCS Runoff	8.603	1	723	24,710	----	------	------	Area to DD No. 28
50	Combine	69.28	1	721	190,673	48, 49	------	------	DD No. 28

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	4.508	1	719	10,367	----	------	------	Area to DD No. 29
2	SCS Runoff	5.740	1	718	12,389	----	------	------	Area to DD No. 30
3	Combine	10.19	1	719	22,756	1, 2	------	------	DD No. 30
4	SCS Runoff	7.876	1	722	21,379	----	------	------	Area to DD No. 31
5	Combine	17.50	1	719	44,135	3, 4	------	------	DD No. 31
6	SCS Runoff	7.892	1	724	23,529	----	------	------	Area to DD No. 32
7	Combine	24.62	1	720	67,664	5, 6	------	------	DD No. 32
8	SCS Runoff	8.396	1	726	27,694	----	------	------	Area to DD No. 33
9	Combine	31.85	1	721	95,358	7, 8	------	------	DD No. 33
10	SCS Runoff	17.83	1	722	48,406	----	------	------	Area to DD No. 34
11	SCS Runoff	22.82	1	723	65,552	----	------	------	Area to DD No. 35
12	Combine	40.51	1	722	113,958	10, 11	------	------	DD No. 35
13	SCS Runoff	24.53	1	723	70,453	----	------	------	Area to DD No. 36
14	Combine	64.97	1	723	184,411	12, 13	------	------	DD No. 36
15	SCS Runoff	19.98	1	723	57,384	----	------	------	Area to DD No. 37
	SCS Runoff	21.42	1	726	70,660	----	------	------	Area to DD No. 38
17	Combine	40.79	1	724	128,044	15, 16	------	------	DD No. 38
18	SCS Runoff	14.85	1	724	44,267	----	------	------	Area to DD No. 39
19	Combine	55.64	1	724	172,310	17, 18	------	------	DD No. 39
20	SCS Runoff	9.765	1	725	30,657	----	------	------	Area to DD No. 40
21	Combine	65.36	1	724	202,967	19, 20	------	------	DD No. 40
22	SCS Runoff	10.52	1	729	39,231	----	------	------	Area to DD No. 41
23	Combine	74.89	1	724	242,198	21, 22	------	------	DD No. 41
24	SCS Runoff	22.81	1	724	67,995	----	------	------	Area to DD No. 42
25	SCS Runoff	20.26	1	724	60,418	----	------	------	Area to DD No. 43
26	Combine	43.07	1	724	128,413	24, 25	------	------	DD No. 43
27	SCS Runoff	24.61	1	724	73,379	----	------	------	Area to DD No. 44
28	Combine	67.68	1	724	201,792	26, 27	------	------	DD No. 44
29	SCS Runoff	15.92	1	724	47,457	----	------	------	Area to DD No. 45
30	SCS Runoff	11.56	1	727	39,378	----	------	------	Area to DD No. 46

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Combine	27.11	1	725	86,835	29, 30	------	------	DD No. 46
32	SCS Runoff	12.89	1	721	32,958	----	------	------	Area to DD No. 47
33	Combine	38.85	1	723	119,793	31, 32	------	------	DD No. 47
34	SCS Runoff	11.96	1	721	30,575	----	------	------	Area to DD No. 48
35	SCS Runoff	10.79	1	719	24,808	----	------	------	Area to DD No. 49
36	Combine	22.52	1	720	55,383	34, 35	------	------	DD No. 49
37	SCS Runoff	11.90	1	720	29,152	----	------	------	Area to DD No. 50
38	Combine	34.42	1	720	84,535	36, 37	------	------	DD No. 50
39	SCS Runoff	12.27	1	721	31,369	----	------	------	Area to DD No. 51
40	Combine	46.57	1	720	115,904	38, 39	------	------	DD No. 51
41	SCS Runoff	13.93	1	723	40,026	----	------	------	Area to DD No. 52
42	Combine	59.73	1	721	155,930	40, 41	------	------	DD No. 52

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	8.099	1	722	21,984	----	------	------	Area to DD No. 53
2	SCS Runoff	12.40	1	720	30,383	----	------	------	Area to DD No. 54
3	Combine	20.31	1	721	52,368	1, 2	------	------	DD No. 54
4	SCS Runoff	12.54	1	719	28,842	----	------	------	Area to DD No. 55
5	Combine	32.66	1	720	81,210	3, 4	------	------	DD No. 55
6	SCS Runoff	11.73	1	720	28,741	----	------	------	Area to DD No. 56
7	Combine	44.39	1	720	109,951	5, 6	------	------	DD No. 56
8	SCS Runoff	10.33	1	721	26,406	----	------	------	Area to DD No. 57
9	Combine	54.61	1	720	136,356	7, 8	------	------	DD No. 57
10	SCS Runoff	10.79	1	721	27,597	----	------	------	Area to DD No. 58
11	Combine	65.30	1	720	163,953	9, 10	------	------	DD No. 58
12	SCS Runoff	5.027	1	720	12,318	----	------	------	Area to DD No. 59
13	SCS Runoff	8.474	1	718	18,288	----	------	------	Area to DD No. 60
14	Combine	13.34	1	719	30,606	12, 13	------	------	DD No. 60
15	SCS Runoff	10.56	1	721	27,001	----	------	------	Area to DD No. 61
	Combine	23.47	1	719	57,607	14, 15	------	------	DD No. 61
17	SCS Runoff	9.627	1	721	24,619	----	------	------	Area to DD No. 62
18	Combine	32.93	1	720	82,226	16, 17	------	------	DD No. 62
19	SCS Runoff	15.83	1	720	38,800	----	------	------	Area to DD No. 63
20	Combine	48.76	1	720	121,027	18, 19	------	------	DD No. 63
21	SCS Runoff	16.31	1	719	37,515	----	------	------	Area to DD No. 64
22	Combine	64.92	1	720	158,541	20, 21	------	------	DD No. 64
23	SCS Runoff	16.42	1	720	40,237	----	------	------	Area to DD No. 65
24	SCS Runoff	10.56	1	720	25,867	----	------	------	Area to DD No. 66
25	Combine	26.98	1	720	66,104	23, 24	------	------	DD No. 66
26	SCS Runoff	9.239	1	721	23,626	----	------	------	Area to DD No. 67
27	Combine	36.13	1	720	89,731	25, 26	------	------	DD No. 67

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	13.58	1	723	39,005	----	------	------	SCC No. 1 Area
2	Manual	67.68	1	724	201,792	----	------	------	DD No. 44
3	Manual	38.85	1	723	119,793	----	------	------	DD No. 47
4	Combine	119.84	1	723	360,590	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	4.522	1	717	9,381	----	------	------	SCC No. 2 Area
6	Combine	122.00	1	723	369,970	4, 5	------	------	SCC No. 2
7	Manual	59.73	1	721	155,930	----	------	------	DD No. 52
8	SCS Runoff	7.536	1	723	21,647	----	------	------	SCC No. 3 Area
9	Combine	187.10	1	722	547,547	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	2.469	1	715	4,500	----	------	------	SCC No. 4 Area
11	Combine	187.57	1	722	552,046	9, 10	------	------	SCC No. 4
12	SCS Runoff	2.896	1	716	5,647	----	------	------	SCC No. 6
13	Manual	65.30	1	720	163,953	----	------	------	DD No. 58
14	SCS Runoff	11.21	1	727	38,179	----	------	------	SCC No. 5 Area
15	Combine	76.25	1	720	207,780	12, 13, 14	------	------	SCC No. 5
[illegible]	Combine	262.30	1	721	759,827	11, 15	------	------	Pipe No. 400
17	Reservoir	28.39	1	758	624,547	16	64.32	431,424	Sed. Basin 4-perm pool
18	Reservoir	71.95	1	739	759,812	16	66.15	273,938	Sed. Basin 4-ES
19	SCS Runoff	4.758	1	716	9,278	----	------	------	SCC No. 7
20	SCS Runoff	20.11	1	739	102,569	----	------	------	SCC No. 8 Area
21	Manual	64.92	1	720	158,541	----	------	------	DD No. 64
22	Manual	36.13	1	720	89,731	----	------	------	DD No. 67
23	Combine	114.48	1	720	360,119	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	7.919	1	721	20,251	----	------	------	SCC No. 9 Area
25	Manual	30.36	1	725	104,968	----	------	------	DD No. 3
26	Combine	149.02	1	720	485,338	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	9.112	1	718	19,665	----	------	------	SCC No. 10 Area
28	SCS Runoff	6.930	1	716	13,513	----	------	------	Area to DD No. 4
29	Combine	162.19	1	720	518,516	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	8.109	1	718	17,502	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	34.31	1	720	90,324	----	------	------	DD No. 11
32	SCS Runoff	4.253	1	715	7,753	----	------	------	SCC No. 12 Area
33	Combine	44.19	1	719	115,579	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	10.52	1	719	24,203	----	------	------	SCC No. 11 Area
35	Manual	24.37	1	718	53,773	----	------	------	DD No. 7
36	Combine	78.76	1	719	193,554	33, 34, 35	------	------	SCC No. 11
37	Combine	239.55	1	719	712,070	29, 36	------	------	Pipe No. 200
38	Reservoir	7.341	1	940	599,283	37	55.32	487,002	Ex. Sed. Basin No. 2
39	Reservoir	62.40	1	741	712,061	37	59.08	245,072	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	12.21	1	718	26,351	----	------	------	SCC No. 14
2	Manual	62.23	1	722	184,188	----	------	------	DD No. 20
3	Combine	71.82	1	721	210,539	1, 2	------	------	Pipe No. 300
4	SCS Runoff	5.378	1	716	10,488	----	------	------	SCC No. 15
5	SCS Runoff	9.876	1	717	20,487	----	------	------	SCC No. 21
6	SCS Runoff	6.247	1	717	12,958	----	------	------	SCC No. 20 Area
7	Combine	16.12	1	717	33,445	5, 6	------	------	SCC No. 20
8	SCS Runoff	10.09	1	725	31,666	----	------	------	SCC No. 19 Area
9	Combine	23.77	1	718	65,111	7, 8	------	------	SCC No. 19
10	Manual	74.89	1	724	242,198	----	------	------	DD No. 41
11	Manual	64.97	1	723	184,411	----	------	------	DD No. 36
12	SCS Runoff	11.06	1	730	42,444	----	------	------	SSC No. 18 Area
13	Combine	165.82	1	723	534,164	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	31.85	1	721	95,358	----	------	------	DD No. 33
15	SCS Runoff	12.51	1	724	37,288	----	------	------	SCC No. 17 Area
16	Combine	209.13	1	722	666,811	13, 14, 15	------	------	SCC No. 17
17	Manual	69.28	1	721	190,673	----	------	------	DD No. 28
18	SCS Runoff	13.79	1	723	39,617	----	------	------	SCC No. 16 Area
19	Combine	291.27	1	722	897,100	16, 17, 18	------	------	SCC No. 16
20	Combine	293.29	1	722	907,588	4, 19	------	------	Pipe No. 301
21	Combine	364.62	1	722	1,118,127	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	44.17	1	758	961,463	21	61.19	640,312	Ex. Sed. Basin No. 3
23	Reservoir	209.88	1	732	1,118,123	21	62.93	275,379	Ex Sed. Basin No. 3-ES

d. Landfill SideSlope Drainage Berm and Riser Design

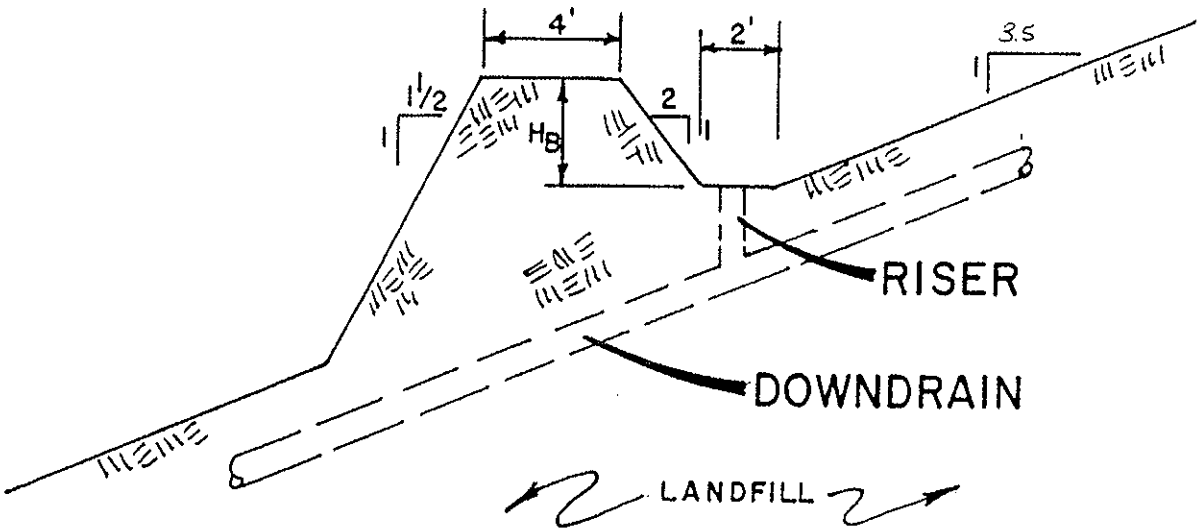
The following sketch shows a selected cross section for the sideslope drainage berm. Using Manning's Equation with "Flowmaster", it is determined that the berm will carry 35.98 cfs at a depth of 1.30 feet. The maximum flow carried in any one berm is 17.24 cfs (see Table 1). Therefore the berm design is sufficient with a minimum safety factor of 2.09 for flow.

The riser is designed as an orifice based on handling the maximum flow for each subdrainage area between the sideslope berms. The risers are designed to be a minimum of 18" in diameter to minimize clogging and a maximum of 24" in diameter.

The maximum head on all other risers is 1.30. Therefore, a berm height of 2' is sufficient with a minimum safety factor of 1.54.

These calculations assume good maintenance of the site to prevent clogging of the inlets.

SIDE SLOPE DRAINAGE BERM



DRAINAGE BERM DESIGN

(1) Q max for drainage berm @ 2% slope = 35.98 cfs.

(2) Q actual (Berm to Downdrain No. 44 / See Downdrain Inlet Calculations) = 17.24 cfs.

Max. Depth = 1.30

Use **2** ' HIGH BERM (H)

Qmax for Berm
Worksheet for Trapezoidal Channel

Project Description	
Project File	p:\republic - east carolina\projects\phase 5\drainage\dd.fm2
Worksheet	Side Slope Diversion Berm
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Mannings Coefficient	0.035	
Channel Slope	0.020000	ft/ft
Depth	1.30	ft
Left Side Slope	2.000000	H : V
Right Side Slope	3.500000	H : V
Bottom Width	2.00	ft

Results		
Discharge	35.98	cfs
Flow Area	7.25	ft²
Wetted Perimeter	9.64	ft
Top Width	9.15	ft
Critical Depth	1.29	ft
Critical Slope	0.020725	ft/ft
Velocity	4.96	ft/s
Velocity Head	0.38	ft
Specific Energy	1.68	ft
Froude Number	0.98	
Flow is subcritical.		

TABLE 1 - RISER CALCULATIONS

RISER DESIGN

Orfice Flow => $Q = 3.782(D)^2(H)^{(1/2)}$

Riser Diameter	*Max. Allowable Head on Riser*	*Max. Allowable Flow*
(inches)	(feet)	(cfs)
18	1.30	9.70
24	1.30	17.25

Riser No.	*Flow in Berm (cfs)*	*Riser Dia. (in.)*	*Head on Riser (ft.)*
1	6.26	24	0.17
2	7.95	24	0.28
3	8.11	24	0.29
4	4.90	18	0.33
5	5.71	18	0.45
6	6.73	24	0.20
7	4.91	24	0.11
8	8.60	24	0.32
9	8.95	24	0.35
10	3.70	24	0.06
11	3.61	24	0.06
12	2.67	24	0.03
13	4.14	24	0.07
14	4.73	24	0.10
15	5.31	24	0.12
16	6.43	24	0.18
17	5.29	24	0.12
18	5.53	24	0.13
19	5.38	24	0.13
20	5.63	24	0.14
21	5.87	24	0.15
22	6.13	24	0.16
23	7.51	24	0.25
24	7.10	24	0.22
25	5.74	24	0.14
26	5.84	24	0.15
27	6.15	24	0.17
28	6.03	24	0.16
29	3.17	24	0.04
30	4.05	24	0.07
31	5.53	24	0.13
32	5.53	24	0.13
33	5.87	24	0.15
34	12.52	24	0.68
35	16.00	24	1.12
36	17.19	24	1.29
37	14.00	24	0.86
38	14.98	24	0.98
39	10.40	24	0.47
40	6.83	24	0.20
41	7.34	24	0.24
42	15.98	24	1.12
43	14.20	24	0.88
44	17.24	24	1.30
45	11.15	24	0.54
46	8.08	24	0.29
47	9.06	24	0.36
48	8.40	24	0.31
49	7.60	24	0.25
50	8.36	24	0.31

TABLE 1 - RISER CALCULATIONS (cont'd)

Riser No.	*Flow in Berm (cfs)*	*Riser Dia. (in.)*	*Head on Riser (ft.)*
51	8.62	24	0.32
52	9.77	24	0.42
53	5.68	24	0.14
54	8.72	24	0.33
55	8.83	24	0.34
56	8.25	24	0.30
57	7.26	24	0.23
58	7.59	24	0.25
59	3.53	24	0.05
60	5.98	24	0.16
61	7.42	24	0.24
62	6.77	24	0.20
63	11.13	24	0.54
64	11.49	24	0.58
65	11.54	24	0.58
66	7.42	24	0.24
67	6.49	24	0.18

e. Downdrain Calculations

Tables 2A and 2B summarize the sizing of each downdrain that appears on the Final Drainage Plan. These tables list the total peak discharge to be handled by each downdrain, the percentage of full flow capacity, and the size of each downdrain.

All proposed downdrains are sized to be a minimum of 24" diameter to minimize clogging. The size of the downdrain is verified to ensure that the maximum flow is less than or equal to 60% of the capacity of the pipe. The maximum depth of flow for any single downdrain is 57% of the diameter. If the calculated flow requires greater than a 24" diameter downdrain, then additional downdrain pipes are installed.

East Carolina Phase 5 Drainage Calcs.
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	24" Downdrain Maximum Capacity
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Slope

Input Data		
Mannings Coefficient	0.020	
Depth	1.20	ft
Diameter	24.00	in
Discharge	52.80	cfs

Results		
Channel Slope	28.5680	%
Flow Area	1.97	ft²
Wetted Perimeter	3.54	ft
Top Width	1.96	ft
Critical Depth	1.98	ft
Percent Full	60.00	
Critical Slope	0.119718	ft/ft
Velocity	26.83	ft/s
Velocity Head	11.18	ft
Specific Energy	12.38	ft
Froude Number	4.72	
Maximum Discharge	84.54	cfs
Full Flow Capacity	78.59	cfs
Full Flow Slope	0.128947	ft/ft
Flow is supercritical.		

TABLE NO. 2A - EXISTING DOWNDRAIN CALCULATIONS

DOWN DRAIN NO.	PEAK DISCHARGE (cfs)	SIZE OF DOWNDRAIN (in)	% FULL	SIZE OF RISER (in)
4	4.90	18	25	18
5	5.71	18	27	18
6	12.26	24	26	24
7	17.17	24	31	24

TABLE NO. 2B - DOWNDRAIN CALCULATIONS

DOWN DRAIN NO.	PEAK DISCHARGE (cfs)	SIZE OF DOWNDRAIN (in)	% FULL	SIZE OF RISER (in)
1	6.26	24	19	24
2	13.14	24	27	24
3	21.20	24	34	24
8	8.60	24	22	24
9	17.50	24	31	24
10	20.82	24	34	24
11	24.06	24	37	24
12	2.67	24	12	24
13	6.51	24	19	24
14	11.02	24	25	24
15	15.96	24	30	24
16	21.97	24	35	24
17	27.08	24	39	24
18	32.61	24	43	24
19	37.94	24	47	24
20	43.52	24	51	24
21	5.87	24	18	24
22	11.96	24	26	24
23	18.46	24	32	24
24	25.47	24	38	24
25	30.99	24	42	24
26	36.66	24	46	24
27	42.75	24	50	24
28	48.58	24	54	24
29	3.17	24	13	24
30	7.20	24	20	24
31	12.28	24	26	24
32	17.24	24	31	24
33	22.28	24	35	24
34	12.52	24	26	24
35	28.40	24	40	24
36	45.59	24	52	24
37	14.00	24	28	24
38	28.52	24	40	24
39	38.92	24	48	24
40	45.71	24	53	24
41	52.39	24	57	24
42	15.98	24	30	24
43	30.17	24	41	24
44	47.42	24	54	24
45	11.15	24	25	24
46	18.97	24	32	24
47	27.17	24	39	24
48	8.40	24	21	24
49	15.84	24	30	24
50	24.21	24	37	24

TABLE NO. 2B - DOWNDRAIN CALCULATIONS

DOWN DRAIN NO.	PEAK DISCHARGE (cfs)	SIZE OF DOWNDRAIN (in)	% FULL	SIZE OF RISER (in)
51	32.72	24	43	24
52	41.98	24	50	24
53	5.68	24	18	24
54	14.28	24	28	24
55	22.96	24	36	24
56	31.21	24	42	24
57	38.37	24	47	24
58	45.86	24	53	24
59	3.53	24	14	24
60	9.40	24	23	24
61	16.48	24	30	24
62	23.16	24	36	24
63	34.29	24	44	24
64	45.70	24	52	24
65	11.54	24	25	24
66	18.97	24	32	24
67	25.38	24	38	24

f. Stormwater Conveyance Channel (SCC) Calculations

Table 3 summarizes each design parameter of each SCC as shown on the Erosion Control Plan shown in the Phase 5 Engineering Plans.

The objective of this section is to properly size the shape of each SCC based on the calculated discharge to be handled and to determine if temporary SCC protection is required if velocities are too high for initial groundcover conditions.

In Table 3 the selected bottom width and sideslopes are listed. Based on the contributing area, 25-year, 24-hour storm event, time of concentration, curve number, and hydraulic length, a discharge is calculated. The selected shape, Manning's "n", slope, and the calculated flow are entered into a computer program called "Flowmaster", which calculates the depth of flow and velocity based on Manning's Open Channel Equation. If the velocity is less than 2.0 fps, then we assume that no temporary SCC protection is required. If the velocity is greater than 2.0 fps, then temporary SCC protection is required. Tables 8.05e, 8.05f, and 8.05g lists various temporary SCC protection materials including their Manning's "n" values and the maximum allowable shear stress.

The new Manning's "n" is reinserted into the computer program which calculates a new depth of flow and velocity. This new depth is then used to calculate the shear stress for the temporary SCC protection material selected. If the calculated shear stress exceeds the allowable shear stress shown in Table 8.05g, then a different protection material is selected. This process continues until the calculated shear stress is less than the allowable for the selected SCC protection material. The selected material is also shown on the Erosion Control Plan of the Phase 5 Engineering Plans.

(Note: Operator may use concrete lined or fabric lined SCC in lieu of any size rip-rap SCC at his discretion.)

Tractive Force Procedure

The design of riprap-lined channels and temporary channel linings is based on analysis of tractive force.

NOTE: **This procedure is for uniform flow in channels and is *not* to be used for design of deenergizing devices.**

To calculate the required size of an open channel, assume the design flow is uniform and does not vary with time. Since actual flow conditions change through the length of a channel, subdivide the channel into design reaches as appropriate.

PERMISSIBLE SHEAR STRESS

The permissible shear stress, T_d, is the force required to initiate movement of the lining material. Permissible shear stress for the liner is not related to the erodibility of the underlying soil. However, if the lining is eroded or broken, the bed material will be exposed to the erosive force of the flow.

COMPUTING NORMAL DEPTH

The first step in selecting an appropriate lining is to compute the design flow depth (the normal depth) and determine the shear stress.

Normal depths can be calculated by Manning's equation as shown for trapezoidal channels in Figure 8.05d. Values of the Manning's roughness coefficient for different ranges of depth are provided in Table 8.05e for temporary linings and Table 8.05f for riprap. The coefficient of roughness generally decreases with increasing flow depth.

Table 8.05e
Manning's Roughness Coefficients for Temporary Lining Materials

	n value for Depth Ranges		
	0-0.5 ft	0.5-2.0 ft	>2.0 ft
Lining Type			
Woven Paper Net	0.016	0.015	0.015
Jute Net	0.028	0.022	0.019
Fiberglass Roving	0.028	0.021	0.019
Straw with Net	0.065	0.033	0.025
Curled Wood Mat	0.066	0.035	0.028
Synthetic Mat	0.036	0.025	0.021

Table 8.05f
Manning's Roughness Coefficient for Riprap and Gravel

Material	d_{50} (inches)	*n* value for Depth Ranges 0-0.5 ft	0.5-1.0 ft	1.0-2.0 ft	> 2.0 ft
Gravel	1	0.033	0.028	0.026	0.025
	2	0.045	0.034	0.034	0.031
Riprap	6	0.106	0.054	0.044	0.041
	9	0.215	0.068	0.062	0.047
	12	0.797	0.084	0.060	0.053
	15	—	0.104	0.068	0.059
	18	—	0.127	0.076	0.064
	21	—	0.158	0.085	0.070
	24	—	0.199	0.095	0.076

DETERMINING SHEAR STRESS

Shear stress, T, at normal depth is computed for the lining by the following equation:

$$T = yds$$

where:

T = shear stress in lb/ft^2
y = unit weight of water, 62.4 lb/ft^3
d = flow depth in ft
s = channel gradient in ft/ft.

If the permissible shear stress, T_d, given in Table 8.05g is greater than the computed shear stress, the riprap or temporary lining is considered acceptable. If a lining is unacceptable, select a lining with a higher permissible shear stress and repeat the calculations for normal depth and shear stress. In some cases it may be necessary to alter channel dimensions to reduce the shear stress.

Computing tractive force around a channel bend requires special considerations because the change in flow direction imposes higher shear stress on the channel bottom and banks. The maximum shear stress in a bend, T_b, is given by the following equation:

$$T_b = K_b T$$

where:

T_b = bend shear stress in lb/ft^2
K_b = bend factor
T = computed stress for straight channel in lb/ft^2

The value of K_b is related to the radius of curvature of the channel at its center line, R_c, and the bottom width of the channel, B, Figure 8.05e. The length of channel requiring protection downstream from a bend, L_p, is a function of the roughness of the lining material and the hydraulic radius as shown in Figure 8.05f.

Table 8.05g
Permissible Shear Stresses for Riprap and Temporary Liners

Lining Category	Permissible Unit Shear Stress, T_d Lining Type	(lb/ft^2)
Temporary	Woven Paper Net	0.15
	Jute Net	0.45
	Fiberglass Roving:	
	Single	0.60
	Double	0.85
	Straw with Net	1.45
	Curled Wood mat	1.55
	Synthetic Mat	2.00
	d_{50} **Stone Size** (inches)	
Gravel Riprap	1	0.40
	2	0.80
Rock Riprap	6	2.50
	9	3.80
	12	5.00
	15	6.30
	18	7.50
	21	8.80
	24	10.00

Design Procedure-Temporary Liners

The following is a step-by-step procedure for designing a temporary liner for a channel. Because temporary liners have a short period of service, the design Q may be reduced. For liners that are needed for six months or less, the 2-yr frequency storm is recommended.

Step 1. Select a liner material suitable for site conditions and application. Determine roughness coefficient from manufacturer's specifications or Table 8.05e.

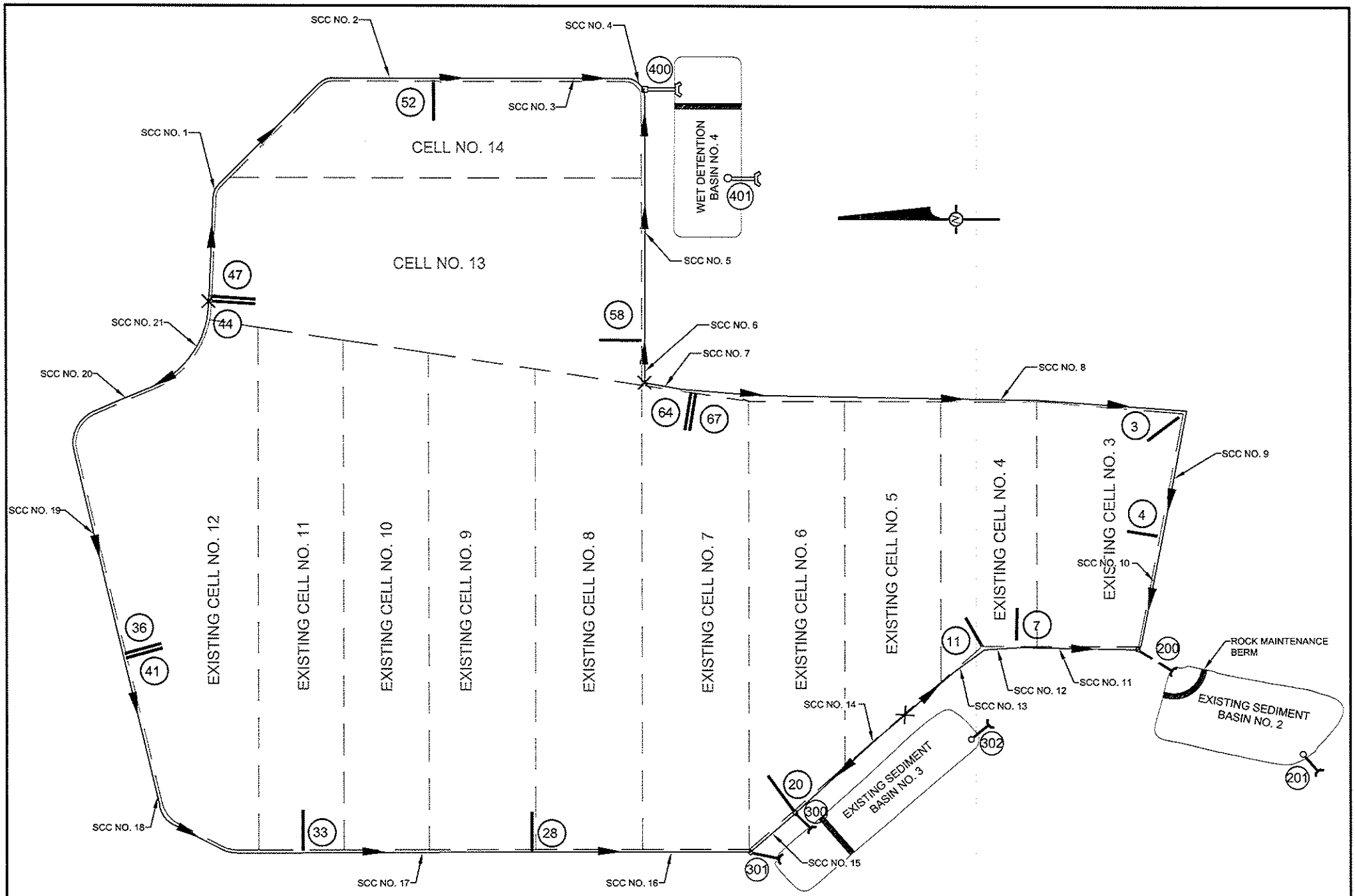
Step 2. Calculate the normal flow depth using Manning's equation (Figure 8.05d). Check to see that depth is consistent with that assumed for selection of Manning's *n* in Figure 8.05d.

Step 3. Calculate shear stress at normal depth.

Step 4. Compare computed shear stress with the permissible shear stress for the liner.

Step 5. If computed shear is greater than permissible shear, adjust channel dimensions to reduce shear or select a more resistant lining and repeat steps 1 through 4.

Design of a channel with temporary lining is illustrated in Sample Problem 8.05b.



EAST CAROLINA ENVIRONMENTAL LANDFILL
PHASE 5

TABLE NO. 3 - STORMWATER CONVEYANCE CHANNEL CALCULATIONS

DESIGN DATA	STORMWATER CONVEYANCE CHANNEL NO. 1	2	3	4	5
Bottom Width	2'	2'	2'	2'	2'
Left Side Slope	2:1	2:1	2:1	2:1	2:1
Right Side Slope	2:1	2:1	2:1	2:1	2:1
Starting Elevation	87.44	82	79.87	76	75.64
Ending Elevation	82	79.87	76	73.45	73.45
Length	872	304	553	116	783
Slope	0.0062	0.0070	0.0070	0.0220	0.0028
Discharge	83.90	85.35	130.98	131.32	53.43
Manning's "n"	0.028	0.028	0.028	0.053	0.028
Depth	2.44	2.40	2.89	2.97	2.39
Velocity	4.98	5.24	5.83	5.56	3.30
Shear Stress	0.95	1.05	1.26	4.07	0.42
Type of Protection	EXCELSIOR	EXCELSIOR	EXCELSIOR	12" RIP-RAP	EXCELSIOR

DESIGN DATA	STORMWATER CONVEYANCE CHANNEL NO. 6	7	8	9	10
Bottom Width	2'	2'	2'	2'	2'
eft Side Slope	2:1	2:1	2:1	2:1	2:1
Right Side Slope	2:1	2:1	2:1	2:1	2:1
Starting Elevation	76	76	75.18	69	67.56
Ending Elevation	75.64	75.18	69	67.56	66.27
Length	133	155	1541	400	358
Slope	0.0027	0.0053	0.0040	0.0036	0.0036
Discharge	2.05	3.37	80.25	104.21	113.54
Manning's "n"	0.026	0.035	0.028	0.028	0.028
Depth	0.48	0.61	2.64	3.02	3.13
Velocity	1.45	1.72	4.18	4.29	4.39
Shear Stress	0.08	0.20	0.66	0.68	0.70
Type of Protection	GRASS	EXCELSIOR	EXCELSIOR	EXCELSIOR	EXCELSIOR

TABLE NO. 3 - STORMWATER CONVEYANCE CHANNEL CALCULATIONS (cont'd)

DESIGN DATA	STORMWATER CONVEYANCE CHANNEL NO.				
	11	12	13	14	15
Bottom Width	2'	2'	2'	2'	2'
Left Side Slope	2:1	2:1	2:1	2:1	2:1
Right Side Slope	2:1	2:1	2:1	2:1	2:1
Starting Elevation	67.64	68	69	69	64.61
Ending Elevation	66.27	67.64	67.64	63.35	63.35
Length	380	100	322	459	187
Slope	0.0036	0.0036	0.0042	0.0123	0.0067
Discharge	55.53	31.01	5.72	8.61	3.81
Manning's "n"	0.028	0.035	0.035	0.035	0.035
Depth	2.30	1.96	0.85	0.79	0.61
Velocity	3.66	2.68	1.83	3.02	1.94
Shear Stress	0.52	0.44	0.22	0.61	0.26
Type of Protection	EXCELSIOR	EXCELSIOR	EXCELSIOR	EXCELSIOR	EXCELSIOR

DESIGN DATA	STORMWATER CONVEYANCE CHANNEL NO.				
	16	17	18	19	20
Bottom Width	2'	2'	2'	2'	2'
Left Side Slope	2:1	2:1	2:1	2:1	2:1
Right Side Slope	2:1	2:1	2:1	2:1	2:1
Starting Elevation	68	71.14	76	80	84
Ending Elevation	64.61	68	71.14	76	80
Length	682	716	990	785	252
Slope	0.0050	0.0044	0.0049	0.0051	0.0159
Discharge	203.66	146.28	115.91	16.66	11.39
Manning's "n"	0.028	0.028	0.028	0.035	0.035
Depth	3.74	3.41	2.96	1.36	0.86
Velocity	5.74	4.86	4.95	2.60	3.58
Shear Stress	1.16	0.93	0.91	0.43	0.85
Type of Protection	EXCELSIOR	EXCELSIOR	EXCELSIOR	EXCELSIOR	EXCELSIOR

TABLE NO. 3 - STORMWATER CONVEYANCE CHANNEL CALCULATIONS (cont'd)

)ESIGN DATA	STORMWATER CONVEYANCE CHANNEL NO. 21				
Bottom Width	2'				
Left Side Slope	2:1				
Right Side Slope	2:1				
Starting Elevation	87.44				
Ending Elevation	84				
Length	343				
Slope	0.0100				
Discharge	6.98				
Manning's "n"	0.035				
Depth	0.75				
Velocity	2.64				
Shear Stress	0.47				
Type of Protection	EXCELSIOR				

g. Drop Inlets, Pipes and Headwalls

Below are sketches detailing the construction of each existing and proposed drop inlet, pipe, and headwall. Location of all of these structures can be found on the Top of Clay Liner Grading Plan of the Phase 5 Engineering Plans.

Each sketch lists the discharge needed to be carried by the pipe and checks to see if the drainage structures are adequately sized to handle the anticipated flows.

The headwater elevation is also checked to be sure that the stormwater conveyance channels leading to the drop inlet are not topped.

All drop inlets, pipes and headwalls leading to Existing Sediment Basin No. 2 are numbered in the 200's. Those leading to Existing Sediment Basin No. 3 are numbered in the 300's. Those leading to Wet Detention Basin No. 4 are numbered in the 400's.

TABLE 4 DRAINAGE STRUCTURES

PIPE NO.	SIZE (DIA)	LENGTH	SLOPE	MATERIAL	AVAILABLE HEAD	ACTUAL HEAD
200 (E)	54"	113'	4.14%	RCP	7.92'	7.88'
201 (E)	30"	69'	2.97%	RCP	10.80'	5.12'
300 (E)	36"	67'	2.30%	CMP	3.90'	6.35'
301 (R)	Twin – 48"	84'	2.56%	RCP	5.80'	5.40'
302 (R)	60"	71'	0.51%	RCP	6.90'	6.53'
400	Twin - 42"	104'	1.92%	RCP	8.50'	6.30'
401	36"	75'	5.33%	RCP	8.75'	8.65'

*(E) – Existing structure to remain
*(R) – Replacement of existing structure

DROP INLET NO.	TOP ELEV.	THROAT ELEV.	INVERT ELEV.
200 (E)	67.77	66.27	58.35
300 (E)	64.85	63.35	59.45
301 (R)	66.11	64.61	58.81
400	74.00	72.50	64.00

*(E) – Existing structure to remain
*(R) – Replacement of existing structure

HEADWALL NO.	INVERT ELEV.
200 (E)	53.69
201 (E)	48.95
300 (E)	57.91
301 (R)	56.65
302 (R)	53.60
400	62.00
401	56.00

*(E) – Existing structure to remain
*(R) – Replacement of existing structure

PIPE NO. 200 (E)

Q = 168 cfs

Allowable headwater = 7.92

Inlet Control:

Assume 54 " dia. RCP at 168 cfs

HW = 4.5 x 1.75 = 7.88

INLET CONTROLS

Outlet Control:

Find critical depth (dc) = 3.7

$h_o = \frac{dc + D}{2} = \frac{3.7 + 4.5}{2} = 4.1$ - OR - (54.09 - 53.69 = 0.40)

WILL USE 4.1

H = head = 3.2

L = length = 113'

S_o = slope = 4.14%

$HW = H + h_o - LS_o = 3.2 + 4.1 - 113(.0414) = 2.62'$

Final Pipe Selection:

EX. 54 " dia. RCP at 168 cfs

Length = 113'

Slope = 4.14%

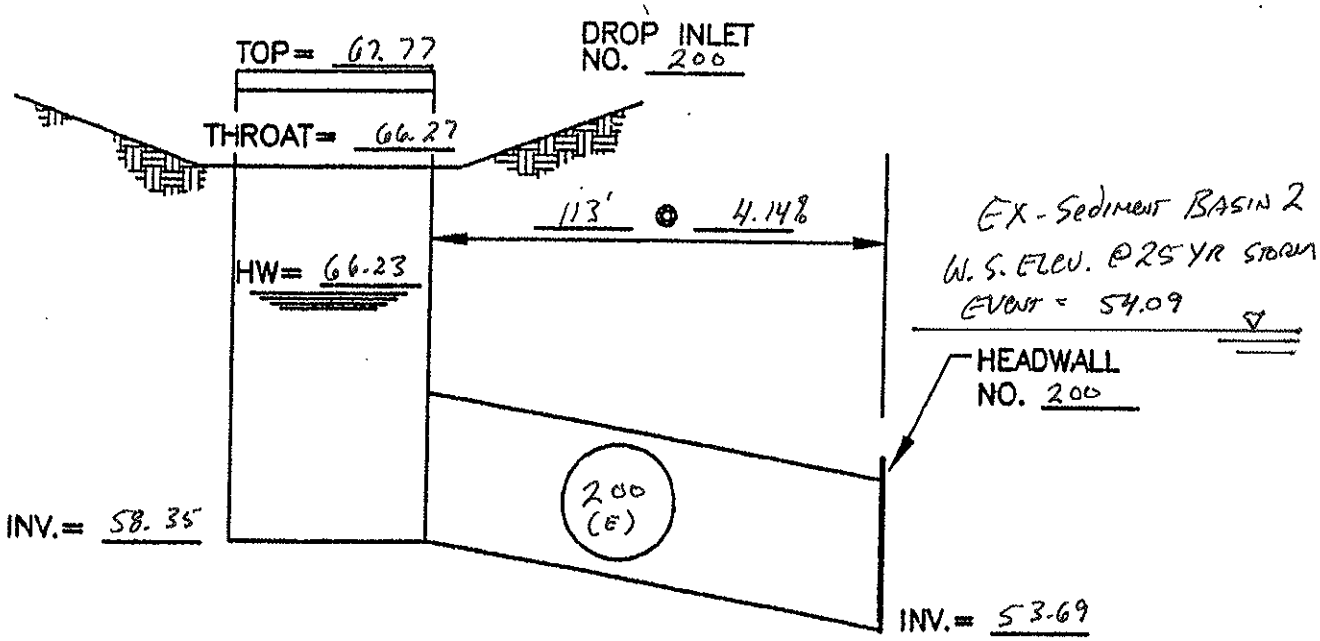
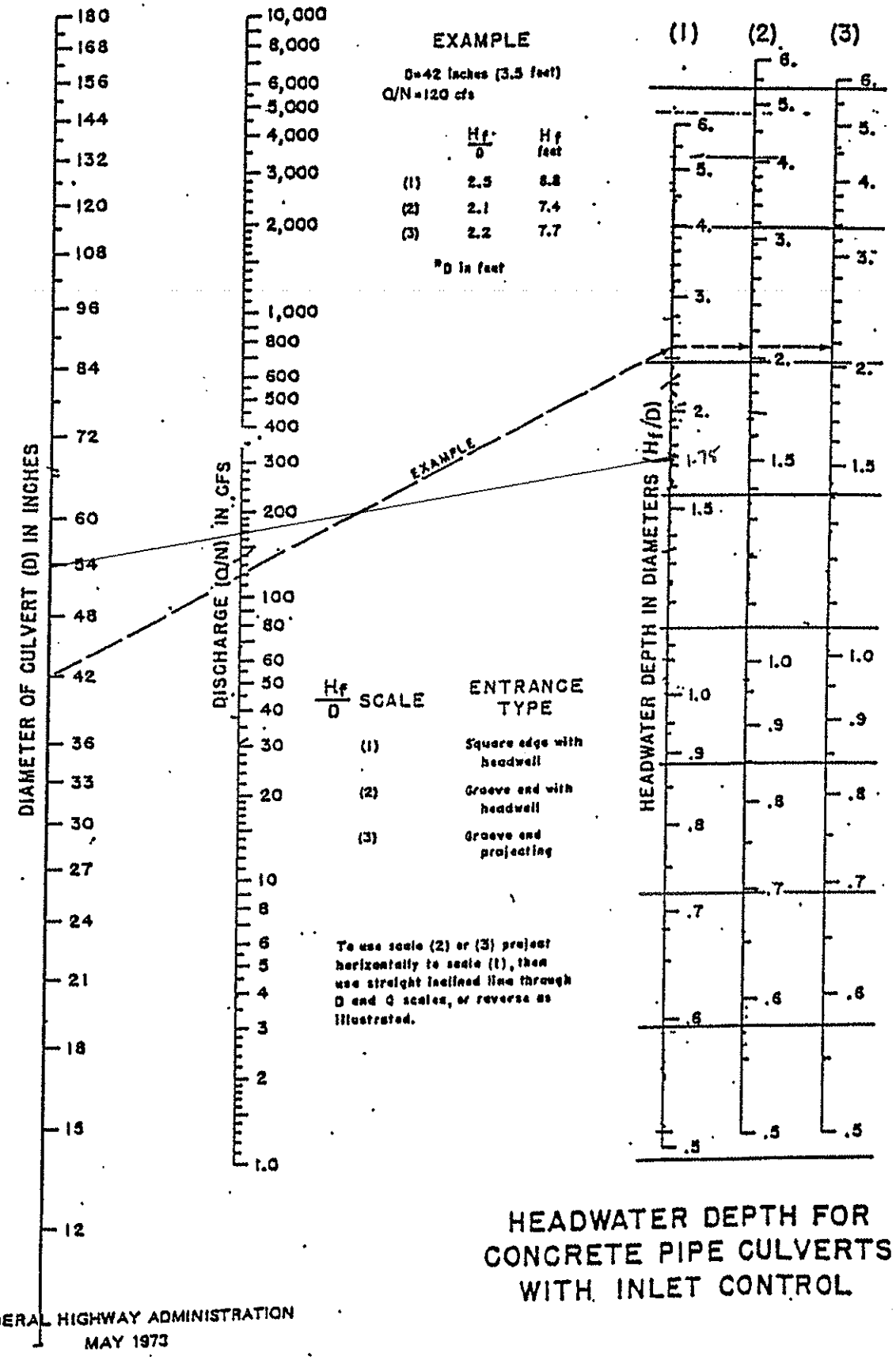
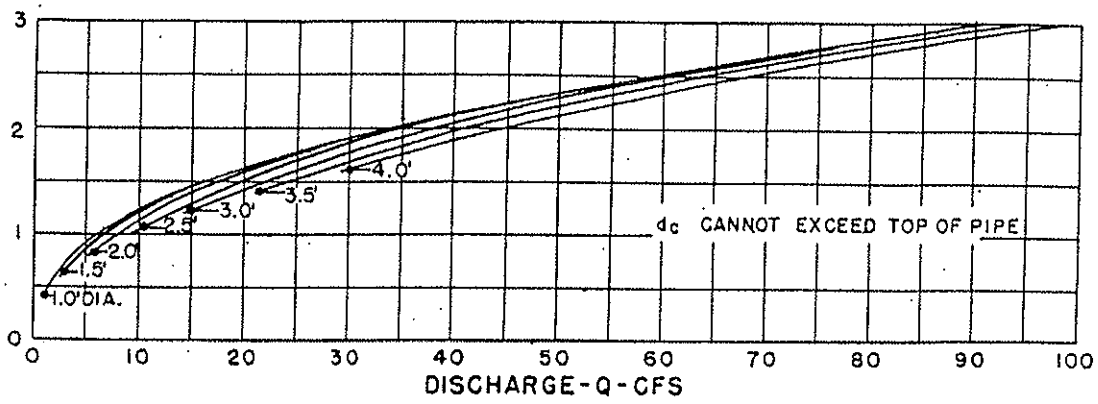


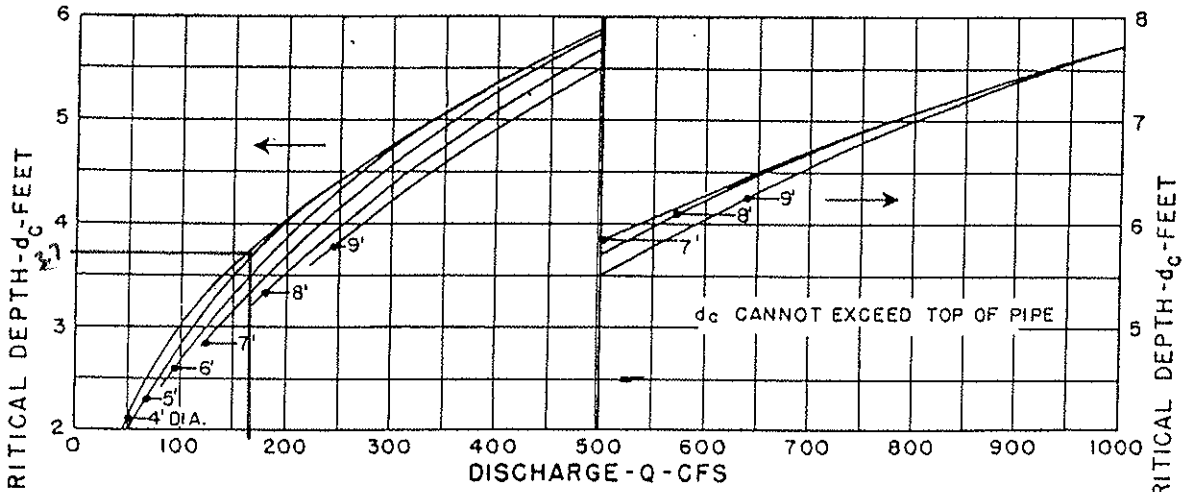
Chart 11

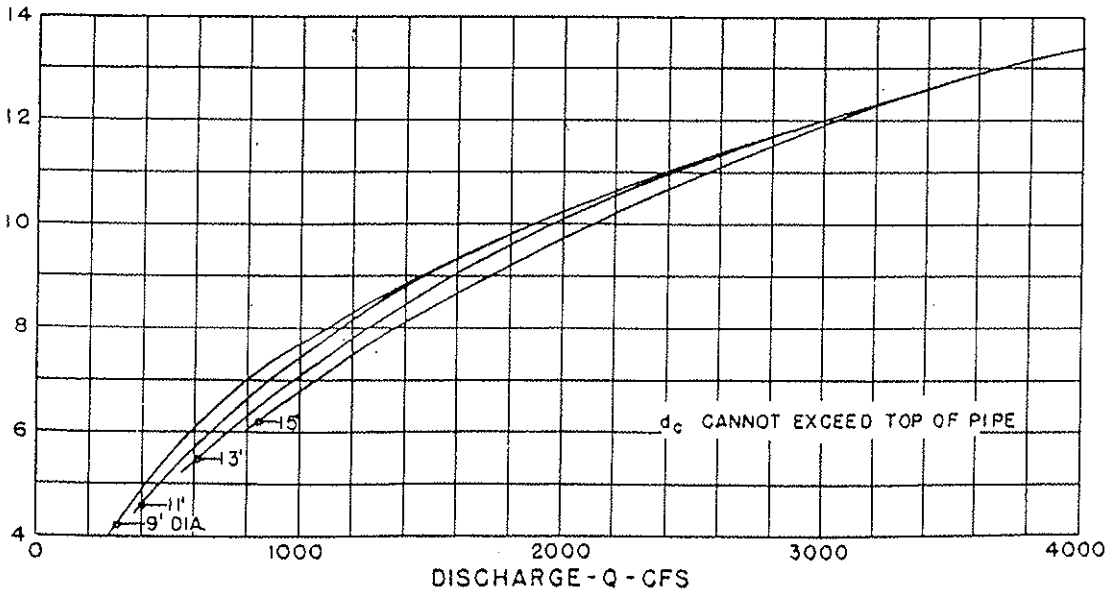


HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

FEDERAL HIGHWAY ADMINISTRATION
MAY 1973





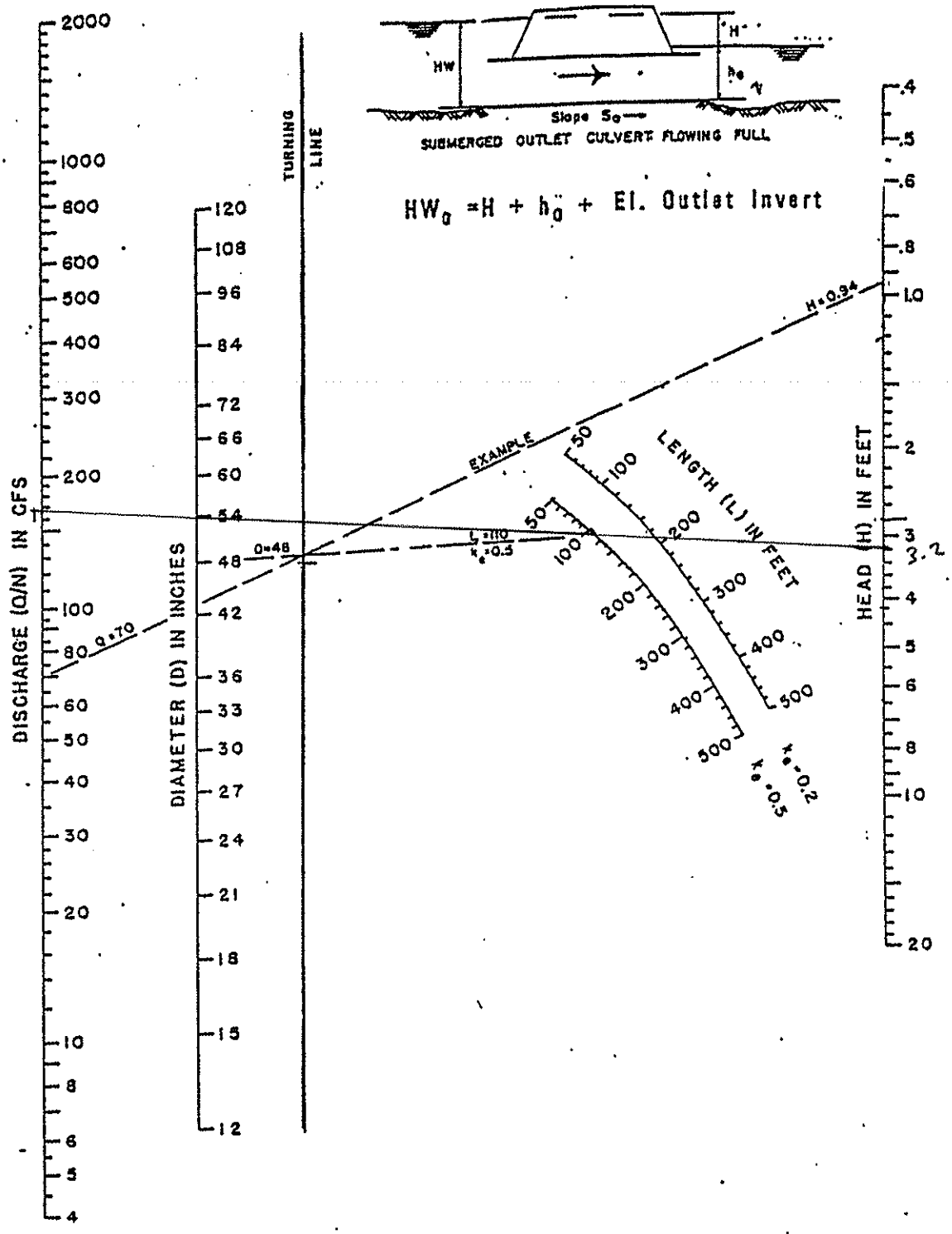


BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

Chart 2



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n.=0.012

BUREAU OF PUBLIC ROADS JAN. 1963

PIPE NO. 300 (E)

Q = 50 cfs

Allowable headwater = 3.90'

Inlet Control:

Assume 36 " dia. CMP at 50 cfs

HW = 3.0 x 1.30 = 3.90'

Outlet Control:

Find critical depth (dc) = 2.3

$h_o = \frac{dc + D}{2} = \frac{2.3 + 3}{2} = 5.3$ -or- (60.31 - 57.91 = 2.4)

H = head = 2.6

L = length = 67'

S_o = slope = 2.30%

HW = H + h_o − LS_o = 2.6 + 5.3 − 67(.023) = 6.35'

OUTLET CONTROLS

L, WILL USE 5.3

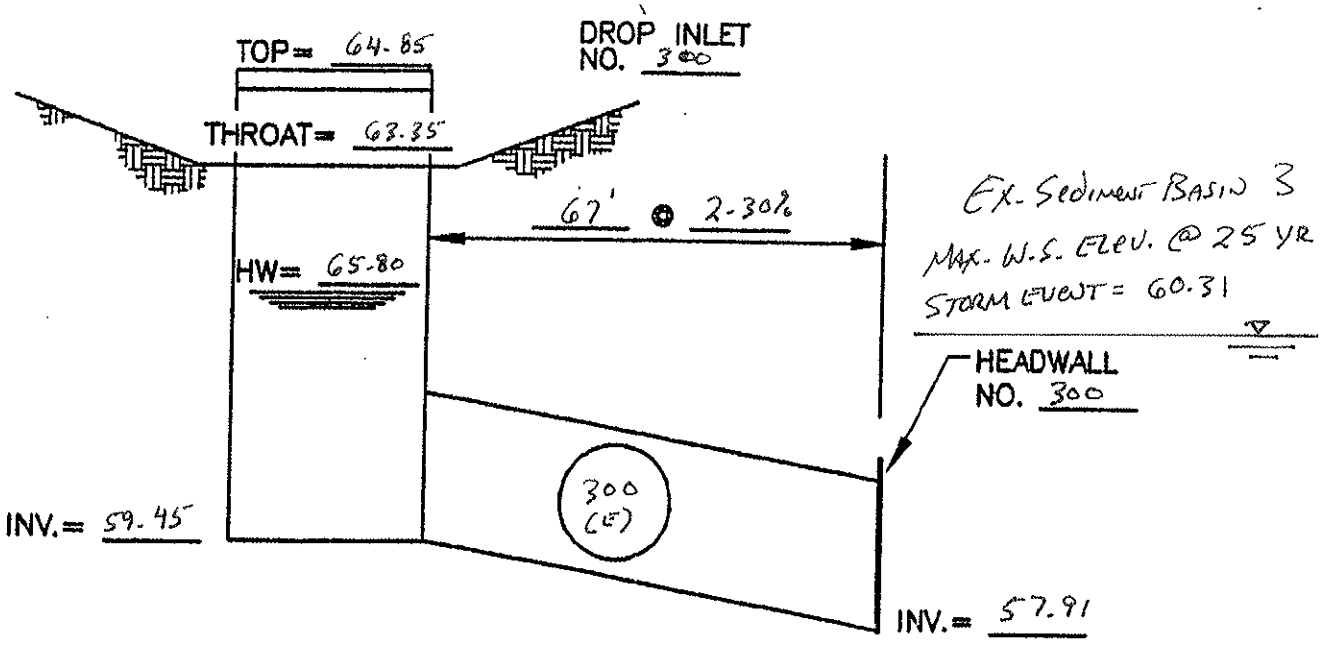
Final Pipe Selection:

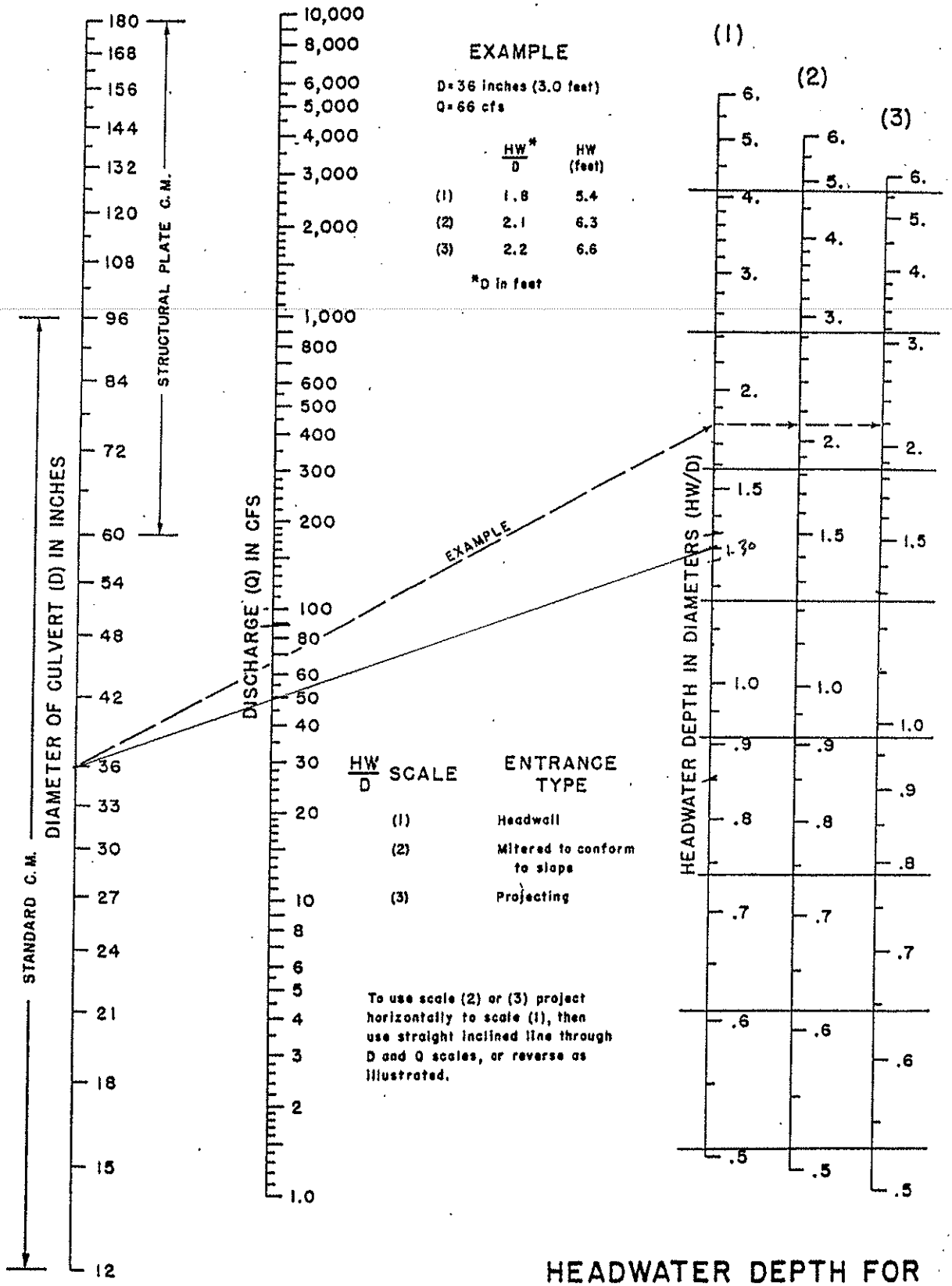
EX. 36 " dia. CMP at 50 cfs

Length = 67'

Slope = 2.3%

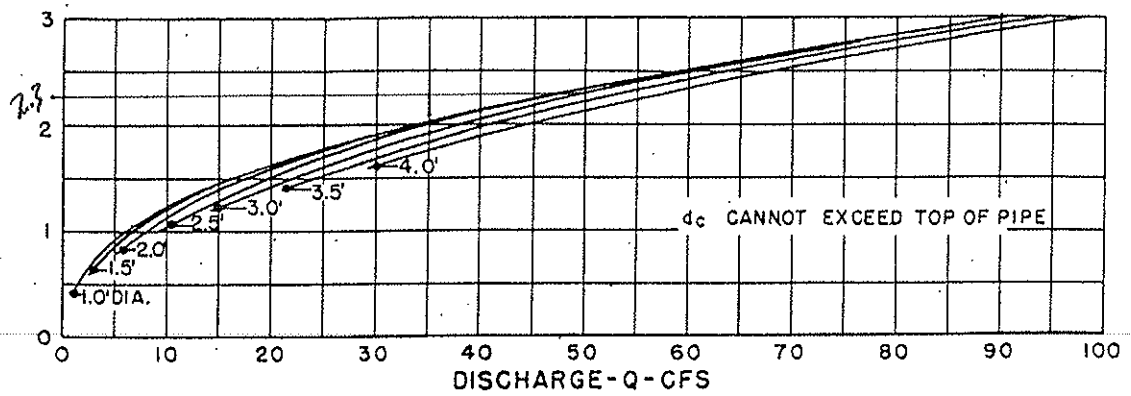
WATER LEVEL = 65.80 IN THE CHANNEL

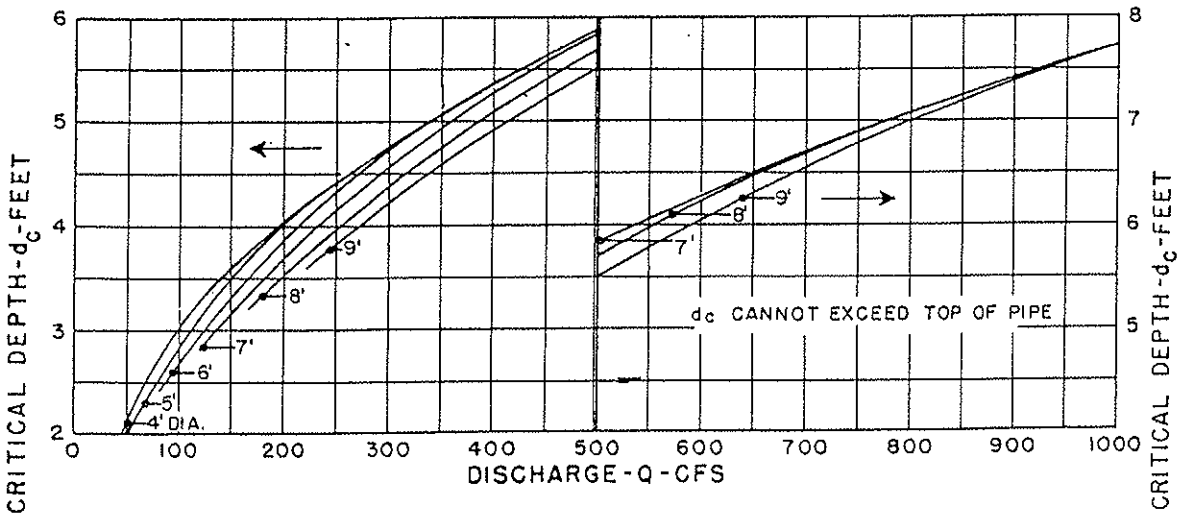


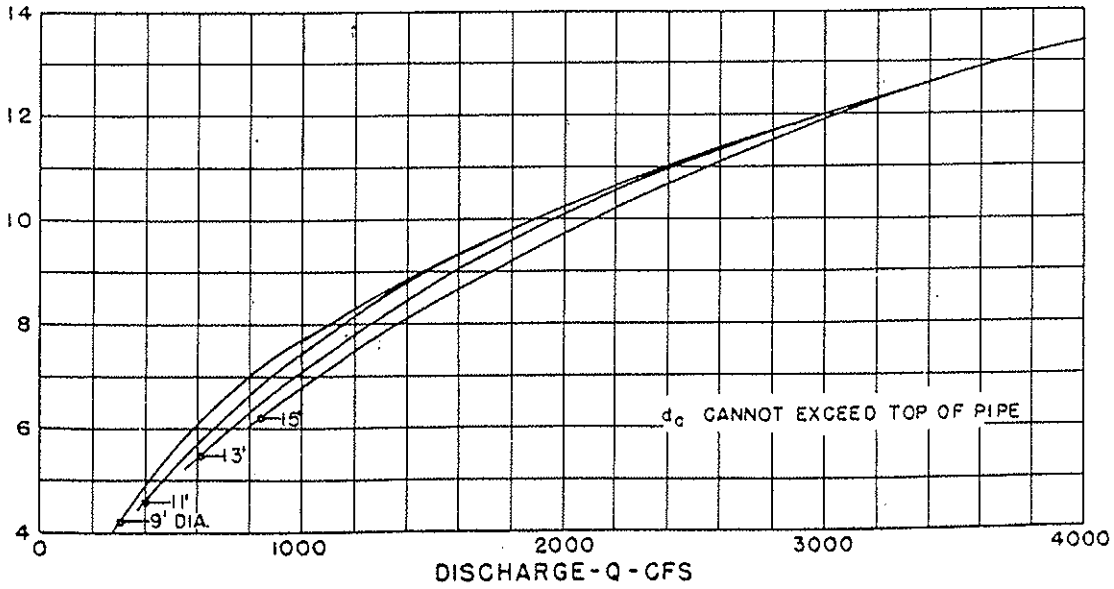


HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963



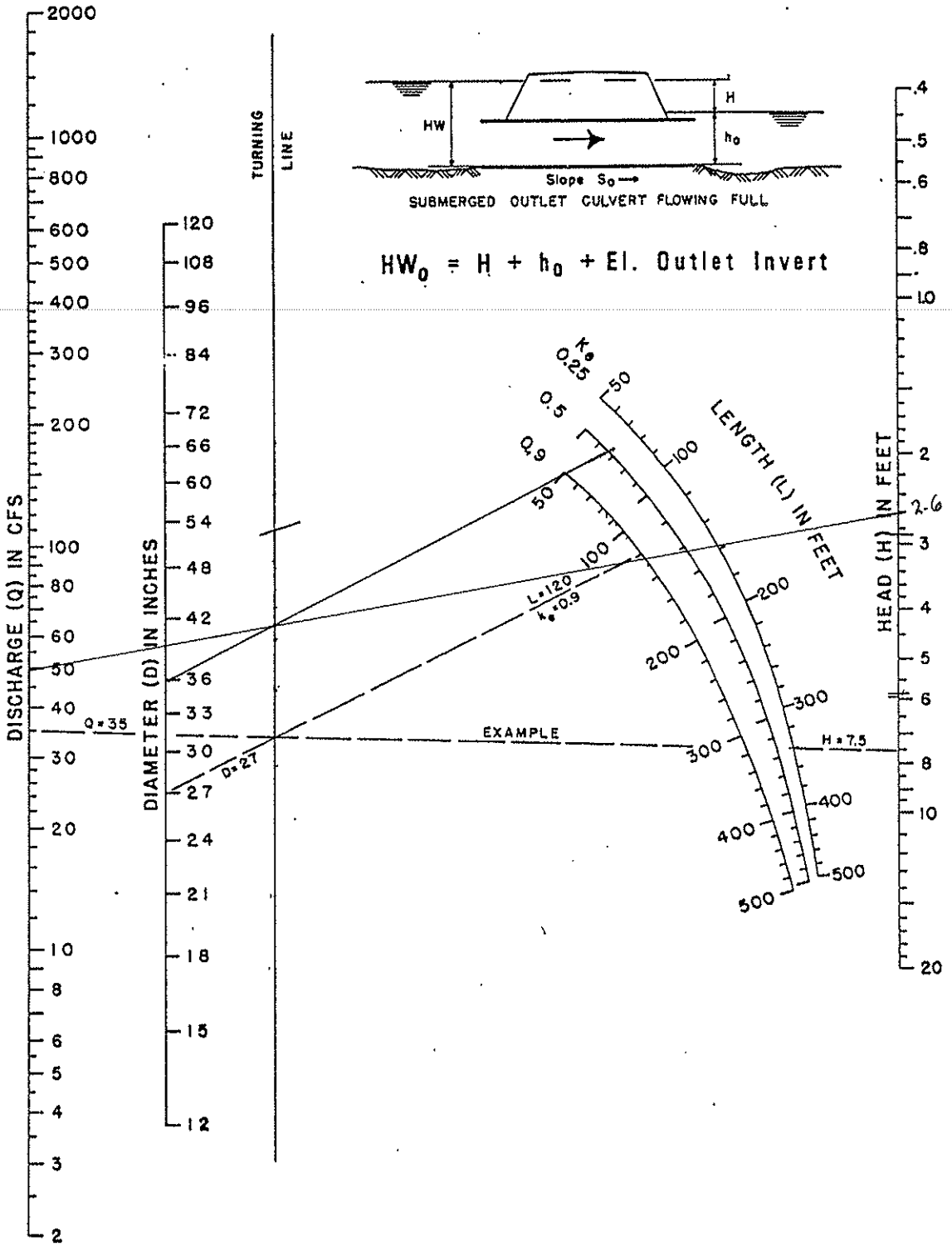




BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE



HEAD FOR STANDARD C. M. PIPE CULVERTS FLOWING FULL n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

PIPE NO. 301 (R)

Q = 205 cfs

Allowable headwater = 5.80'

Inlet Control:

Assume Twin 48 " dia. RCP at 103 cfs

HW = 4.0 x 1.35 = 5.40

INLET CONTROLS

Outlet Control:

Find critical depth (dc) = 3.0

$h_o = \frac{dc + D}{2} = \frac{3+4}{2} = 3.5$ -or- (60.31 - 56.65 = 3.66)

h_o will use 3.66

H = head = 1.7

L = length = 84'

S_o = slope = 2.56%

$HW = H + h_o - LS_o = 1.7 + 3.66 - 84(.0256) = 3.21$

Final Pipe Selection:

Twin 48 " dia. RCP at 205 cfs

Length = 84'

Slope = 2.56%

Replace ex. 42" CMP w/ Twin 48" RCP's.

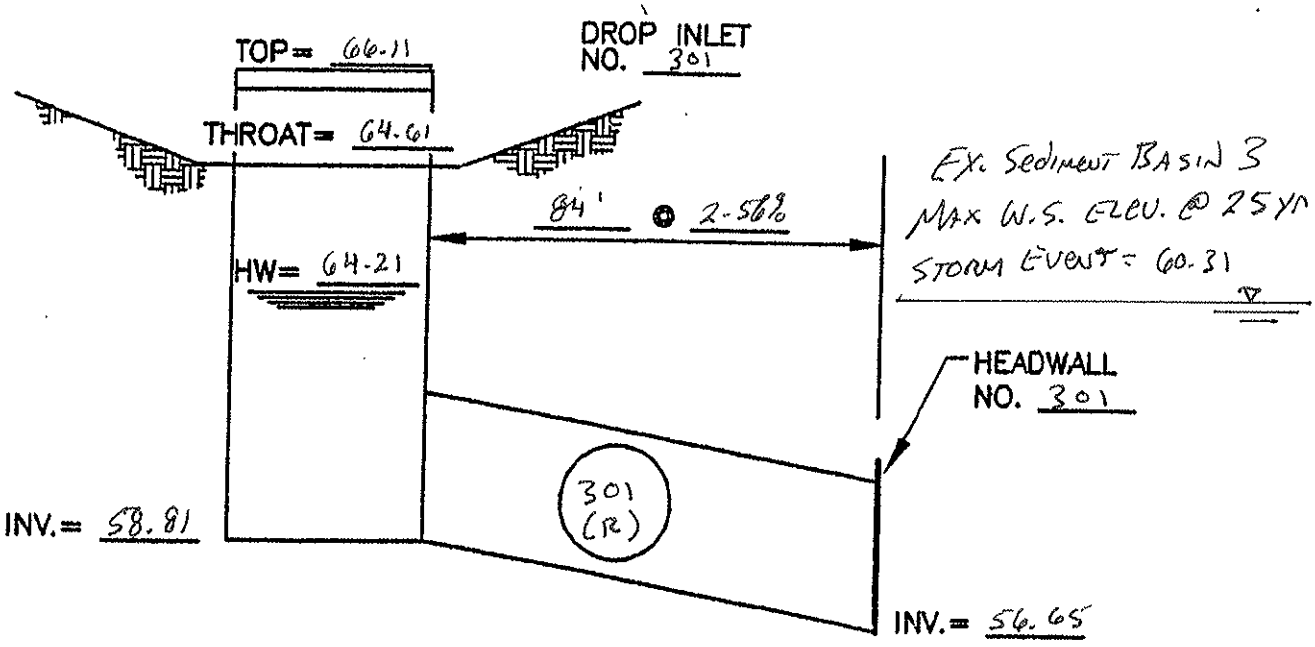
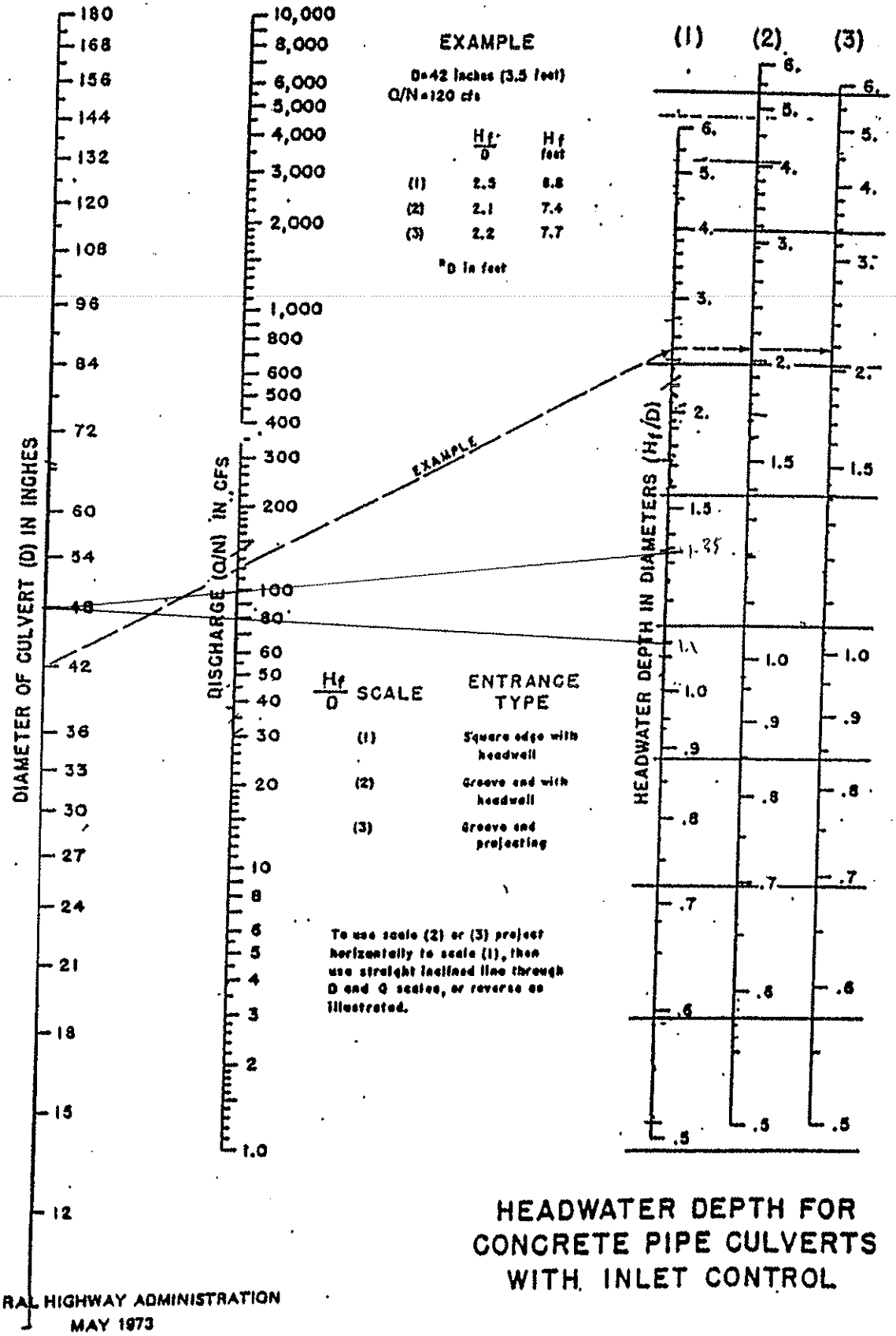
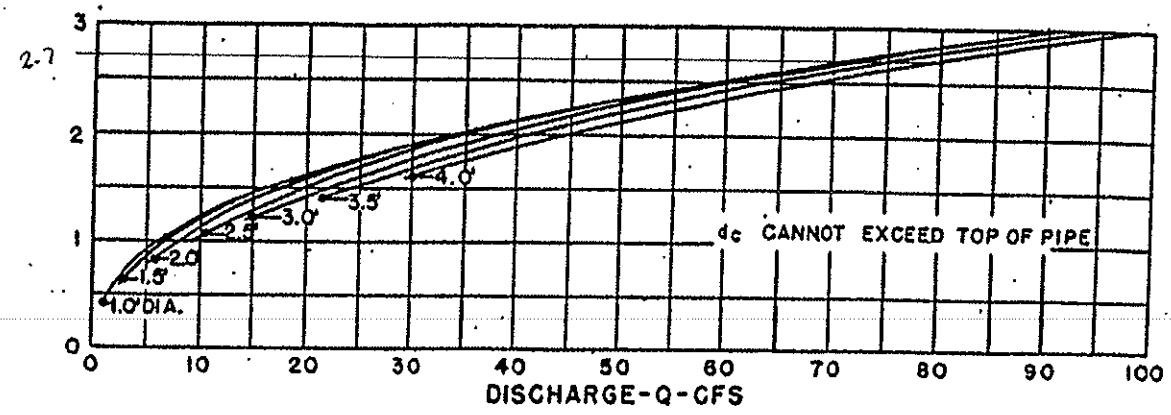


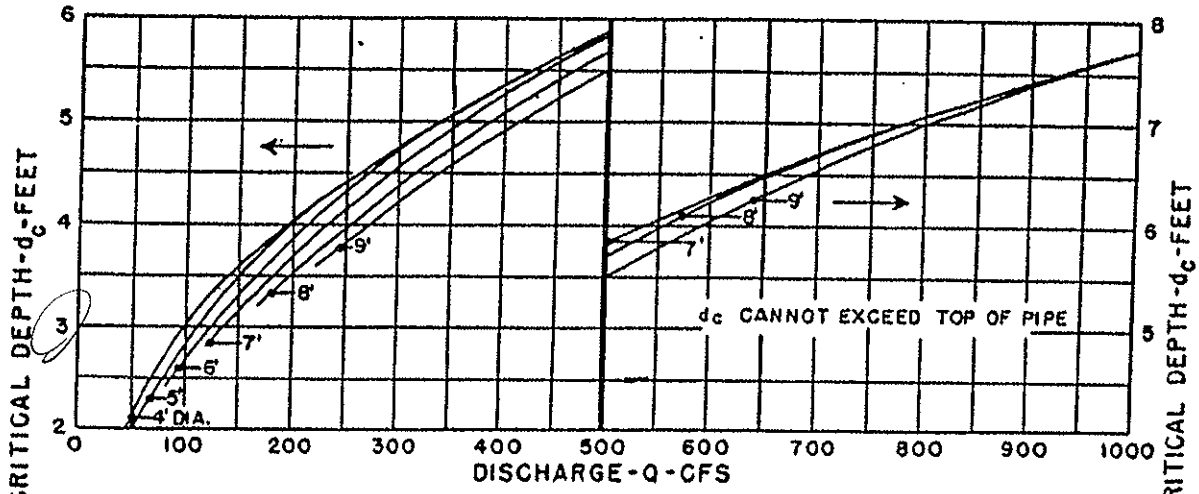
Chart 11

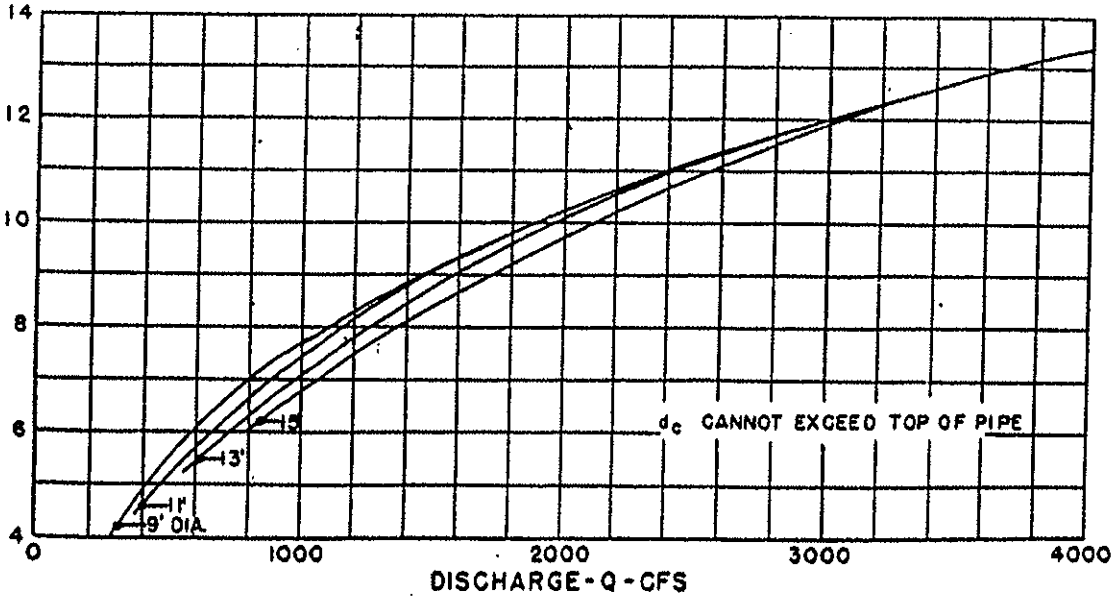


HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

FEDERAL HIGHWAY ADMINISTRATION
MAY 1973





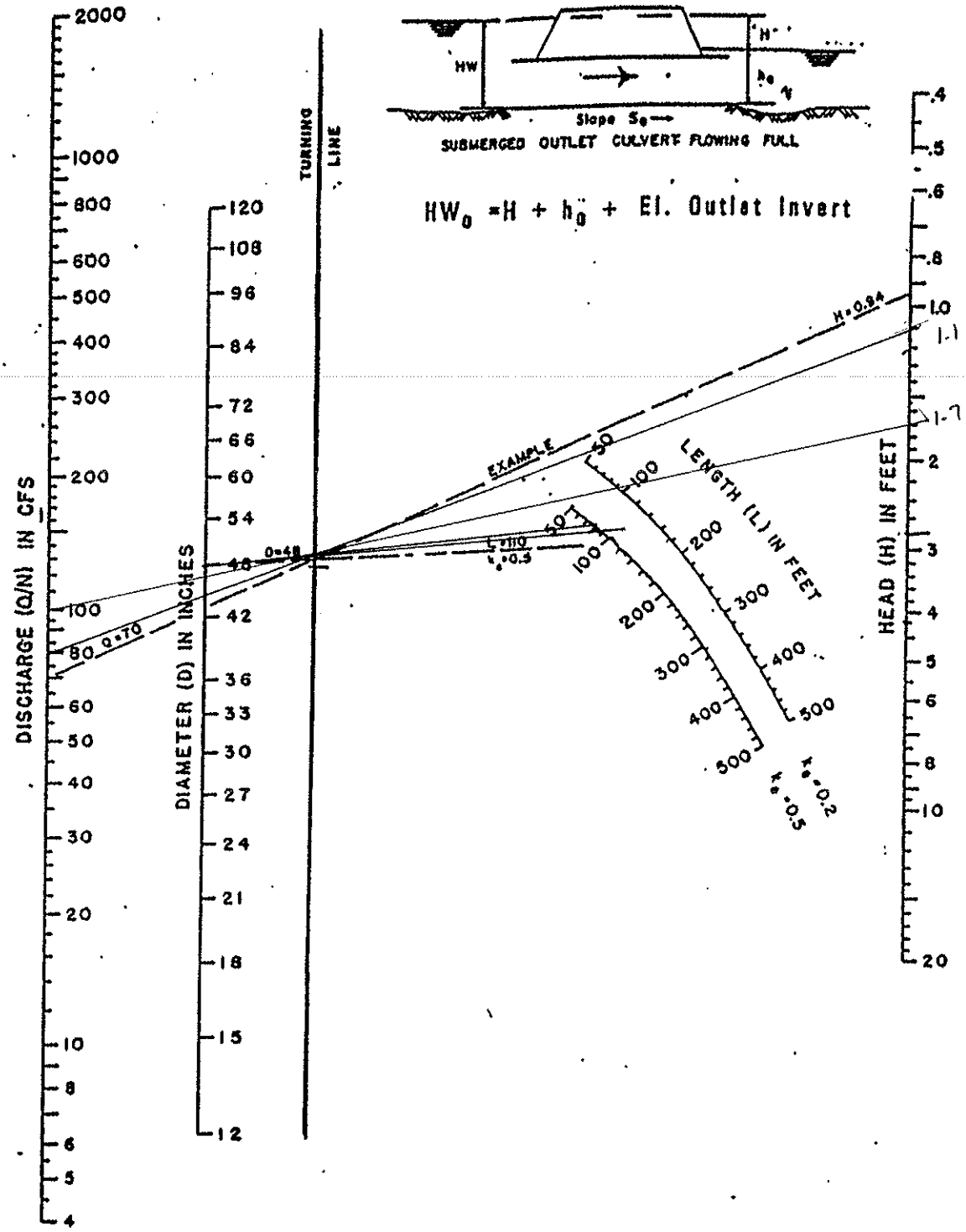


BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

Chart 2



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

PIPE NO. 400

Q = 184 cfs

Allowable headwater = 805

Inlet Control:

Assume Twin 42" dia. RCP at 92 cfs ea.

HW = 3.5 x 1.8 = 6.3'

INLET CONTROLS

Outlet Control:

Find critical depth (dc) = 2.95

$h_o = \frac{dc + D}{2} = \frac{2.95 + 3.5}{2} = 3.23$ OR (63.68 - 62 = 1.68 use 3.23)

H = head = 2.8'

L = length = 104'

S_o = slope = 1.92%

$HW = H + h_o - LS_o = 2.8 + 3.23 - 104(.0192) = 4.03'$

Final Pipe Selection:

Twin 42" dia. RCP at 92 cfs

Length = 104'

Slope = 1.92%

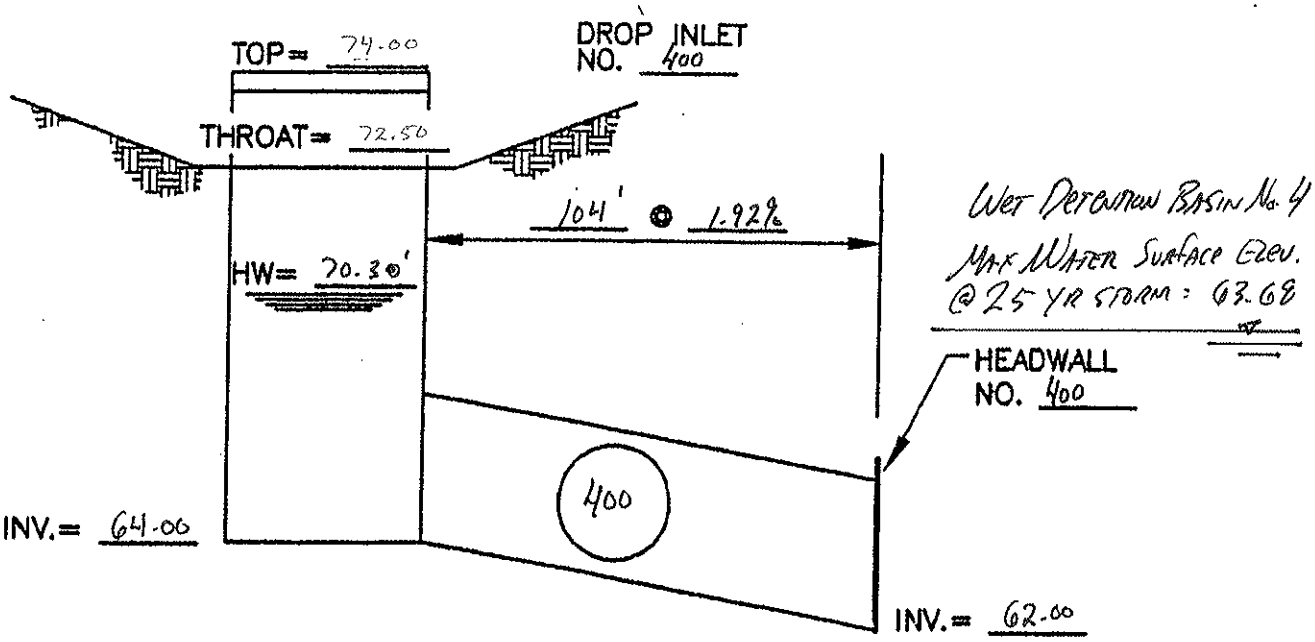
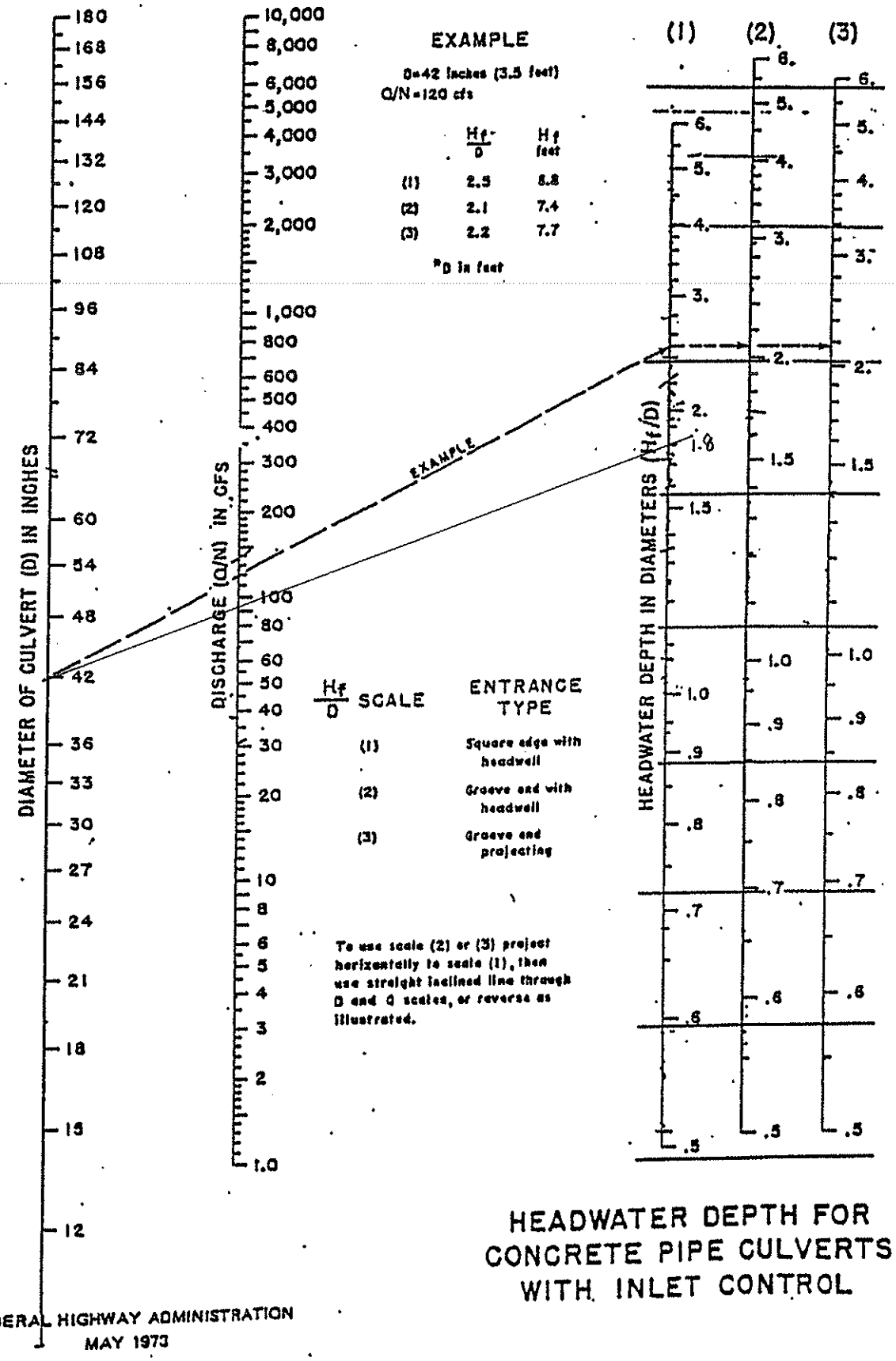
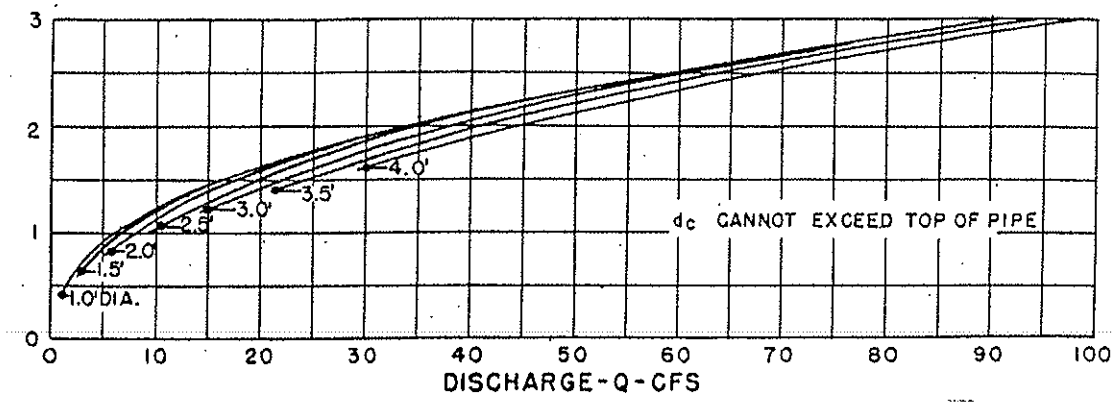


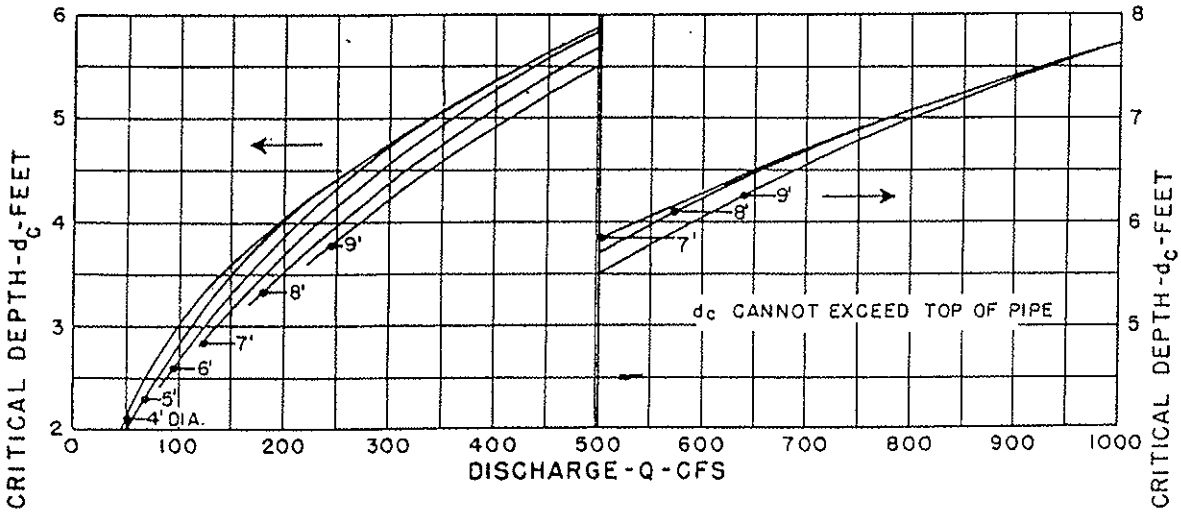
Chart 11

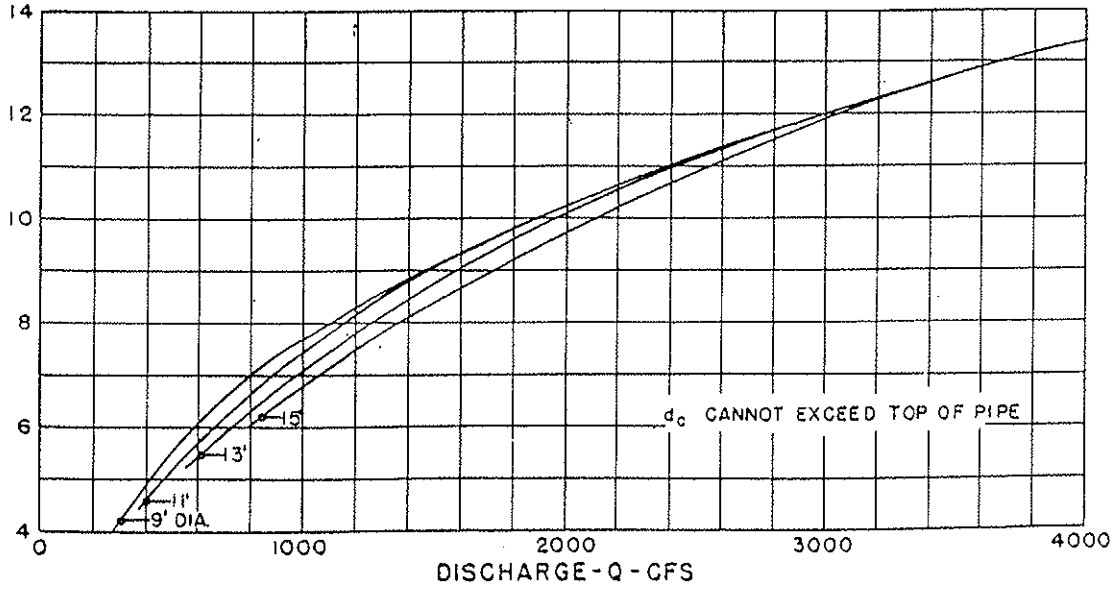


HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

FEDERAL HIGHWAY ADMINISTRATION
MAY 1973





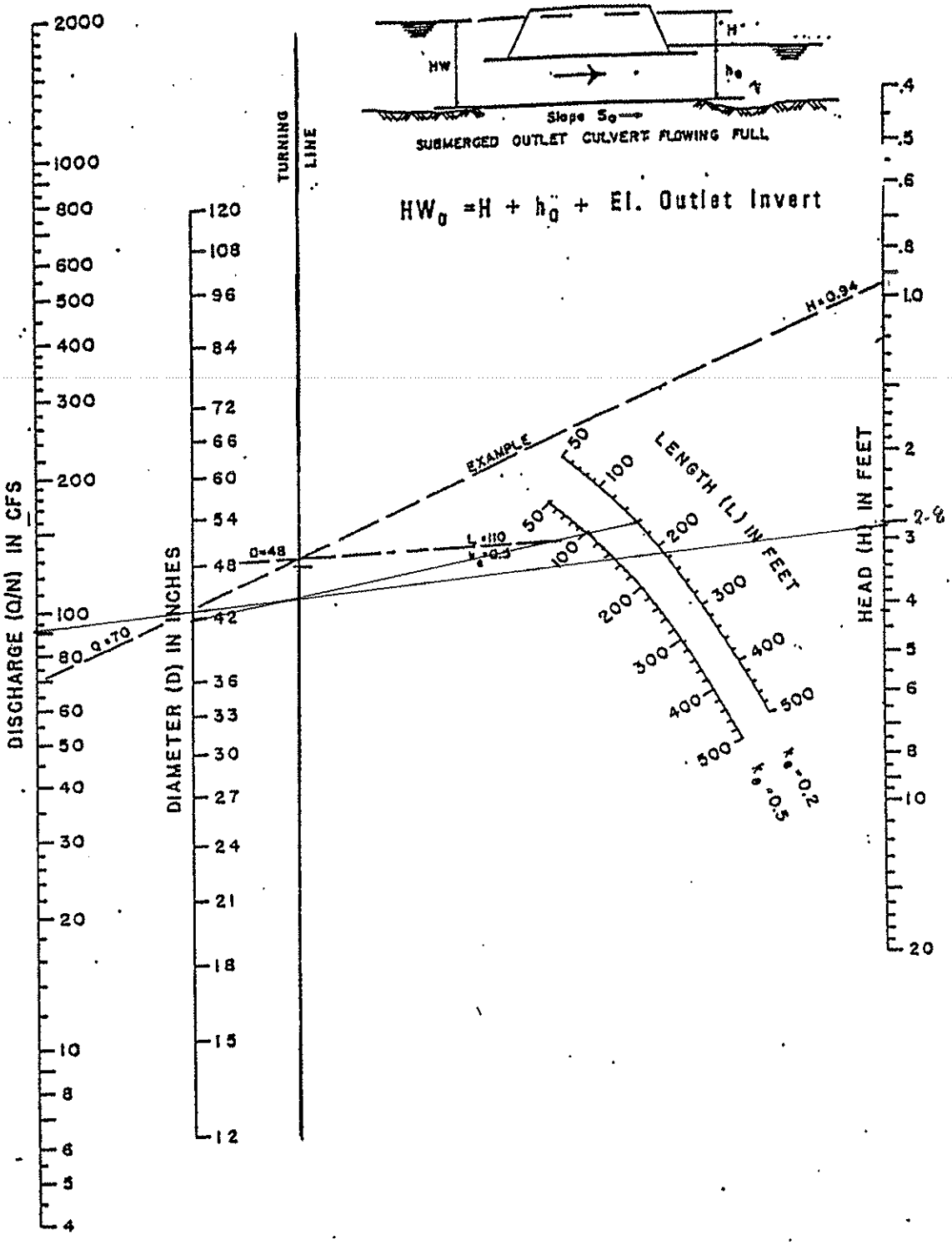


BUREAU OF PUBLIC ROADS

JAN. 1964

CRITICAL DEPTH
CIRCULAR PIPE

Chart 2



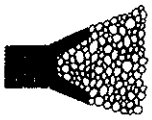
HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n=0.012

BUREAU OF PUBLIC ROADS JAN. 1963

h. Outlet Protection Calculations

6.41

OUTLET STABILIZATION STRUCTURE



Definition

A structure designed to control erosion at the outlet of a channel or conduit.

Purpose

To prevent erosion at the outlet of a channel or conduit by reducing the velocity of flow and dissipating energy.

Conditions Where Practice Applies

This practice applies where the discharge velocity of a pipe, box culvert, diversion, open channel, or other water conveyance structure exceeds the permissible velocity of the receiving channel or disposal area.

Planning Considerations

The outlets of channels, conduits, and other structures are points of high erosion potential because they frequently carry flows at velocities that exceed the allowable limit for the area downstream. To prevent scour and undermining, an outlet stabilization structure is needed to absorb the impact of the flow and reduce the velocity to non-erosive levels. A riprap-lined apron is the most commonly used practice for this purpose because of its relatively low cost and ease of installation. The riprap apron should be extended downstream until stable conditions are reached even though this may exceed the length calculated for design velocity control.

Riprap-stilling basins or plunge pools reduce flow velocity rapidly. They should be considered in lieu of aprons where pipe outlets are cantilevered or where high flows would require excessive apron length (Figure 6.41a). Consider other energy dissipaters such as concrete impact basins or paved outlet structures where site conditions warrant.

Alternative methods of energy dissipation can be found in Hydraulic Design of Energy Dissipaters for Culverts and Channels, Hydraulic Engineering Circular No. 14, U.S. Department of Transportation, Federal Highway Administration.

The installation of a culvert in a stream is subject to the conditions of a U.S. Army Corps of Engineers 404 Permit and a N.C. Division of Water Quality 401 Certification. These permit conditions may not allow the use of a riprap apron, and may require that the bottom of the culvert be buried below the natural stream bed elevation. A pre-formed scour pool or plunge pool should be considered in these situations. Plunge pool designs in streams should not use a cantilevered outlet because it would pose a barrier to migration of aquatic life through the culvert. Reducing the outlet velocity may require a combination of techniques, including a culvert with a flat bottom, a downstream cross vane to create tail-water at the pipe outlet, and/or a preformed scour pool.

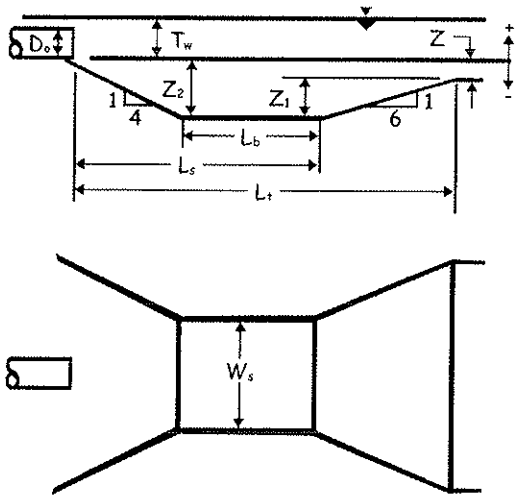
Design Criteria

Capacity—10-year, peak runoff or the design discharge of the water conveyance structure, whichever is greater.

Tail-water depth—Determine the tail-water depth immediately below the culvert or pipe outlet based on the design discharge. The ratio of tail-water depth to pipe diameter must be determined in order to select the appropriate riprap apron or plunge pool design method.

Plunge Pools—Two plunge pool methods are presented in Appendix 8.06, the USDA Plunge Pool Design at Submerged Pipe Spillway Outlets, and the USDA Riprap Lined Plunge Pool for Cantilevered Outlet. Software from the Federal Highway Administration can be downloaded at http://www.fhwa.dot.gov/engineering/hydraulics/software.cfm. Excel spreadsheets for the USDA methods are available through the Land Quality web-site at http://www.dlr.enr.state.nc.us/pages/sedimenttecassist.html.

Figure 6.41a Typical plunge pool design showing variable dimensions.



Riprap Aprons size—The apron length and width can be determined according to the tail-water condition. If the water conveyance structure discharges directly into a well-defined channel, extend the apron across the channel bottom and up the channel banks to an elevation of 0.5 foot above the maximum tail-water depth or to the top of the bank, whichever is less (Figure 6.41c).

Determine the maximum allowable velocity for the receiving stream, and design the riprap apron to reduce flow to this velocity before flow leaves the apron. Calculate the apron length for velocity control or use the length required to meet stable conditions downstream, whichever is greater.

Grade—Ensure that the apron has zero grade. There should be no overfall at the end of the apron; that is, the elevation of the top of the riprap at the downstream end should be the same as the elevation of the bottom of the receiving channel or the adjacent ground if there is no channel.

Alignment—The apron should be straight throughout its entire length, but if a curve is necessary to align the apron with the receiving stream, locate the curve in the upstream section of riprap.

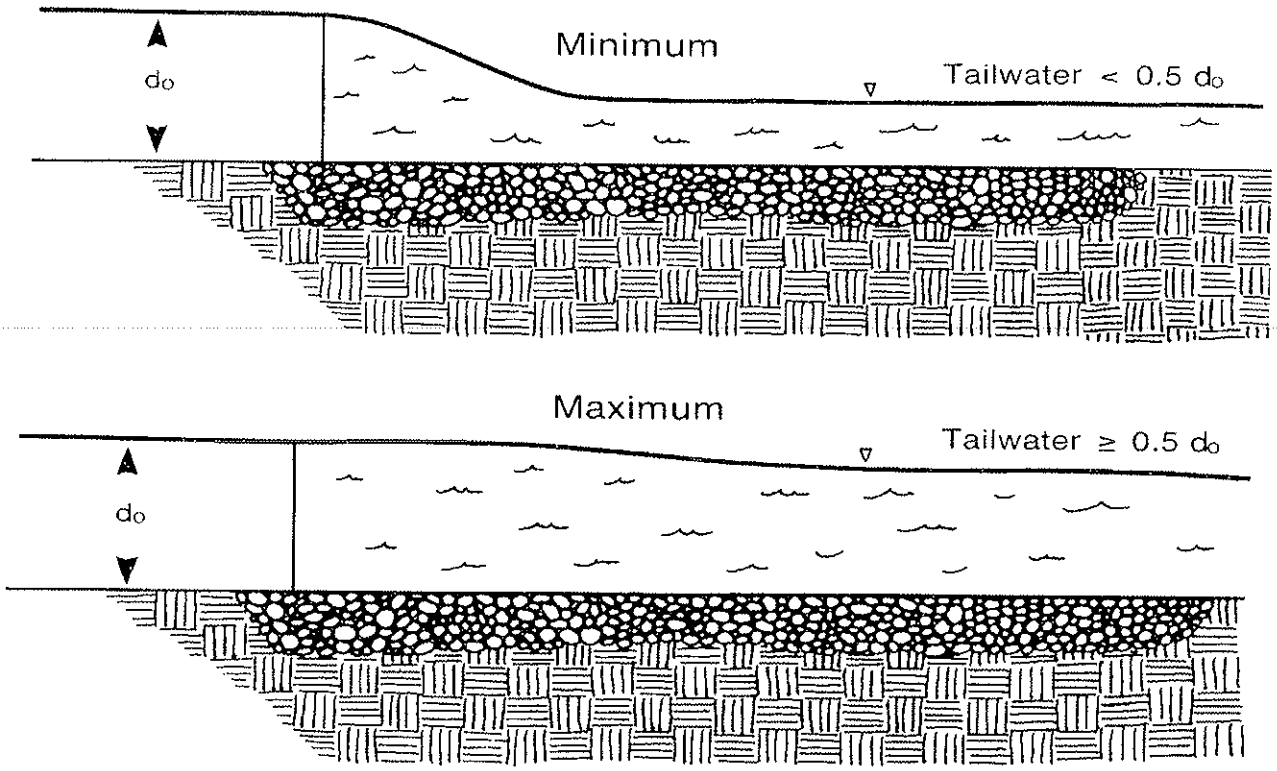


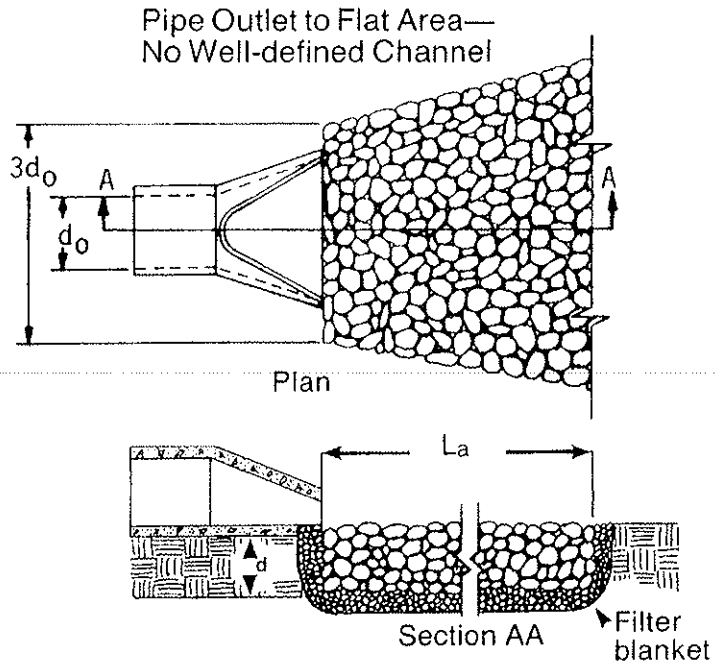
Figure 6.41b Stage showing maximum and minimum tailwater condition.

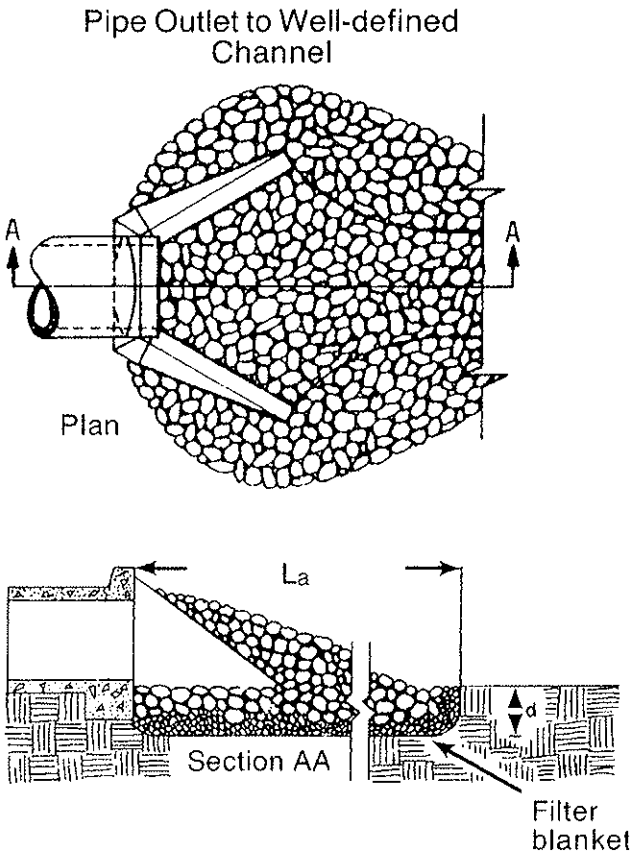
Materials—Ensure that riprap consists of a well-graded mixture of stone. Larger stone should predominate, with sufficient smaller sizes to fill the voids between the stones. The diameter of the largest stone size should be no greater than 1.5 times the d_{50} size.

Thickness—Make the minimum thickness of riprap 1.5 times the maximum stone diameter.

Stone quality—Select stone for riprap from field stone or quarry stone. The stone should be hard, angular, and highly weather-resistant. The specific gravity of the individual stones should be at least 2.5.

Filter—Install a filter to prevent soil movement through the openings in the riprap. The filter should consist of a graded gravel layer or a synthetic filter cloth. Design filter blankets by the method described in Practice 6.15, *Riprap*.





Notes

1. L_a is the length of the riprap apron.
2. d = 1.5 times the maximum stone diameter but not less than 6″.
3. In a well-defined channel extend the apron up the channel banks to an elevation of 6″ above the maximum tailwater depth or to the top of the bank, whichever is less.
4. A filter blanket or filter fabric should be installed between the riprap and soil foundation.

Figure 6.41c Riprap outlet protection (modified from Va SWCC).

Construction Specifications

1. Ensure that the subgrade for the filter and riprap follows the required lines and grades shown in the plan. Compact any fill required in the subgrade to the density of the surrounding undisturbed material. Low areas in the subgrade on undisturbed soil may also be filled by increasing the riprap thickness.

2. The riprap and gravel filter must conform to the specified grading limits shown on the plans.

3. Filter cloth, when used, must meet design requirements and be properly protected from punching or tearing during installation. Repair any damage by removing the riprap and placing another piece of filter cloth over the damaged area. All connecting joints should overlap so the top layer is above the downstream layer a minimum of 1 foot. If the damage is extensive, replace the entire filter cloth.

4. Riprap may be placed by equipment, but take care to avoid damaging the filter.

5. The minimum thickness of the riprap should be 1.5 times the maximum stone diameter.

6. Riprap may be field stone or rough quarry stone. It should be hard, angular, highly weather-resistant and well graded.

7. Construct the apron on zero grade with no overfill at the end. Make the top of the riprap at the downstream end level with the receiving area or slightly below it.

8. Ensure that the apron is properly aligned with the receiving stream and preferably straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.

9. Immediately after construction, stabilize all disturbed areas with vegetation (Practices 6.10, *Temporary Seeding*, and 6.11, *Permanent Seeding*).

Maintenance

Inspect riprap outlet structures weekly and after significant (1/2 inch or greater) rainfall events to see if any erosion around or below the riprap has taken place, or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.

References

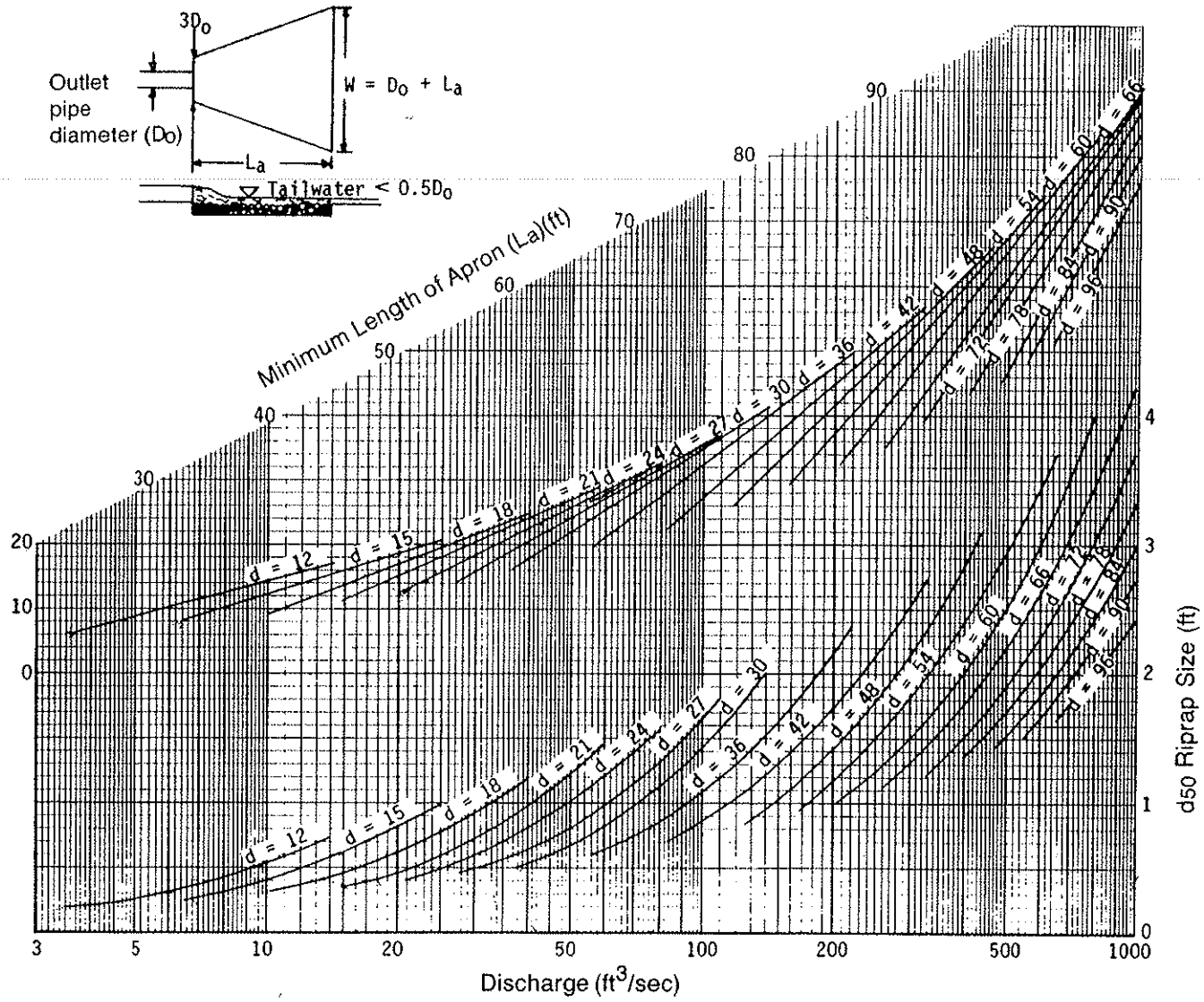
Surface Stabilization
6.10, Temporary Seeding
6.11, Permanent Seeding
6.15, Riprap

Appendix
8.06, Design of Riprap Outlet Protection

Rice, C.E., Kadavy, K.C "Riprap Design for Pipe Spillways at $-1 \leq TW/D \leq 0.7$" Presented at the December 13, 1994 International Winter Meeting, American Society of Agricultural Engineers, Paper Number 942541.

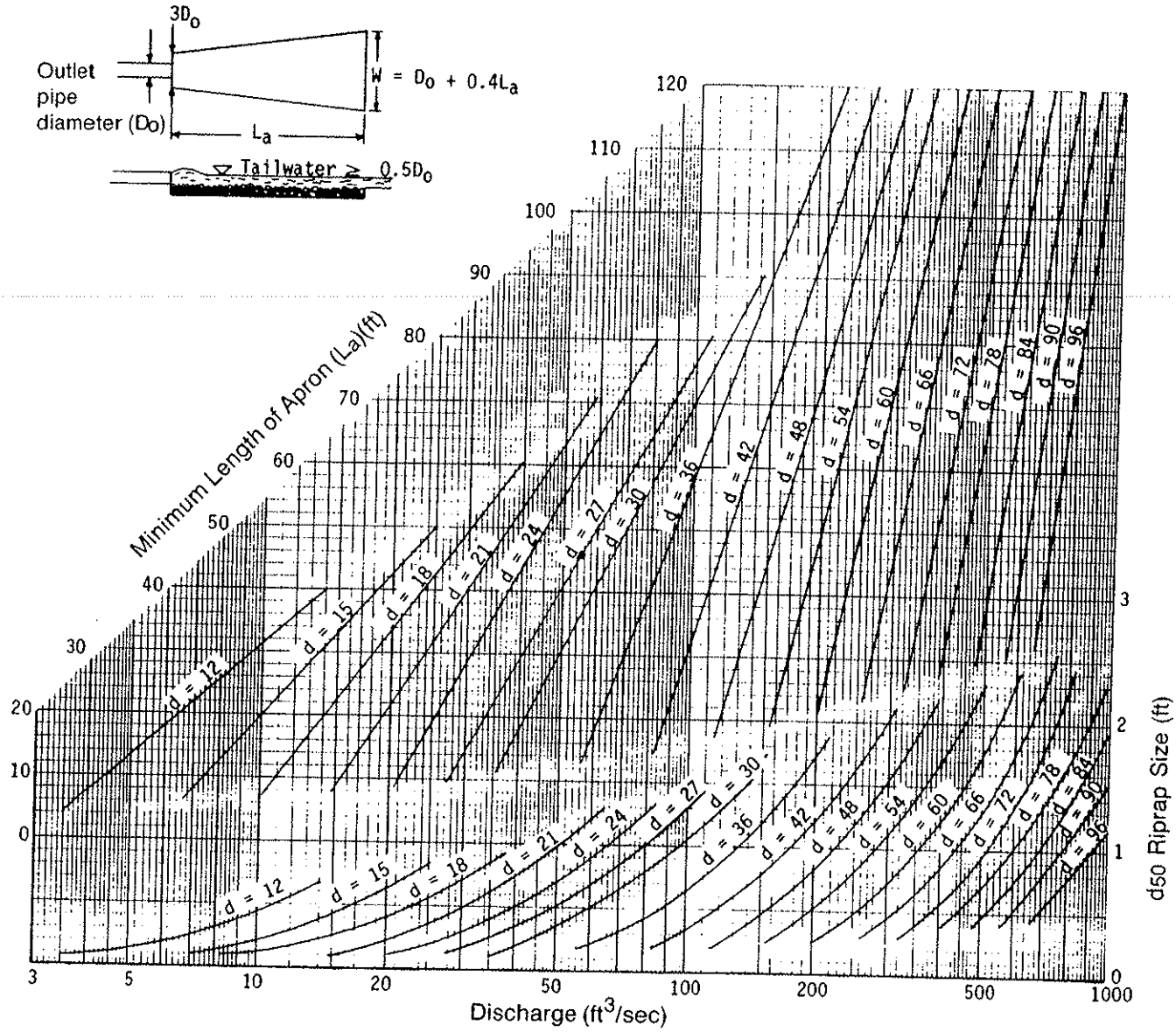
Rice, C.E. and K.C. Kadavy. 1994, Plunge Pool Design at Submerged Pipe Spillway Outlets. Transactions of the ASAE 37(4):1167-1173.

FHWA. 1983. Hydralic Design of Energy Dissipaters for Culverts and Channels. Hydraulic Engineering Circular Number 14.



Curves may not be extrapolated.

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



Curves may not be extrapolated.

Figure 8.06b Design of outlet protection from a round pipe flowing full, maximum tailwater condition ($T_w \geq 0.5$ diameter).

DOWNDRAIN NO. 3

Q_{25} = 21.20 cfs La = 11 ft.

D_o = 24 in. d^{50} = 6 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right) + La}{2} \times \frac{La}{9}$$

= 14 S.Y. 6" Rip Rap

Use 22 S.Y.		6" Rip Rap
L = 11	W1 = 18	W2 = 18

DOWNDRAIN NO. 4 Existing

Q_{25} = 4.90 cfs La = 9 ft.

D_o = 18 in. d^{50} = 6 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right) + La}{2} \times \frac{La}{9}$$

= 9 S.Y. 6" Rip Rap

Use 18 S.Y.		6" Rip Rap
L = 9	W1 = 18	W2 = 18

DOWNDRAIN NO. 7 Existing

Q_{25} = 17.17 cfs La = 13 ft.

D_o = 24 in. d^{50} = 6 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right) + La}{2} \times \frac{La}{9}$$

= 18 S.Y. 6" Rip Rap

Use 26 S.Y.		6" Rip Rap
L = 13	W1 = 18	W2 = 18

DOWNDRAIN NO. 11

Q_{25} = 24.06 cfs La = 15 ft.

D_o = 24 in. d^{50} = 6 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right) + La}{2} \times \frac{La}{9}$$

= 23 S.Y. 6" Rip Rap

Use 30 S.Y.		6" Rip Rap
L = 15	W1 = 18	W2 = 18

DOWNDRAIN NO. 28

Q_{25} = 48.58 cfs La = 25 ft.

D_o = 24 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 51 S.Y. 12" Rip Rap

Use 50 S.Y.		12" Rip Rap
L = 25	W1 = 18	W2 = 18

DOWNDRAIN NO. 33

Q_{25} = 22.28 cfs La = 14 ft.

D_o = 24 in. d^{50} = 6 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 20 S.Y. 6" Rip Rap

Use 28 S.Y.		6" Rip Rap
L = 14	W1 = 18	W2 = 18

DOWNDRAIN NO. 36 and 41

Q_{25} = 52.39 cfs La = 26 ft.

D_o = 2 - 24 in. d^{50} = 15 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 55 S.Y. 15" Rip Rap

Use 52 S.Y. 15" Rip Rap
L = 26 W1 = 18 W2 = 18

DOWNDRAIN NO. 44 and 47

Q_{25} = 47.42 cfs La = 25 ft.

D_o = 2 - 24 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 51 S.Y. 12" Rip Rap

Use 50 S.Y. 12" Rip Rap
L = 25 W1 = 18 W2 = 18

DOWNDRAIN NO. 52

Q_{25} = 41.98 cfs La = 23 ft.

D_o = 24 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 45 S.Y. 12" Rip Rap

Use 46 S.Y. 12" Rip Rap
L = 23 W1 = 18 W2 = 18

DOWNDRAIN NO. 58

Q_{25} = 45.86 cfs La = 24 ft.

D_o = 24 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 48 S.Y. 12" Rip Rap

Use 48 S.Y. 12" Rip Rap
L = 24 W1 = 18 W2 = 18

DOWNDRAIN NO. 64 and 67

Q_{25} = 45.70 cfs La = 24 ft.

D_o = 2 - 24 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 48 S.Y. 12" Rip Rap

Use 48 S.Y. 12" Rip Rap
L = 24 W1 = 18 W2 = 18

PIPE NO. 200

Q_{25} = 168 cfs La = 32 ft.

D_o = 54 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 105 S.Y. 12 " Rip Rap

Use 105 S.Y. 12 " Rip Rap
L = 32 W1 = 13.5 W2 = 45.5

PIPE NO. 201

Q_{100} = 63 cfs La = 25 ft.

D_o = 30 in. d^{50} = 9 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right) + La}{2} \times \frac{La}{9}$$

= 56 S.Y. 9" Rip Rap

Use 28 S.Y.	9" Rip Rap
L = 25	W1 = 7.5	W2 = 32.5

PIPE NO. 300

Q_{25} = 50 cfs La = 20 ft.

D_o = 36 in. d^{50} = 9 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right) + La}{2} \times \frac{La}{9}$$

= 42 S.Y. 9" Rip Rap

Use 42 S.Y.	9 " Rip Rap
L = 20	W1 = 9	W2 = 29

PIPE NO. 301(R)

Q_{25} = 205 cfs La = 26 ft.

D_o = Twin - 48 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 72 S.Y. 12" Rip Rap

Use 87 S.Y.		12" Rip Rap
L = 26	W1 = 17	W2 = 43

PIPE NO. 302(R)

Q_{100} = 210 cfs La = 33 ft.

D_o = 60 in. d^{50} = 15 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 116 S.Y. 15" Rip Rap

Use 116 S.Y.		15" Rip Rap
L = 33	W1 = 15	W2 = 48

PIPE NO. 400

Q_{25} = 184 cfs La = 25 ft.

D_o = Twin - 42 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 64 S.Y. 12" Rip Rap (Per Pipe)

Use 77 S.Y. 12" Rip Rap
L = 25 W1 = 15 W2 = 40

PIPE NO. 401

Q_{100} = 72 cfs La = 25 ft.

D_o = 36 in. d^{50} = 12 in.

$$\text{Quantity of Rip Rap} = \frac{6\left(\frac{D_O}{12}\right)+La}{2}\times\frac{La}{9}$$

= 60 S.Y. 12" Rip Rap

Use 60 S.Y. 12" Rip Rap
L = 25 W1 = 9 W2 = 34

2. EXISTING SEDIMENT BASIN NO. 2

a. Existing Sediment Basin Design Criteria

The existing sediment basin 2 at East Carolina Regional Landfill was originally designed utilizing the following design criteria.

A. Minimum Length to Width Ratio = 2:1
B. Surface Area @ 100 year storm = 0.01 acres min. per cfs of flow.
C. 1800 cubic feet of volume per acre of disturbed land measured at 3' depth elevation.
D. Retain the 25 year storm plus the sediment from item C above below the crest of the riser.

For the Sediment Basin, the actual design criteria is compared to the NCDENR recommended criteria for sediment basins.

Existing Sediment Basin No. 2

Criteria	NC DENR	Actual
Length	2:1	2.8:1
Surface Area	.010 Acre/cfs	0.0122 Acre/cfs
Volume at 3' Depth Elevation	1,800 C.F./Acre	8,382 C.F./Acre
Storm Retention	25 year	100 year

Existing Sediment Basin No. 2 was originally designed, approved and constructed as part of the first phase of landfill development at the East Carolina Environmental Landfill. The basin was appropriately sized for final build out of the landfill. Subsequent phases of the landfill have utilized the existing basin design.

The Phase 5 drainage plan will also utilize the existing design of Sediment Basin No. 2. With the addition of Wet Detention Basin No. 4, the overall drainage area to Sediment Basin No. 2 has been reduced to 39.3 acres. As illustrated in the chart above, the existing design of the Sediment Basin No. 2 meets or exceeds the minimum NCDENR requirements for sediment basins. The existing basin design is sufficient to maintain all design storms up to and including the 100 year storm below the crest of the riser. This design parameter allows maximum sediment removal efficiency from a dry pond design.

b. Sediment Volumes and Surface Area Calculations

SEDIMENT VOLUME REQUIREMENTS = 1,800 cu.ft. / acre

= 1,800 x 39.3 acres

= 70,740 cf

From the Hydraflow Hydrographs 2004 Computer Program, this volume of sediment will occupy a depth of approximately 0.67 feet (interpolated from printout on next page). This sediment volume corresponds to elevation = 51.67 feet.

RECOMMENDED SURFACE AREA REQUIREMENTS = 0.01 ACRE PER CFS

Q_{100} = 239.55 cfs

Minimum Surface Area = 0.01 acres x Q_{100}

= 2.4 acres

= 104,348 s.f.

Actual Surface Area At Top of Riser (El. 57.21) = Sediment Basin 2 Area

= 127,058 s.f.

Actual Surface is greater than minimum surface area.

Pond Report

Hydraflow Hydrographs by Intelisolve — Wednesday, Feb 20 2008, 2:33 PM

Pond No. 1 - Existing Sed. Basin No. 2

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	51.00	104,154	0	0
1.00	52.00	107,959	106,057	106,057
3.00	54.00	115,388	223,347	329,404
5.00	56.00	122,560	237,948	567,352
7.00	58.00	129,994	252,554	819,906
8.00	59.00	134,112	132,053	951,959
9.00	60.00	138,276	136,194	1,088,153
11.00	62.00	146,748	285,024	1,373,177

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 30.00	1.00	4.00	0.00
Span (in)	= 30.00	1.00	4.00	0.00
No. Barrels	= 1	115	4	0
Invert El. (ft)	= 50.66	51.71	54.21	0.00
Length (ft)	= 69.00	0.00	0.00	0.00
Slope (%)	= 2.97	0.00	0.00	0.00
N-Value	= .013	.013	.013	.000
Orif. Coeff.	= 0.60	0.60	0.60	0.00
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 14.92	0.00	0.00	0.00
Crest El. (ft)	= 57.21	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Riser	---	---	---
Multi-Stage	= Yes	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control. Weir riser checked for orifice conditions.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	51.00	0.00	0.00	0.00	---	0.00	---	---	---	---	0.00
1.00	106,057	52.00	1.55	1.50	0.00	---	0.00	---	---	---	---	1.50
3.00	329,404	54.00	4.53	4.53	0.00	---	0.00	---	---	---	---	4.53
5.00	567,352	56.00	8.31	6.17	2.14	---	0.00	---	---	---	---	8.31
7.00	819,906	58.00	42.77	5.07	2.82	---	34.89	---	---	---	---	42.77
8.00	951,959	59.00	62.00	1.37	0.76	---	59.86	---	---	---	---	62.00
9.00	1,088,153	60.00	66.46	1.28	0.71	---	64.46	---	---	---	---	66.46
11.00	1,373,177	62.00	74.30	1.37	0.76	---	72.16	---	---	---	---	74.29

Pond Report

Hydraflow Hydrographs by Intelisolve — Monday, Mar 17 2008, 1:20 PM

Pond No. 5 - Ex. Sed. Basin No. 2-ES

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	57.21	127,058	0	0
0.79	58.00	129,994	101,536	101,536
1.79	59.00	134,112	132,053	233,589
2.79	60.00	138,276	136,194	369,783
4.79	62.00	146,748	285,024	654,807

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 30.00	0.00	0.00	0.00
Span (in)	= 30.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 50.66	0.00	0.00	0.00
Length (ft)	= 69.00	0.00	0.00	0.00
Slope (%)	= 2.97	0.00	0.00	0.00
N-Value	= .013	.000	.000	.000
Orif. Coeff.	= 0.60	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 14.92	0.00	0.00	0.00
Crest El. (ft)	= 57.21	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Riser	---	---	---
Multi-Stage	= Yes	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control. Weir riser checked for orifice conditions.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	57.21	0.00	---	---	---	0.00	---	---	---	---	0.00
0.79	101,536	58.00	54.41	---	---	---	34.89	---	---	---	---	34.89
1.79	233,589	59.00	61.92	---	---	---	61.91	---	---	---	---	61.91
2.79	369,783	60.00	66.40	---	---	---	66.40	---	---	---	---	66.40
4.79	654,807	62.00	74.24	---	---	---	74.23	---	---	---	---	74.23

c. Sediment Basin Dewatering of First 1" of Runoff

- Volume of 1" Runoff = 1" x 39.3 Acres = 142,659 c.f.
- Volume of Sediment = 70,740 cf
- Total volume = 213,399 cf
- In Basin No. 2, this volume equates to Elevation 52.96
- At Elev. 52.96, surface area = 111,525 s.f.
- Use 115 - 1" diameter holes at an elevation 51.17

$$\text{Dewatering Time} = T = \frac{As \times (2h)^{1/2}}{Ao \times Cd \times 20{,}428}$$

Ao = Surface Area of Dewatering Holes, ft^2 = 115 - 1" diameter holes = 0.6272 s.f.
As = Surface Area = 111,525 s.f.
h = Head of Water Above Holes, ft = 52.96 – 51.17 = 1.79 ft.
Cd = Coefficient of Contraction for an Orifice (use 0.6)
T = Detention Time or Time to Dewater Sediment Basin
(must be 24 - 120 hours)

$$T = \frac{As \times (2h)^{1/2}}{Ao \times Cd \times 20{,}428} = \frac{111{,}525\ (2 \times 1.79)^{1/2}}{0.6272\ (.6)(20{,}428)} = 27 \text{ hours}$$

d. Total Basin Dewatering at Top of Overflow Structure (Elev. 57.21)

T = 24 hours < T < 72 hours

Ao = 0.6272 = 115 - 1" dia. holes
= 0.3491 = 4 – 4" dia. holes = TOTAL = 0.9763

As = 127,058 s.f. @ elev. 57.21

h = 57.21 – 52.96 = 4.25'

$$T = \frac{127{,}058\ (2 \times 4.25)^{1/2}}{(0.9763)(0.6)(20428)} = 31 \text{ hours}$$

(Okay, 24 hours < T < 72 hours)

e. **Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow computer program. Peak inflow rates are calculated for the 2 year, 5 year, 10 year, 25-year, 50 year, and 100 year storm events and are summarized below.

Q_2 = 58.81 cfs
Q_5 = 102.63 cfs
Q_{10} = 134.83 cfs
Q_{25} = 167.89 cfs
Q_{50} = 203.42 cfs
Q_{100} = 239.55 cfs

The bottom of the sediment basin has been set at 51.00. Dewatering of the sediment basin is accomplished by 115 – 1" diameter holes beginning at an invert elevation of 57.17 and 4 - 4" diameter holes beginning at an invert elevation of 54.21.

For routing calculations, the existing 54" diameter riser with the dewatering holes described above is used. The top of the riser is at an elevation of 57.21. The bottom of the sediment basin is elevation 51.00. The invert of the carrier pipe 50.66. The top of the levee around the sediment basin is at an elevation of 62.00.

Based on the above information the reservoir routing calculations are performed and summarized below.

STORM YEAR	PEAK INFLOW CFS	PEAK OUTFLOW CFS	PEAK ELEV. FEET
2	58.81	1.77	52.10
5	102.63	3.14	52.84
10	134.83	3.92	53.44
25	167.89	4.61	54.09
50	203.42	6.12	54.70
100	239.55	7.34	55.32

Based on these routing calculations, the riser is large enough and the sediment basin has sufficient storage volume to retain the sediment from 39.3 disturbed acres plus the 100-year storm event from the entire drainage area below the crest of the riser (elev. 57.21).

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	8.444	1	721	22,431	----	------	------	DD No. 11
32	SCS Runoff	1.107	1	716	1,925	----	------	------	SCC No. 12 Area
33	Combine	10.88	1	720	28,703	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	2.644	1	720	6,011	----	------	------	SCC No. 11 Area
35	Manual	6.136	1	719	13,354	----	------	------	DD No. 7
36	Combine	19.61	1	719	48,067	33, 34, 35	------	------	SCC No. 11
37	Combine	58.81	1	720	176,834	29, 36	------	------	Pipe No. 200
38	Reservoir	1.770	1	1046	102,412	37	52.10	117,530	Ex. Sed. Basin No. 2
39	Reservoir	15.20	1	744	176,825	37	57.66	58,277	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	14.69	1	720	38,434	----	------	------	DD No. 11
32	SCS Runoff	1.876	1	716	3,299	----	------	------	SCC No. 12 Area
33	Combine	18.95	1	719	49,180	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	4.552	1	719	10,299	----	------	------	SCC No. 11 Area
35	Manual	10.56	1	718	22,881	----	------	------	DD No. 7
36	Combine	34.03	1	719	82,360	33, 34, 35	------	------	SCC No. 11
37	Combine	102.63	1	720	302,996	29, 36	------	------	Pipe No. 200
38	Reservoir	3.141	1	975	227,527	37	52.84	199,327	Ex. Sed. Basin No. 2
39	Reservoir	33.26	1	736	302,987	37	57.97	98,297	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	19.31	1	720	50,410	----	------	------	DD No. 11
32	SCS Runoff	2.435	1	716	4,327	----	------	------	SCC No. 12 Area
33	Combine	24.90	1	719	64,505	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	5.963	1	719	13,508	----	------	------	SCC No. 11 Area
35	Manual	13.83	1	718	30,011	----	------	------	DD No. 7
36	Combine	44.60	1	719	108,024	33, 34, 35	------	------	SCC No. 11
37	Combine	134.83	1	720	397,410	29, 36	------	------	Pipe No. 200
38	Reservoir	3.923	1	975	319,158	37	53.44	266,889	Ex. Sed. Basin No. 2
39	Reservoir	48.39	1	734	397,401	37	58.19	126,944	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	24.06	1	720	62,884	----	------	------	DD No. 11
32	SCS Runoff	3.011	1	715	5,397	----	------	------	SCC No. 12 Area
33	Combine	31.01	1	719	80,466	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	7.410	1	719	16,850	----	------	------	SCC No. 11 Area
35	Manual	17.17	1	718	37,437	----	------	------	DD No. 7
36	Combine	55.43	1	719	134,753	33, 34, 35	------	------	SCC No. 11
37	Combine	167.89	1	720	495,743	29, 36	------	------	Pipe No. 200
38	Reservoir	4.614	1	983	409,705	37	54.09	339,799	Ex. Sed. Basin No. 2
39	Reservoir	57.33	1	734	495,735	37	58.43	158,749	Ex Sed. Basin No. 2-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	29.16	1	720	76,449	----	------	------	DD No. 11
32	SCS Runoff	3.630	1	715	6,562	----	------	------	SCC No. 12 Area
33	Combine	37.57	1	719	97,824	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	8.960	1	719	20,485	----	------	------	SCC No. 11 Area
35	Manual	20.76	1	718	45,512	----	------	------	DD No. 7
36	Combine	67.05	1	719	163,821	33, 34, 35	------	------	SCC No. 11
37	Combine	203.42	1	719	602,685	29, 36	------	------	Pipe No. 200
38	Reservoir	6.122	1	949	504,184	37	54.70	412,403	Ex. Sed. Basin No. 2
39	Reservoir	60.22	1	737	602,675	37	58.74	199,710	Ex Sed. Basin No. 2-ES

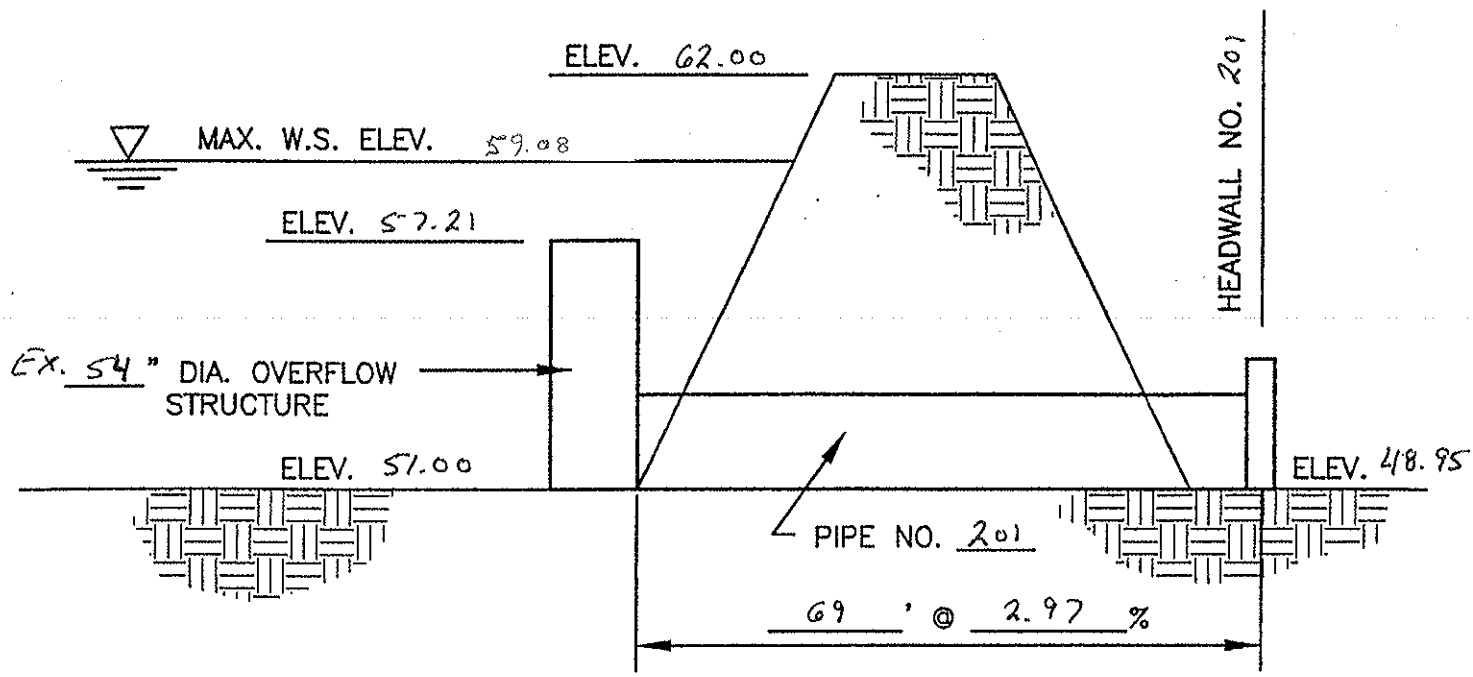
Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
31	Manual	34.31	1	720	90,324	----	------	------	DD No. 11
32	SCS Runoff	4.253	1	715	7,753	----	------	------	SCC No. 12 Area
33	Combine	44.19	1	719	115,579	30, 31, 32	------	------	SCC No. 12
34	SCS Runoff	10.52	1	719	24,203	----	------	------	SCC No. 11 Area
35	Manual	24.37	1	718	53,773	----	------	------	DD No. 7
36	Combine	78.76	1	719	193,554	33, 34, 35	------	------	SCC No. 11
37	Combine	239.55	1	719	712,070	29, 36	------	------	Pipe No. 200
38	Reservoir	7.341	1	940	599,283	37	55.32	487,002	Ex. Sed. Basin No. 2
39	Reservoir	62.40	1	741	712,061	37	59.08	245,072	Ex Sed. Basin No. 2-ES

f. Riser Pipe and Carrier Pipe Design

(Existing Riser Structure and Carrier Pipe are Adequate)

OVERFLOW STRUCTURE NO. 2



DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 63 CFS

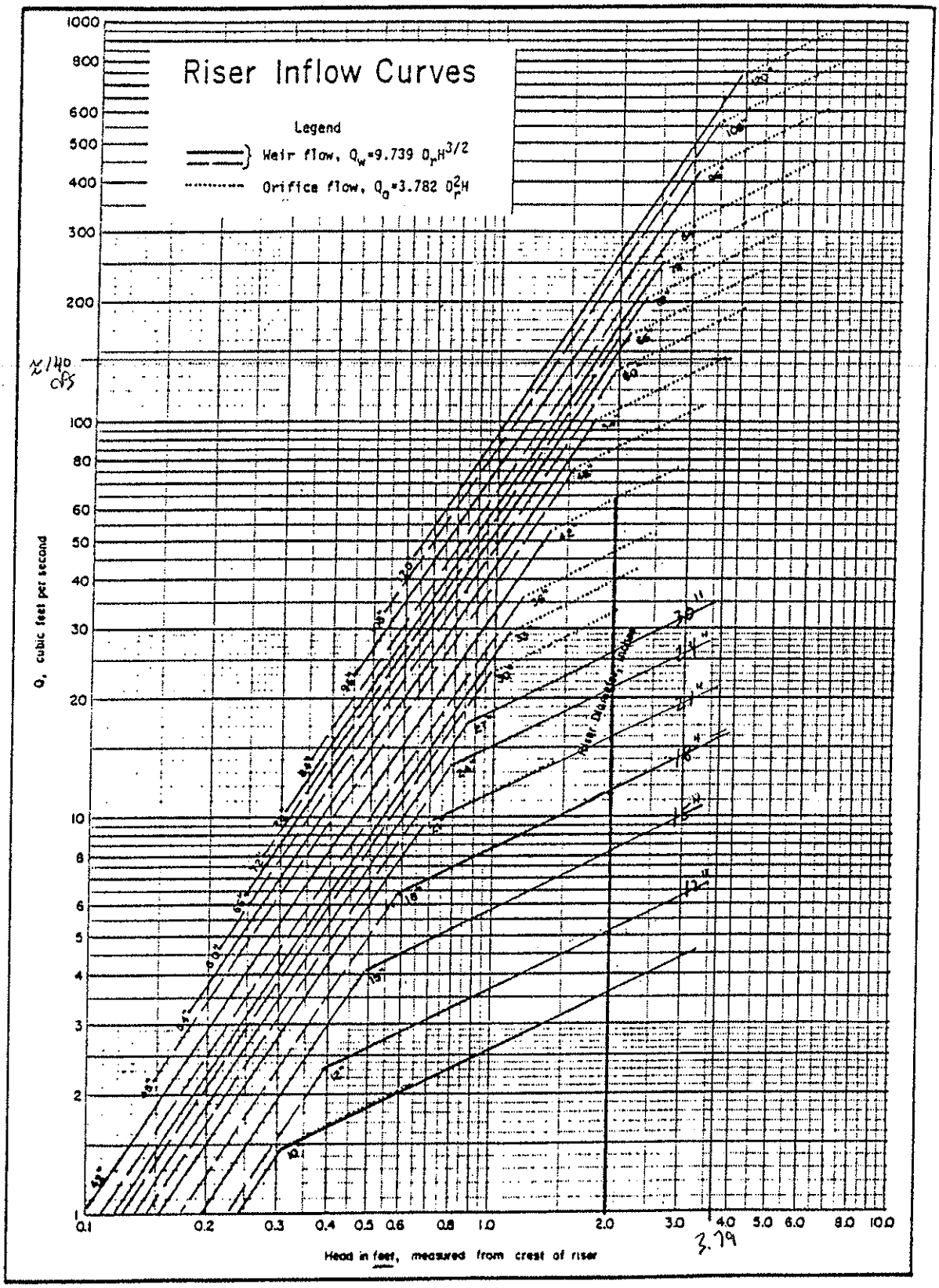
HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION FOR WORST CASE FLOW MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 61.00 − 57.21 = 3.79 FEET

BASED ON ABOVE HEAD, USE Ex. 54 " DIA. OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

Entrance to Downdrain & standpipes



Source: USDA-SCS

Plate 1.26h

FIGURE A-10

CARRIER PIPE NO. 201

Q = 63 CFS worst case

Maximum headwater = Top of levee elevation minus 1' freeboard
= 62.00 − 1.00' = 61.00'

Head (H) = maximum water elevation allowed minus the centerline elevation at the downstream end of the carrier pipe
= 61.00 − 50.20 = 10.80'

Length (L) = 69'

Length Factor = 1.00 for lengths other than 70'

Q (available) = Q from table times length factor
= 85 X 1.0 = 85 CFS

Q (available) must be greater than Q worst case

USE Ex. 30 " DIAMETER RCP CARRIER PIPE

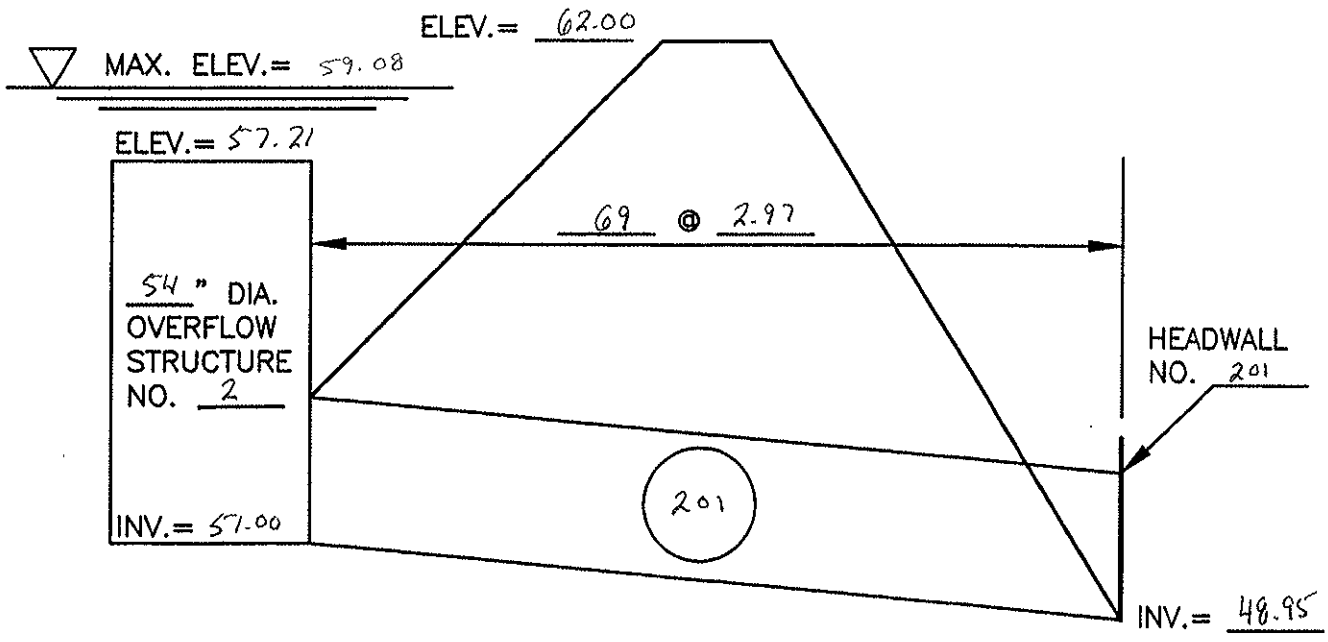


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_m = K_e + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

H, in feet	diameter of pipe in inches																	
	12"	15"	18"	21"	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"	102"
1	3.22	5.44	8.29	11.8	15.9	26.0	38.6	53.8	71.4	91.5	114	139	167	197	229	264	302	342
2	4.55	7.69	11.7	16.7	22.5	36.8	54.6	76.0	101	129	161	197	236	278	324	374	427	483
3	5.57	9.42	14.4	20.4	27.5	45.0	66.9	93.1	124	159	198	241	289	341	397	458	523	592
4	6.43	10.9	16.6	23.5	31.8	52.0	77.3	108	143	183	228	278	334	394	459	529	604	683
5	7.19	12.2	18.5	26.3	35.5	58.1	86.4	120	160	205	255	311	373	440	513	591	675	764
6	7.88	13.3	20.3	28.8	38.9	67.7	94.6	132	175	224	280	341	409	482	562	647	739	837
7	8.51	14.4	21.9	31.1	42.0	68.8	102	142	189	242	302	368	441	521	607	699	798	904
8	9.10	15.4	23.5	33.3	44.9	73.5	109	152	202	259	323	394	472	557	685	748	854	966
9	9.65	16.3	24.9	35.3	47.7	78.0	116	161	214	275	342	418	500	590	688	793	905	1025
10	10.2	17.2	26.2	37.2	50.2	82.2	122	170	226	289	361	440	527	622	725	836	954	1080
11	10.7	18.0	27.5	39.0	52.7	86.2	128	178	237	304	379	462	553	653	761	877	1001	1133
12	11.1	18.9	28.7	40.8	55.0	90.1	134	186	247	317	395	482	578	682	794	916	1045	1184
13	11.6	19.6	29.9	42.4	57.3	93.7	139	194	257	330	411	502	601	710	827	953	1088	1232
14	12.0	20.4	31.0	44.1	59.4	97.3	145	201	267	342	427	521	624	736	858	989	1129	1278
15	12.5	21.1	32.1	45.6	61.5	101	150	208	277	354	442	539	646	762	888	1024	1169	1323
16	12.9	21.8	33.2	47.1	63.5	104	155	215	286	366	457	557	667	787	917	1057	1207	1367
17	13.3	22.4	34.2	48.5	65.5	107	159	222	294	377	471	574	688	812	946	1090	1244	1409
18	13.7	23.1	35.2	49.9	67.4	110	164	228	303	388	484	591	708	835	973	1121	1280	1450
19	14.0	23.8	36.1	51.3	69.2	113	168	234	311	399	497	607	727	858	1000	1152	1315	1489
20	14.4	24.3	37.1	52.6	71.0	116	173	240	319	409	510	623	746	880	1026	1182	1350	1528
21	14.7	24.9	38.0	53.9	72.8	119	177	246	327	419	523	638	764	902	1051	1211	1383	1566
22	15.1	25.5	38.9	55.2	74.5	122	181	252	335	429	535	653	782	923	1076	1240	1415	1603
23	15.4	26.1	39.8	56.5	76.2	125	186	258	342	439	547	668	800	944	1100	1268	1447	1639
24	15.8	26.7	40.6	57.7	77.8	127	189	263	350	448	559	682	817	964	1123	1295	1478	1674
25	16.1	27.2	41.5	58.9	79.4	130	193	269	357	458	571	696	834	984	1147	1322	1509	1708
26	16.4	27.7	42.3	60.0	81.0	133	197	274	364	467	582	710	850	1004	1169	1348	1539	1742
27	16.7	28.3	43.1	61.2	82.5	135	201	279	371	476	593	723	867	1023	1192	1373	1568	1775
28	17.0	28.8	43.9	62.3	84.1	138	204	285	378	484	604	737	883	1041	1214	1399	1597	1808
29	17.3	29.3	44.7	63.4	85.5	140	208	290	384	493	615	750	898	1060	1235	1423	1625	1840
30	17.6	29.8	45.4	64.5	87.0	142	212	294	391	501	625	763	913	1078	1256	1448	1653	1871
L, in feet	Correction Factors For Other Pipe Lengths																	
20	1.30	1.24	1.21	1.18	1.15	1.12	1.10	1.08	1.07	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03
30	1.22	1.18	1.15	1.13	1.12	1.09	1.08	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02
40	1.15	1.13	1.11	1.10	1.08	1.07	1.05	1.05	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02
50	1.09	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01
60	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	.96	.97	.97	.97	.98	.98	.98	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99
90	.93	.94	.94	.95	.95	.96	.97	.97	.98	.98	.98	.98	.98	.99	.99	.99	.99	.99
100	.90	.91	.92	.93	.93	.95	.95	.96	.97	.97	.97	.98	.98	.98	.98	.98	.98	.99
120	.84	.86	.87	.89	.90	.91	.93	.94	.94	.95	.96	.96	.96	.97	.97	.97	.97	.98
140	.80	.82	.83	.85	.86	.88	.90	.91	.92	.93	.94	.94	.95	.95	.96	.96	.96	.97
160	.76	.78	.80	.82	.83	.86	.88	.89	.90	.91	.92	.93	.94	.94	.95	.95	.95	.96

Source: USDA - SCS

g. Anti-Seep Collar Design

(Existing Anti-Seep Collars are Adequate)

h. Riser Base Foundation Design

(Existing Riser Base Foundation Design is Adequate)

3. EXISTING SEDIMENT BASIN NO. 3

a. Existing Sediment Basin Design Criteria

The existing sediment basin 3 at East Carolina Regional Landfill was originally designed utilizing the following design criteria.

A. Minimum Length to Width Ratio = 2:1
B. Surface Area @ 10 year storm = 0.01 acres min. per cfs of flow.
C. 1800 cubic feet of volume per acre of disturbed land measured at 3' depth elevation.
D. Retain the 25 year storm plus the sediment from item C above below the crest of the riser.

For the Sediment Basin, the actual design criteria is compared to the NCDENR recommended criteria for sediment basins.

Existing Sediment Basin No. 3

Criteria	NC DENR	Actual
Length	2:1	5.2:1
Surface Area	.010 Acre/cfs	0.011 Acre/cfs
Volume at 3' Depth Elevation	1,800 C.F./Acre	3,900 C.F./Acre
Storm Retention	25 year	25 year

Existing Sediment Basin No. 3 was originally designed, approved and constructed as part of an earlier phase of landfill development at the East Carolina Environmental Landfill. The basin was appropriately sized for final build out of the landfill. Subsequent phases of the landfill have utilized the existing basin design.

The Phase 5 drainage plan will also utilize the existing design of Sediment Basin No. 3. With the addition of Wet Detention Basin No. 4, the overall drainage area to Sediment Basin No. 3 is approximately 59.5 acres. As illustrated in the chart above, the existing design of the Sediment Basin No. 3 meets or exceeds the minimum NCDENR requirements for sediment basins. The existing basin design is sufficient to maintain all design storms up to and including the 25 year storm below the crest of the riser. This design parameter allows maximum sediment removal efficiency from a dry pond design.

b. Sediment Volumes and Surface Area Calculations

SEDIMENT VOLUME REQUIREMENTS = 1,800 cu.ft. / acre

= 1,800 x 59.5 acres

= 107,100 cf

From the Hydraflow Hydrographs 2004 Computer Program, this volume of sediment will occupy a depth of approximately 1.46 feet (interpolated from printout on next page). This sediment volume corresponds to elevation = 55.46 feet.

RECOMMENDED SURFACE AREA REQUIREMENTS = 0.01 ACRE PER CFS

Q_{10} = 204.46 cfs

Minimum Surface Area = 0.01 acres x Q_{10}

= 2.04 acres

= 89,063 s.f.

Actual Surface Area At Top of Riser (El. 60.50) = Sediment Basin 3 Area

= 105,977 s.f.

Actual Surface is greater than minimum surface area.

Pond Report

Hydraflow Hydrographs by Intelisolve — Thursday, Mar 27 2008, 3:57 PM

Pond No. 1 - Existing Sed. Basin No. 3

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	54.00	68,029	0	0
2.00	56.00	79,085	147,114	147,114
4.00	58.00	90,752	169,837	316,951
6.00	60.00	103,382	194,134	511,085
8.00	62.00	113,760	217,142	728,227
10.00	64.00	125,310	239,070	967,297

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 60.00	1.00	0.00	0.00
Span (in)	= 60.00	1.00	0.00	0.00
No. Barrels	= 1	115	0	0
Invert El. (ft)	= 53.96	55.51	0.00	0.00
Length (ft)	= 70.54	0.00	0.00	0.00
Slope (%)	= 0.51	0.00	0.00	0.00
N-Value	= .013	.013	.013	.013
Orif. Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 22.00	0.00	0.00	0.00
Crest El. (ft)	= 60.50	0.00	0.00	0.00
Weir Coeff.	= 3.00	3.33	0.00	3.33
Weir Type	= Riser	---	---	---
Multi-Stage	= Yes	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control. Weir riser checked for orifice conditions.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	54.00	0.00	0.00	---	---	0.00	---	---	---	---	0.00
2.00	147,114	56.00	2.02	2.02	---	---	0.00	---	---	---	---	2.02
4.00	316,951	58.00	4.73	4.72	---	---	0.00	---	---	---	---	4.72
6.00	511,085	60.00	6.37	6.37	---	---	0.00	---	---	---	---	6.37
8.00	728,227	62.00	125.81	4.56	---	---	121.25	---	---	---	---	125.81
10.00	967,297	64.00	246.47	2.60	---	---	243.86	---	---	---	---	246.46

Pond Report

Pond No. 2 - Ex. Sed. Basin No. 3-ES

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	60.50	105,977	0	0
1.50	62.00	113,760	164,802	164,802
3.50	64.00	125,310	239,070	403,872

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 60.00	0.00	0.00	0.00
Span (in)	= 60.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 53.96	0.00	0.00	0.00
Length (ft)	= 70.54	0.00	0.00	0.00
Slope (%)	= 0.51	0.00	0.00	0.00
N-Value	= .013	.013	.013	.013
Orif. Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 22.00	0.00	0.00	0.00
Crest El. (ft)	= 60.50	0.00	0.00	0.00
Weir Coeff.	= 3.00	3.33	0.00	3.33
Weir Type	= Riser	---	---	---
Multi-Stage	= Yes	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control. Weir riser checked for orifice conditions.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	60.50	0.00	---	---	---	0.00	---	---	---	---	0.00
1.50	164,802	62.00	163.83	---	---	---	121.25	---	---	---	---	121.25
3.50	403,872	64.00	246.12	---	---	---	246.12	---	---	---	---	246.12

c. Sediment Basin Dewatering of First 1" of Runoff

- Volume of 1" Runoff = 1" x 55.46 Acres = 201,320 c.f.
- Volume of Sediment = 107,100 cf
- Total volume = 308,420 cf
- In Basin No. 3, this volume equates to Elevation 57.90
- At Elev. 57.90, surface area = 90,169 s.f.
- Use 115 - 1" diameter holes at an average elevation 55.51

$$\text{Dewatering Time} = T = \frac{As \times (2h)^{1/2}}{Ao \times Cd \times 20{,}428}$$

Ao = Surface Area of Dewatering Holes, ft^2 = 115 - 1" diameter holes = 0.6272 s.f.
As = Surface Area = 90,169 s.f.
h = Head of Water Above Holes, ft = 57.90 – 55.51 = 2.39 ft.
Cd = Coefficient of Contraction for an Orifice (use 0.6)
T = Detention Time or Time to Dewater Sediment Basin
(must be 24 - 120 hours)

$$T = \frac{As \times (2h)^{1/2}}{Ao \times Cd \times 20{,}428} = \frac{90{,}169\ (2 \times 2.39)^{1/2}}{0.6272\ (.6)(20{,}428)} = 25.6 \text{ hours}$$

d. **Total Basin Dewatering at Top of Overflow Structure (Elev. 60.50)**

T = 24 hours < T < 72 hours

Ao = 0.6272 = 115 - 1.00" dia. holes

As = 105,977 s.f. @ elev. 60.50

h = 60.50 – 55.51 = 4.99'

$$T = \frac{105{,}977\ (2 \times 4.99)^{1/2}}{(0.6272)(0.6)(20428)} = 43.6 \text{ hours}$$

(Okay, 24 hours < T < 72 hours)

e. **Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow computer program. Peak inflow rates are calculated for the 2 year, 5 year, 10 year, 25-year, 50 year, and 100 year storm events and are summarized below.

Q_2 = 88.30 cfs
Q_5 = 155.19 cfs
Q_{10} = 204.46 cfs
Q_{25} = 255.14 cfs
Q_{50} = 309.58 cfs
Q_{100} = 364.62 cfs

The bottom of the sediment basin has been set at 54.00. Dewatering of the sediment basin is accomplished by 115 – 1"diameter holes with an average elevation of 55.51

For routing calculations, a 5.5' x 5.5' box overflow structure with 115 – 1" dewatering holes at an average invert elevation of 55.51 is used. The top of the riser is at an elevation of 60.50. The bottom of the sediment basin is elevation of 54.00. The invert of the carrier pipe is 53.96. The top of the levee around the sediment basin is at an elevation of 64.00.

Based on the above information the reservoir routing calculations are performed and summarized below.

STORM YEAR	PEAK INFLOW CFS	PEAK OUTFLOW CFS	PEAK ELEV. FEET
2	88.30	2.80	56.41
5	155.19	4.71	57.99
10	204.46	5.71	59.12
25	255.14	6.59	60.31
50	309.58	18.58	60.81
100	364.62	44.17	61.19

Based on these routing calculations, the riser is large enough and the sediment basin has sufficient storage volume to retain the sediment from 59.5 disturbed acres plus the 25-year storm event from the entire drainage area below the crest of the riser (elev. 60.50).

Hydrograph Summary Report

d.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	3.096	1	719	6,544	----	------	------	SCC No. 14
2	Manual	15.17	1	723	45,741	----	------	------	DD No. 20
3	Combine	17.46	1	722	52,285	1, 2	------	------	Pipe No. 300
4	SCS Runoff	1.390	1	717	2,605	----	------	------	SCC No. 15
5	SCS Runoff	2.530	1	718	5,088	----	------	------	SCC No. 21
6	SCS Runoff	1.600	1	718	3,218	----	------	------	SCC No. 20 Area
7	Combine	4.130	1	718	8,306	5, 6	------	------	SCC No. 20
8	SCS Runoff	2.448	1	726	7,864	----	------	------	SCC No. 19 Area
9	Combine	5.797	1	718	16,170	7, 8	------	------	SCC No. 19
10	Manual	18.13	1	725	60,147	----	------	------	DD No. 41
11	Manual	15.94	1	723	45,796	----	------	------	DD No. 36
12	SCS Runoff	2.651	1	731	10,541	----	------	------	SSC No. 18 Area
13	Combine	40.03	1	724	132,654	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	7.715	1	722	23,681	----	------	------	DD No. 33
15	SCS Runoff	3.049	1	725	9,260	----	------	------	SCC No. 17 Area
16	Combine	50.56	1	723	165,594	13, 14, 15	------	------	SCC No. 17
17	Manual	16.96	1	722	47,351	----	------	------	DD No. 28
18	SCS Runoff	3.373	1	724	9,838	----	------	------	SCC No. 16 Area
19	Combine	70.56	1	723	222,785	16, 17, 18	------	------	SCC No. 16
20	Combine	70.97	1	723	225,389	4, 19	------	------	Pipe No. 301
21	Combine	88.30	1	722	277,674	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	2.803	1	1042	173,449	21	56.41	182,292	Ex. Sed. Basin No. 3
23	Reservoir	40.23	1	736	277,669	21	61.22	78,837	Ex Sed. Basin No. 3-ES

Sed pond 3.gpw | Return Period: 2 Year | Thursday, Mar 27 2008, 3:58 PM

Hydrograph Summary Report

···d.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	5.304	1	719	11,213	----	------	------	SCC No. 14
2	Manual	26.54	1	723	78,375	----	------	------	DD No. 20
3	Combine	30.56	1	721	89,587	1, 2	------	------	Pipe No. 300
4	SCS Runoff	2.368	1	717	4,463	----	------	------	SCC No. 15
5	SCS Runoff	4.328	1	718	8,718	----	------	------	SCC No. 21
6	SCS Runoff	2.738	1	718	5,514	----	------	------	SCC No. 20 Area
7	Combine	7.066	1	718	14,232	5, 6	------	------	SCC No. 20
8	SCS Runoff	4.294	1	725	13,474	----	------	------	SCC No. 19 Area
9	Combine	10.15	1	718	27,706	7, 8	------	------	SCC No. 19
10	Manual	31.87	1	725	103,059	----	------	------	DD No. 41
11	Manual	27.85	1	723	78,470	----	------	------	DD No. 36
12	SCS Runoff	4.673	1	730	18,061	----	------	------	SSC No. 18 Area
13	Combine	70.39	1	723	227,295	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	13.54	1	721	40,576	----	------	------	DD No. 33
15	SCS Runoff	5.340	1	724	15,866	----	------	------	SCC No. 17 Area
··	Combine	88.93	1	723	283,737	13, 14, 15	------	------	SCC No. 17
17	Manual	29.65	1	721	81,134	----	------	------	DD No. 28
18	SCS Runoff	5.895	1	723	16,858	----	------	------	SCC No. 16 Area
19	Combine	123.72	1	722	381,729	16, 17, 18	------	------	SCC No. 16
20	Combine	124.65	1	722	386,192	4, 19	------	------	Pipe No. 301
21	Combine	155.19	1	722	475,779	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	4.714	1	995	367,102	21	57.99	315,999	Ex. Sed. Basin No. 3
23	Reservoir	84.11	1	734	475,775	21	61.67	129,069	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	6.936	1	718	14,707	----	------	------	SCC No. 14
2	Manual	34.91	1	723	102,796	----	------	------	DD No. 20
3	Combine	40.27	1	721	117,503	1, 2	------	------	Pipe No. 300
4	SCS Runoff	3.079	1	717	5,853	----	------	------	SCC No. 15
5	SCS Runoff	5.639	1	718	11,434	----	------	------	SCC No. 21
6	SCS Runoff	3.567	1	718	7,232	----	------	------	SCC No. 20 Area
7	Combine	9.205	1	718	18,666	5, 6	------	------	SCC No. 20
8	SCS Runoff	5.657	1	725	17,673	----	------	------	SCC No. 19 Area
9	Combine	13.36	1	718	36,339	7, 8	------	------	SCC No. 19
10	Manual	41.98	1	725	135,172	----	------	------	DD No. 41
11	Manual	36.60	1	723	102,921	----	------	------	DD No. 36
12	SCS Runoff	6.173	1	730	23,688	----	------	------	SSC No. 18 Area
13	Combine	92.83	1	723	298,120	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	17.85	1	721	53,220	----	------	------	DD No. 33
15	SCS Runoff	7.027	1	724	20,810	----	------	------	SCC No. 17 Area
16	Combine	117.20	1	723	372,150	13, 14, 15	------	------	SCC No. 17
17	Manual	38.99	1	721	106,415	----	------	------	DD No. 28
18	SCS Runoff	7.756	1	723	22,111	----	------	------	SCC No. 16 Area
19	Combine	163.12	1	722	500,676	16, 17, 18	------	------	SCC No. 16
20	Combine	164.31	1	722	506,529	4, 19	------	------	Pipe No. 301
21	Combine	204.46	1	722	624,034	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	5.706	1	1012	506,096	21	59.12	425,912	Ex. Sed. Basin No. 3
23	Reservoir	119.16	1	732	624,029	21	61.98	162,859	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

·d. ·	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	8.610	1	718	18,346	----	------	------	SCC No. 14
2	Manual	43.52	1	722	128,232	----	------	------	DD No. 20
3	Combine	50.25	1	721	146,578	1, 2	------	------	Pipe No. 300
4	SCS Runoff	3.805	1	717	7,302	----	------	------	SCC No. 15
5	SCS Runoff	6.978	1	718	14,263	----	------	------	SCC No. 21
6	SCS Runoff	4.414	1	718	9,021	----	------	------	SCC No. 20 Area
7	Combine	11.39	1	718	23,285	5, 6	------	------	SCC No. 20
8	SCS Runoff	7.058	1	725	22,046	----	------	------	SCC No. 19 Area
9	Combine	16.66	1	718	45,330	7, 8	------	------	SCC No. 19
10	Manual	52.39	1	725	168,618	----	------	------	DD No. 41
11	Manual	45.59	1	723	128,387	----	------	------	DD No. 36
12	SCS Runoff	7.718	1	730	29,550	----	------	------	SSC No. 18 Area
13	Combine	115.91	1	723	371,885	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	22.28	1	721	66,388	----	------	------	DD No. 33
15	SCS Runoff	8.762	1	724	25,960	----	------	------	SCC No. 17 Area
··	Combine	146.28	1	723	464,233	13, 14, 15	------	------	SCC No. 17
17	Manual	48.58	1	721	132,746	----	------	------	DD No. 28
18	SCS Runoff	9.667	1	723	27,582	----	------	------	SCC No. 16 Area
19	Combine	203.66	1	722	624,561	16, 17, 18	------	------	SCC No. 16
20	Combine	205.11	1	722	631,862	4, 19	------	------	Pipe No. 301
21	Combine	255.14	1	722	778,441	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	6.585	1	1032	636,329	21	60.31	544,418	Ex. Sed. Basin No. 3
23	Reservoir	154.31	1	732	778,436	21	62.26	196,453	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

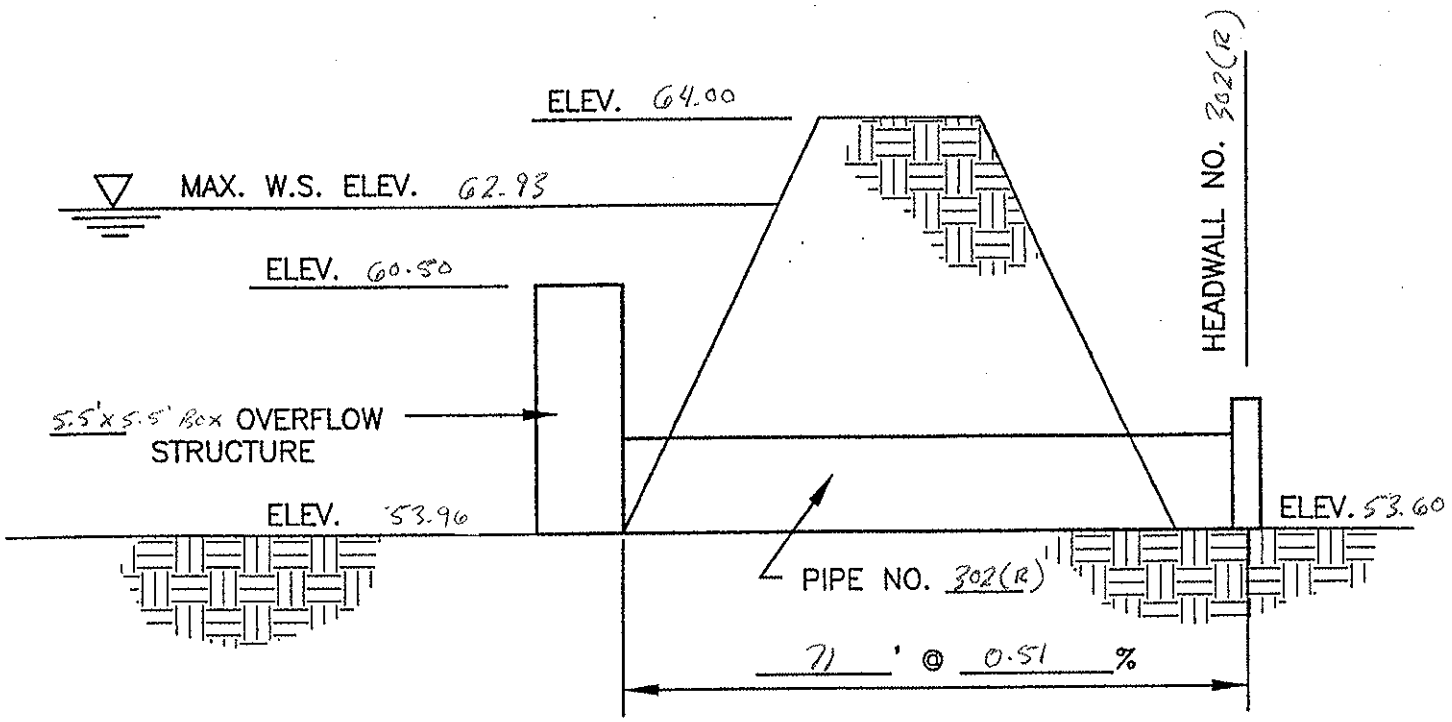
·d. ·	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	10.40	1	718	22,303	----	------	------	SCC No. 14
2	Manual	52.83	1	722	155,894	----	------	------	DD No. 20
3	Combine	60.98	1	721	178,197	1, 2	------	------	Pipe No. 300
4	SCS Runoff	4.586	1	716	8,877	----	------	------	SCC No. 15
5	SCS Runoff	8.415	1	717	17,340	----	------	------	SCC No. 21
6	SCS Runoff	5.323	1	717	10,967	----	------	------	SCC No. 20 Area
7	Combine	13.74	1	717	28,308	5, 6	------	------	SCC No. 20
8	SCS Runoff	8.564	1	725	26,801	----	------	------	SCC No. 19 Area
9	Combine	20.19	1	718	55,109	7, 8	------	------	SCC No. 19
10	Manual	63.56	1	725	204,992	----	------	------	DD No. 41
11	Manual	55.23	1	723	156,083	----	------	------	DD No. 36
12	SCS Runoff	9.379	1	730	35,924	----	------	------	SSC No. 18 Area
13	Combine	140.73	1	723	452,108	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	27.04	1	721	80,710	----	------	------	DD No. 33
15	SCS Runoff	10.62	1	724	31,560	----	------	------	SCC No. 17 Area
16	Combine	177.52	1	723	564,377	13, 14, 15	------	------	SCC No. 17
17	Manual	58.88	1	721	161,382	----	------	------	DD No. 28
18	SCS Runoff	11.72	1	723	33,531	----	------	------	SCC No. 16 Area
19	Combine	247.22	1	722	759,291	16, 17, 18	------	------	SCC No. 16
20	Combine	248.96	1	722	768,168	4, 19	------	------	Pipe No. 301
21	Combine	309.58	1	722	946,364	3, 20	------	------	Ex. Sed Basin No. 3 inflow
22	Reservoir	18.58	1	814	794,041	21	60.81	599,398	Ex. Sed. Basin No. 3
23	Reservoir	186.05	1	732	946,360	21	62.57	233,533	Ex Sed. Basin No. 3-ES

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	12.21	1	718	26,351	----	------	------	SCC No. 14
2	Manual	62.23	1	722	184,188	----	------	------	DD No. 20
3	Combine	71.82	1	721	210,539	1, 2	------	------	Pipe No. 300
4	SCS Runoff	5.378	1	716	10,488	----	------	------	SCC No. 15
5	SCS Runoff	9.876	1	717	20,487	----	------	------	SCC No. 21
6	SCS Runoff	6.247	1	717	12,958	----	------	------	SCC No. 20 Area
7	Combine	16.12	1	717	33,445	5, 6	------	------	SCC No. 20
8	SCS Runoff	10.09	1	725	31,666	----	------	------	SCC No. 19 Area
9	Combine	23.77	1	718	65,111	7, 8	------	------	SCC No. 19
10	Manual	74.89	1	724	242,198	----	------	------	DD No. 41
11	Manual	64.97	1	723	184,411	----	------	------	DD No. 36
12	SCS Runoff	11.06	1	730	42,444	----	------	------	SSC No. 18 Area
13	Combine	165.82	1	723	534,164	9, 10, 11, 12	------	------	SCC No. 18
14	Manual	31.85	1	721	95,358	----	------	------	DD No. 33
15	SCS Runoff	12.51	1	724	37,288	----	------	------	SCC No. 17 Area
16	Combine	209.13	1	722	666,811	13, 14, 15	------	------	SCC No. 17
17	Manual	69.28	1	721	190,673	----	------	------	DD No. 28
18	SCS Runoff	13.79	1	723	39,617	----	------	------	SCC No. 16 Area
19	Combine	291.27	1	722	897,100	16, 17, 18	------	------	SCC No. 16
20	Combine	293.29	1	722	907,588	4, 19	------	------	Pipe No. 301
21	Combine	364.62	1	722	1,118,127	3, 20	------	------	Ex. Sed Basin No. 3 Inflow
22	Reservoir	44.17	1	758	961,463	21	61.19	640,312	Ex. Sed. Basin No. 3
23	Reservoir	209.88	1	732	1,118,123	21	62.93	275,379	Ex Sed. Basin No. 3-ES

f. Riser Pipe and Carrier Pipe Design

OVERFLOW STRUCTURE NO. 3(R)



DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

* UNDER A WEIR FLOW CONDITION THE EQUIVALENT RISER PIPE DIA. FOR A 5.5'x5.5' BOX ⇒ 84" DIA. PIPE

FLOW (Q) MAXIMUM = 210. CFS

HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION FOR WORST CASE FLOW MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 63.00 − 60.50 = 2.5' FEET

FOR WEIR FLOW:

$Q = 9.739 (D_c) H^{3/2}$

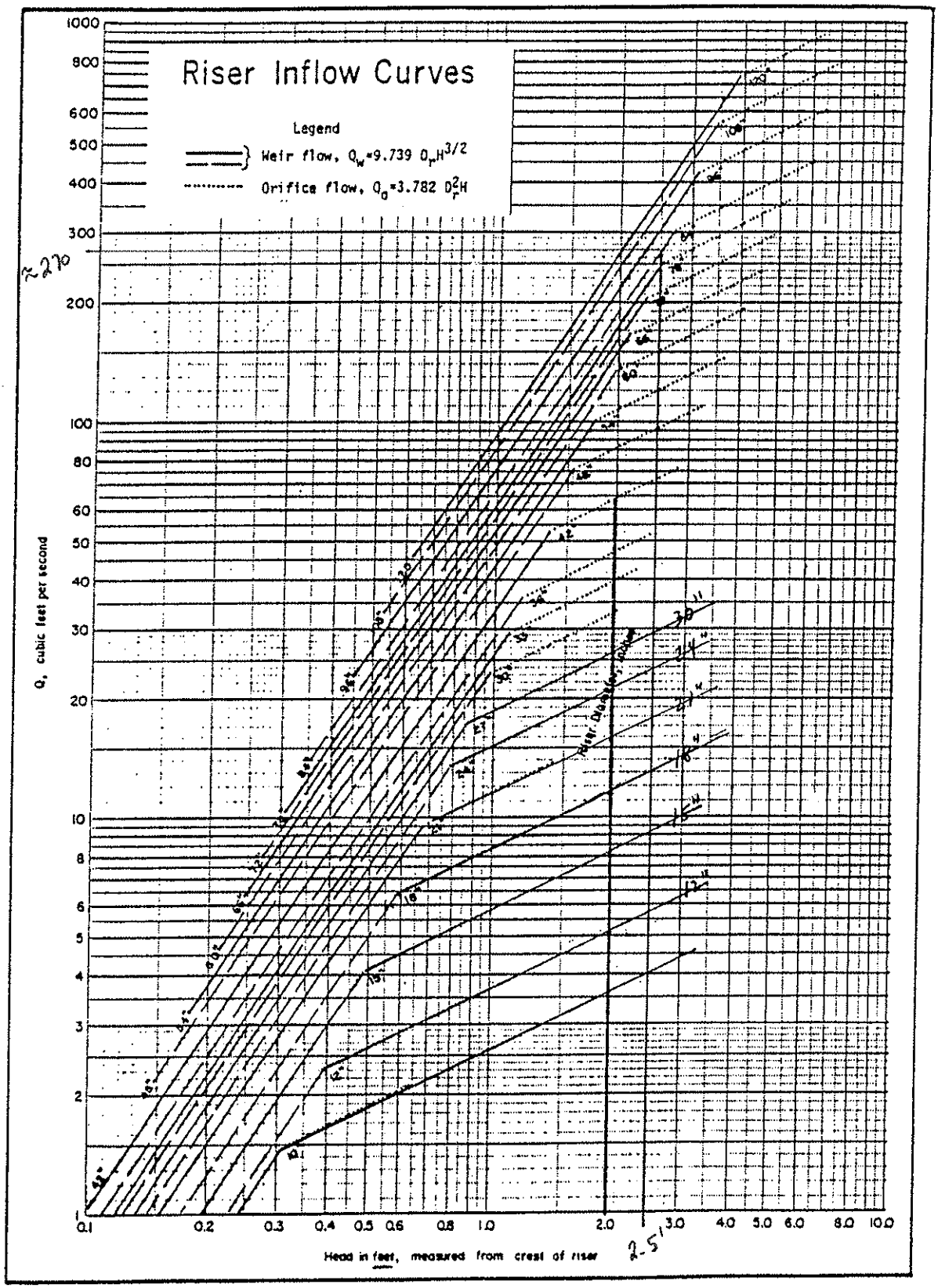
$= 9.739 (7) (2.5)^{3/2}$

$= 269$ cfs

BASED ON ABOVE HEAD, USE 5.5'x5.5' Box OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

Entrance to Downdrain & standpipes



Source: USDA-SCS

Plate 1.26h

FIGURE A-10

Table 6-23

CARRIER PIPE NO. 302 (R)

Q = 210 CFS worst case

Maximum headwater = Top of levee elevation minus 1' freeboard
= 64 − 1.0 = 63.0

Head (H) = maximum water elevation allowed minus the centerline elevation at the downstream end of the carrier pipe
= 63.00 − 56.10' = 6.9'

Length (L) = 71.0'

Length Factor = 1.00 for lengths other than 70'

Q (available) = Q from table times length factor
= 300 X 1.0 = 300 CFS

Q (available) must be greater than Q worst case

USE 60 " DIAMETER RCP CARRIER PIPE

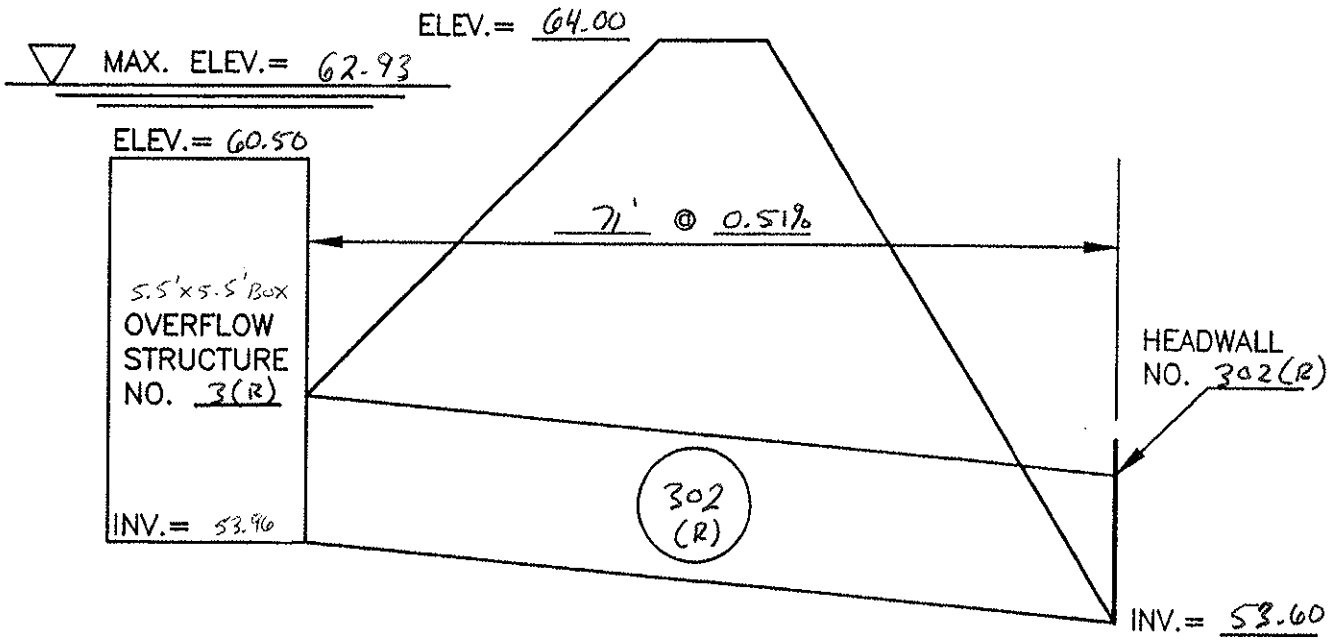


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_e = K_a + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet

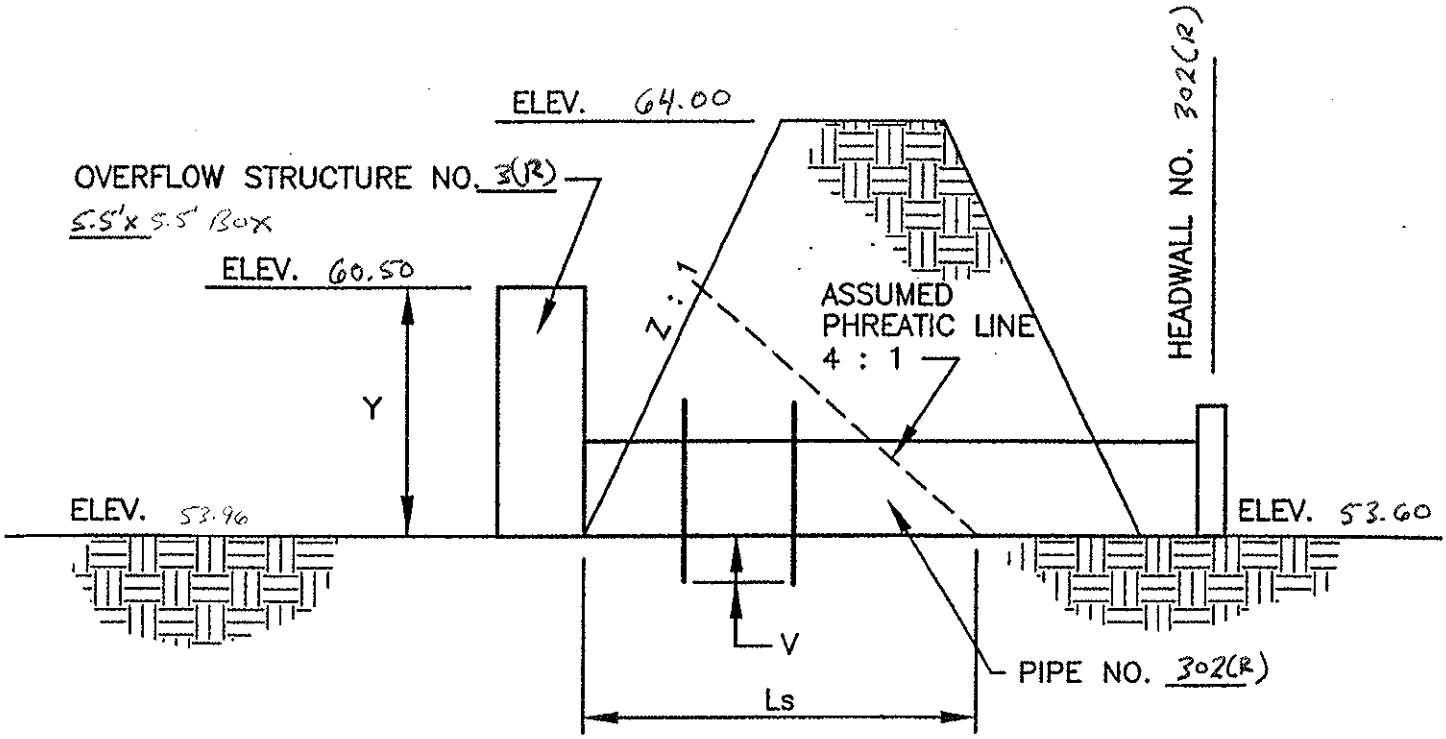
diameter of pipe in inches

H, in feet	12"	15"	18"	21"	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"	102"
1	3.22	5.44	8.29	11.8	15.9	26.0	38.6	53.8	71.4	91.5	114	139	167	197	229	264	302	342
2	4.55	7.69	11.7	16.7	22.5	36.8	54.6	76.0	101	129	161	197	236	278	324	374	427	483
3	5.57	9.42	14.4	20.4	27.5	45.0	66.9	93.1	124	159	198	241	289	341	397	458	523	592
4	6.43	10.9	16.6	23.5	31.8	52.0	77.3	108	143	183	228	278	334	394	459	529	604	683
5	7.19	12.2	18.5	26.3	35.5	58.1	86.4	120	160	205	255	311	373	440	513	591	675	764
6	7.88	13.3	20.3	28.8	38.9	67.7	94.6	132	175	224	280	341	409	482	562	647	739	837
7	8.51	14.4	21.9	31.1	42.0	68.8	102	142	189	242	302	368	441	521	607	699	798	904
8	9.10	15.4	23.5	33.3	44.9	73.5	109	152	202	259	323	394	472	557	685	748	854	966
9	9.65	16.3	24.9	35.3	47.7	78.0	116	161	214	275	342	418	500	590	688	793	905	1025
10	10.2	17.2	26.2	37.2	50.2	82.2	122	170	226	289	361	440	527	622	725	836	954	1080
11	10.7	18.0	27.5	39.0	52.7	86.2	128	178	237	304	379	462	553	653	761	877	1001	1133
12	11.1	18.9	28.7	40.8	55.0	90.1	134	186	247	317	395	482	578	682	794	916	1045	1184
13	11.6	19.6	29.9	42.4	57.3	93.7	139	194	257	330	411	502	601	710	827	953	1088	1232
14	12.0	20.4	31.0	44.1	59.4	97.3	145	201	267	342	427	521	624	736	858	989	1129	1278
15	12.5	21.1	32.1	45.6	61.5	101	150	208	277	354	442	539	646	762	888	1024	1169	1323
16	12.9	21.8	33.2	47.1	63.5	104	155	215	286	366	457	557	667	787	917	1057	1207	1367
17	13.3	22.4	34.2	48.5	65.5	107	159	222	294	377	471	574	688	812	946	1090	1244	1409
18	13.7	23.1	35.2	49.9	67.4	110	164	228	303	388	484	591	708	835	973	1121	1280	1450
19	14.0	23.8	36.1	51.3	69.2	113	168	234	311	399	497	607	727	858	1000	1152	1315	1489
20	14.4	24.3	37.1	52.6	71.0	116	173	240	319	409	510	623	746	880	1026	1182	1350	1528
21	14.7	24.9	38.0	53.9	72.8	119	177	246	327	419	523	638	764	902	1051	1211	1383	1566
22	15.1	25.5	38.9	55.2	74.5	122	181	252	335	429	535	653	782	923	1076	1240	1415	1603
23	15.4	26.1	39.8	56.5	76.2	125	186	258	342	439	547	668	800	944	1100	1268	1447	1639
24	15.8	26.7	40.6	57.7	77.8	127	189	263	350	448	559	682	817	964	1123	1295	1478	1674
25	16.1	27.2	41.5	58.9	79.4	130	193	269	357	458	571	696	834	984	1147	1322	1509	1708
26	16.4	27.7	42.3	60.0	81.0	133	197	274	364	467	582	710	850	1004	1169	1348	1539	1742
27	16.7	28.3	43.1	61.2	82.5	135	201	279	371	476	593	723	867	1023	1192	1373	1568	1775
28	17.0	28.8	43.9	62.3	84.1	138	204	285	378	484	604	737	883	1041	1214	1399	1597	1808
29	17.3	29.3	44.7	63.4	85.5	140	208	290	384	493	615	750	898	1060	1235	1423	1625	1840
30	17.6	29.8	45.4	64.5	87.0	142	212	294	391	501	625	763	913	1078	1256	1448	1653	1871
L, in feet	Correction Factors For Other Pipe Lengths																	
20	1.30	1.24	1.21	1.18	1.15	1.12	1.10	1.08	1.07	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03
30	1.22	1.18	1.15	1.13	1.12	1.09	1.08	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02
40	1.15	1.13	1.11	1.10	1.08	1.07	1.05	1.05	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02
50	1.09	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01
60	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	.96	.97	.97	.97	.98	.98	.98	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99
90	.93	.94	.94	.95	.95	.96	.97	.97	.98	.98	.98	.98	.98	.98	.99	.99	.99	.99
100	.90	.91	.92	.93	.93	.95	.95	.96	.97	.97	.97	.98	.98	.98	.98	.98	.98	.99
120	.84	.86	.87	.89	.90	.91	.93	.94	.94	.95	.96	.96	.96	.97	.97	.97	.97	.98
140	.80	.82	.83	.85	.86	.88	.90	.91	.92	.93	.94	.94	.95	.95	.96	.96	.96	.97
160	.76	.78	.80	.82	.83	.86	.88	.89	.90	.91	.92	.93	.94	.94	.95	.95	.95	.96

Source: USDA - SCS

g. Anti-Seep Collar Design

ANTI – SEEP COLLAR DESIGN



Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 6.54 FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 0.51 % = 0.0051 FEET/FEET

$$Ls = Y (Z + 4) \left(1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 46 FEET

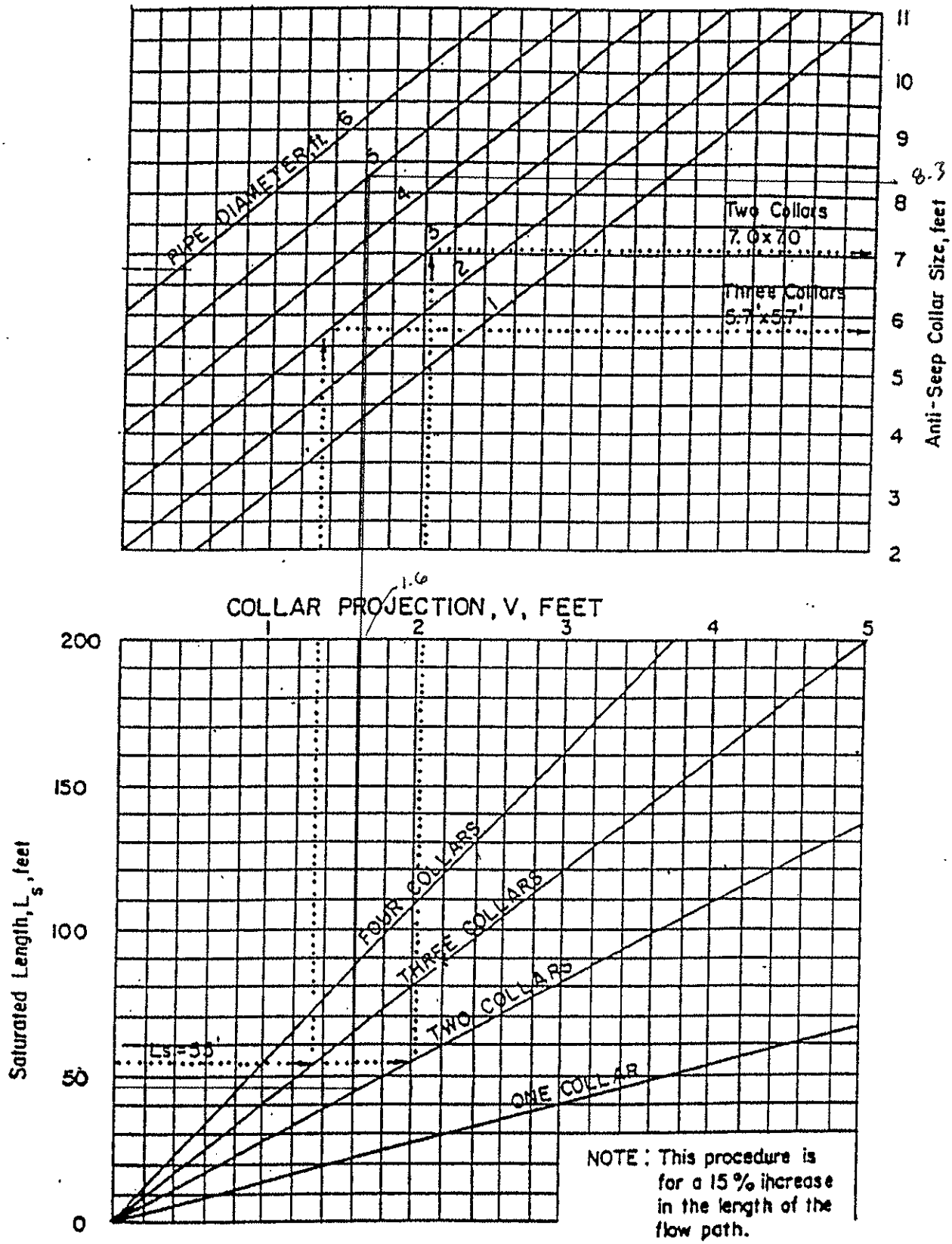
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.6 FEET

DIMENSIONS OF 12" THICK COLLAR = 9.0' x 9.0'

NUMBER OF REQUIRED COLLARS = 2

ANTI-SEEP COLLAR DESIGN



h. Riser Base Foundation Design

RISER BASE FOUNDATION DESIGN

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

Overflow Structure

= (L)(w)(h)(62.4) L = w = 5.5' inside = 6.0' outside

= (6.0)(6.0)(6.5)(62.4) h = height = 6.5'

= 14,602 #

Carrier Pipe = $3.1416(R_2^2)(Ls)(62.4)$ Ls = length in saturation zone = 46'

= 3.1416(2.92)(2.92)(46)(62.4) R_2 = outside radius = 35" = 2.92'

= 76,888 # r_2 = inside radius = 30" = 2.5'

TOTAL WEIGHT

= 91,490 # x 1.2 (SAFETY FACTOR)

= 109,788 #

TOTAL REVISED VOLUME OF CONCRETE =
TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 109,788/87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 1,253 C.F.

This volume of concrete will be made up from six areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement
6. Weight of Saturated Soil Directly Above Carrier Pipe

1. Overflow Structure = $(L_2 - l_2)h$

   $(6.0^2 - 5.5^2)(6.5) =$ 37.4 C.F.

   L = outside dimension of box = 6.0'

   l = inside dimension of box = 5.5'

   h = height of overflow structures = 6.5'

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

   = [(9' x 9') - $(3.1416)(R_2^2)$

   x 1' x 2

   = 108 c.f.

   R_2 = outside radius of carrier pipe = 35" = 2.92'

   r_2 = inside radius of carrier pipe = 30" = 2.5'

3. Carrier Pipe

   = $3.1416\ (R_2^2 - r_2^2)$ Ls = 329 L.F.

   Ls = length in saturation = 46'

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

   = (L)(w)h(62.4)(1.2)/weight of conc. in water

   = (6.0)(6.0)(6.5)(62.4)(1.2)/87.6

   = 200 C.F.

   Use 11' x 11' x 2' = 242 C.F.

   L = w = 6.0' outside

   h = height = 6.5'

5. Carrier Pipe Encasement

   Must extend 5' into dam. Distance from overflow structure to dam is equal to 17.5'. Therefore, encasement length will be 22.5':

   Use 6.5'H x 8'W x 22.5' long

   Carrier pipe encasement volume = 567 C.F.

6. Weight of Saturated Soil in the Length of Saturation =

   a. Weight of Soil = 100 lbs/C.F.

   b. Weight of Saturated Soil = 100 lbs/C.F. – 62.4 lbs/C.F. = 37 lbs/C.F.

   c. Volume of Soil in Length of Saturation over Carrier Pipe = 2.2 s.f. x 5.83' = 12.8 C.F.

   d. 12.8 C.F. x 37 lbs/C.F. = 473.6 lbs

   e. 473.6 lbs ÷ 87.6 lbs/C.F. = 5.4 C.F. (equivalent of submerged concrete)

TOTAL REQUIRED VOLUME = 1,253 C.F.

Actual Total Volume

Overflow Structure	= 37 C.F.
Anti-Seep Collars	= 108 C.F.
Carrier Pipe	= 329 C.F.
Overflow Structure Base	= 242 C.F.
Carrier Pipe Encasement	= 567 C.F.
Weight of Saturated Soil	= 5 C.F.
TOTAL	= 1,288 C.F. => Okay

4. WET DETENTION BASIN NO. 4

a. **Wet Detention Basin Design Criteria**

Wet Detention Basin No. 4 at East Carolina Regional MSW Landfill will be constructed to meet the requirements of the North Carolina Sedimentation Pollution Control Act of 1973 and Rule 15A NCAC 2H.1000 for wet detention basins. The most current editions of the North Carolina Erosion and Sediment Control Plan and Design Manual and the Stormwater Best Management Practices design manual are also being used to design the necessary controls for this project.

Requirements:

1. Minimum Length to Width Ratio = 3H:1V (recommended)

2. Sediment Storage per Disturbed Acre = 1,800 c.f. per acre with a sediment storage depth of 1' kept below the depth of permanent pool.

3. A forebay equal to approximately 20% of the total basin volume shall be constructed at the head of the basin.

4. Minimum Permanent Pool Average Depth = 3 feet = $\frac{\text{(Permanent Pool Volume)}}{\text{(Permanent Pool Surface Area)}}$

5. Temporary Water Quality Pool = volume of stormwater run-off from drainage area and is constructed above the permanent pool.

6. Temporary Water Quality Pool dewatered between 48 – 120 hours.

7. At 50% impervious cover and a 3.6 foot permanent pool average depth, there must be a permanent pool surface area equal to 4.8% of the drainage area.

8. Retain run-off from the 25-year, 24-hour storm event.

b. Design Calculations

Criteria	NCDENR Requirements	Actual Design
1. Length:Width	3H:1V	3H:1V
2. Sediment Storage in Permanent Pool	1,800 c.f./acre	7,825 c.f./acre
3. Forebay Volume as % of Total Basin Volume	± 20%	± 24%
4. Permanent Pool Average Depth	3' - 6'	3.64'
5. Temporary Water Quality Pool Volume from Drainage Area	1"	2.37"
6. Temporary Water Quality Pool Dewatering Time	48 – 120 Hours	48.8 Hours
7. Permanent Pool Surface Area for 50% Impervious, 3.6' permanent pool average depth and 90% TSS Removal as a Percentage of the Total Drainage Area	4.8%	4.94%
8. Storm Event Retention below Top of Riser	25 Years	25 Years

Pond Report

Hydraflow Hydrographs by Intelisolve — Tuesday, Mar 11 2008, 3:24 PM

Pond No. 2 - Sed Basin No. 4

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	56.00	74,153	0	0
2.00	58.00	82,100	156,253	156,253
4.00	60.00	90,335	172,435	328,688
6.00	62.00	98,860	189,195	517,883
8.00	64.00	107,673	206,533	724,416
10.00	66.00	116,775	224,448	948,864
11.00	67.00	121,296	119,036	1,067,900

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 36.00	6.00	6.00	0.00
Span (in)	= 36.00	7.00	10.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 60.00	60.00	62.00	0.00
Length (ft)	= 75.00	0.00	0.00	0.00
Slope (%)	= 5.33	0.00	0.00	0.00
N-Value	= .013	.013	.013	.000
Orif. Coeff.	= 0.60	0.60	0.60	0.00
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 16.00	0.00	0.00	0.00
Crest El. (ft)	= 63.70	0.00	0.00	0.00
Weir Coeff.	= 3.33	0.00	0.00	0.00
Weir Type	= Riser	---	---	---
Multi-Stage	= Yes	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control. Weir riser checked for orifice conditions.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	56.00	0.00	0.00	0.00	---	0.00	---	---	---	---	0.00
2.00	156,253	58.00	0.00	0.00	0.00	---	0.00	---	---	---	---	0.00
4.00	328,688	60.00	0.00	0.00	0.00	---	0.00	---	---	---	---	0.00
6.00	517,883	62.00	1.76	1.74	0.00	---	0.00	---	---	---	---	1.74
8.00	724,416	64.00	13.81	2.25	2.65	---	8.75	---	---	---	---	13.66
10.00	948,864	66.00	70.88	0.57	0.81	---	69.49	---	---	---	---	70.87
11.00	1,067,900	67.00	78.43	0.61	0.87	---	76.93	---	---	---	---	78.41

Recommended Sediment Storage/Acre = 1800 cf/AC.

Drainage Area ≈ 42 AC.

Available Sediment Storage in Permanent Pool = $\frac{328,688 \text{ cf}}{42 \text{ AC}}$ = 7,825 cf/AC.

Volume in Forebay @ Elev. 60.00 = 76,197 cf.

Volume in Basin @ Elev. 60.00 = 241,132 cf

Percent Vol. of Forebay to Total Vol. = $\frac{76,197 \text{ cf}}{76,197 + 241,132}$

≈ 24.0%

Pond Report

Hydraflow Hydrographs by Intelisolve — Tuesday, Mar 11 2008, 3:24 PM

Pond No. 3 - Sed Basin No. 4-perm pool

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	60.00	90,335	0	0
2.00	62.00	98,860	189,195	189,195
4.00	64.00	107,673	206,533	395,728
6.00	66.00	116,775	224,448	620,176
7.00	67.00	121,296	119,036	739,212

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 36.00	6.00	6.00	0.00
Span (in)	= 36.00	7.00	10.00	0.00
No. Barrels	= 1	1	1	0
Invert El. (ft)	= 60.00	60.00	62.00	0.00
Length (ft)	= 75.00	0.00	0.00	0.00
Slope (%)	= 5.33	0.00	0.00	0.00
N-Value	= .013	.013	.013	.013
Orif. Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	Yes	Yes	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 16.00	0.00	0.00	0.00
Crest El. (ft)	= 63.70	0.00	0.00	0.00
Weir Coeff.	= 3.00	0.00	0.00	0.00
Weir Type	= Riser	---	---	---
Multi-Stage	= Yes	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control. Weir riser checked for orifice conditions.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	60.00	0.00	0.00	0.00	---	0.00	---	---	---	---	0.00
2.00	189,195	62.00	1.76	1.74	0.00	---	0.00	---	---	---	---	1.74
4.00	395,728	64.00	13.02	2.27	2.65	---	7.89	---	---	---	---	12.81
6.00	620,176	66.00	70.88	0.57	0.81	---	69.49	---	---	---	---	70.86
7.00	739,212	67.00	78.43	0.61	0.87	---	76.93	---	---	---	---	78.41

VOLUME of RUNOFF IN TEMPORARY WATER QUALITY POOL = 1" MIN.

ACTUAL VOLUME = VOLUME BETWEEN the PERMANENT POOL AND TOP of RISER DIVIDED BY the DRAINAGE AREA

$\Rightarrow \frac{362,061 \text{ cf}}{42 \text{ AC}} = 2.37"$

Pond Report

Hydraflow Hydrographs by Intelisolve — Tuesday, Mar 11 2008, 3:25 PM

Pond No. 4 - Sed Basin No. 4 - ES

Pond Data

Pond storage is based on known contour areas. Average end area method used.

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	63.70	106,351	0	0
0.30	64.00	107,673	32,104	32,104
2.30	66.00	116,775	224,448	256,552
3.30	67.00	121,296	119,036	375,587

Culvert / Orifice Structures

	[A]	[B]	[C]	[D]
Rise (in)	= 36.00	0.00	0.00	0.00
Span (in)	= 36.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 60.00	0.00	0.00	0.00
Length (ft)	= 75.00	0.00	0.00	0.00
Slope (%)	= 5.33	0.00	0.00	0.00
N-Value	= .013	.013	.013	.013
Orif. Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 16.00	0.00	0.00	0.00
Crest El. (ft)	= 63.70	0.00	0.00	0.00
Weir Coeff.	= 3.00	0.00	0.00	0.00
Weir Type	= Riser	---	---	---
Multi-Stage	= Yes	No	No	No

Exfiltration = 0.000 in/hr (Contour) Tailwater Elev. = 0.00 ft

Note: Culvert/Orifice outflows have been analyzed under inlet and outlet control. Weir riser checked for orifice conditions.

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	Clv D cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Total cfs
0.00	0	63.70	0.00	---	---	---	0.00	---	---	---	---	0.00
0.30	32,104	64.00	50.48	---	---	---	7.89	---	---	---	---	7.89
2.30	256,552	66.00	70.81	---	---	---	70.81	---	---	---	---	70.81
3.30	375,587	67.00	78.36	---	---	---	78.35	---	---	---	---	78.35

c. Wet Detention Basin Dewatering of First 1" of Runoff

- Volume of 1" Runoff = 1" x 42 Acres = 152,460 c.f.
- In Basin No. 4, this volume equates to Elevation 61.61
- At Elev. 61.61, surface area = 97,198 s.f.
- Assume 1 - 6" x 7" dewatering opening at elevation 60.00

$$\text{Dewatering Time} = T = \frac{As \times (2h)^{1/2}}{Ao \times Cd \times 20{,}428}$$

Ao = Surface Area of Dewatering Opening, ft^2 = 1 – 6" x 7" opening = 0.2917 s.f.
As = Surface Area = 97,198 s.f.
h = Head of Water Above Holes, ft = 61.61 – 60.00 = 1.61 ft.
Cd = Coefficient of Contraction for an Orifice (use 0.6)
T = Detention Time or Time to Dewater Wet Detention Basin (must be 48 - 120 hours)

$$T = \frac{As \times (2h)^{1/2}}{Ao \times Cd \times 20{,}428} = \frac{97{,}198\ (2 \times 1.61)^{1/2}}{0.2917\ (.6)(20{,}428)} = 48.8 \text{ hours}$$

d. Permanent Pool Surface Area

The following tables from the North Carolina Division of Water Quality's Stormwater Best Management Practices design manual lists the required surface area of the permanent pool for 90% pollutant removal efficiency in the Coastal Region. Based on a permanent pool average depth of 3.6 feet and a 50% impervious cover area, the surface area of the permanent pool needs to be 4.8% of the drainage area.

- Drainage Area = 42 acres = 1,829,520 s.f.
- Required Surface Area = 0.048 x 1,829,520 = 87,817 s.f.
- Actual Permanent Pool Surface Area @ Elev. 60.00 = 90,335 s.f.
- Actual Percent of Drainage Area = 90,335 s.f. ÷ 1,829,520 s.f. x 100% = 4.94%

Table 10-1

Surface Area to Drainage Area Ratio for Permanent Pool Sizing to Achieve *85 Percent* TSS Pollutant Removal Efficiency in the *Mountain and Piedmont* Regions, Adapted from Driscoll, 1986

Percent Impervious Cover	Permanent Pool Average Depth (ft)						
	3.0	4.0	5.0	6.0	7.0	8.0	9.0
10%	0.59	0.49	0.43	0.35	0.31	0.29	0.26
20%	0.97	0.79	0.70	0.59	0.51	0.46	0.44
30%	1.34	1.08	0.97	0.83	0.70	0.64	0.62
40%	1.73	1.43	1.25	1.05	0.90	0.82	0.77
50%	2.06	1.73	1.50	1.30	1.09	1.00	0.92
60%	2.40	2.03	1.71	1.51	1.29	1.18	1.10
70%	2.88	2.40	2.07	1.79	1.54	1.35	1.26
80%	3.36	2.78	2.38	2.10	1.86	1.60	1.42
90%	3.74	3.10	2.66	2.34	2.11	1.83	1.67

Table 10-2

Surface Area to Drainage Area Ratio for Permanent Pool Sizing to Achieve *85 Percent* TSS Pollutant Removal Efficiency in the *Coastal* Region, Adapted from Driscoll, 1986

Percent Impervious Cover	Permanent Pool Average Depth (ft)									
	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5'
10%	0.9	0.8	0.7	0.6	0.5	0	0	0	0	0
20%	1.7	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5
30%	2.5	2.2	1.9	1.8	1.6	1.5	1.3	1.2	1.0	0.9
40%	3.4	3.0	2.6	2.4	2.1	1.9	1.6	1.4	1.1	1.0
50%	4.2	3.7	3.3	3.0	2.7	2.4	2.1	1.8	1.5	1.3
60%	5.0	4.5	3.8	3.5	3.2	2.9	2.6	2.3	2.0	1.6
70%	6.0	5.2	4.5	4.1	3.7	3.3[a]	2.9	2.5	2.1	1.8
80%	6.8	6.0	5.2	4.7	4.2	3.7	3.2	2.7	2.2	2.0
90%	7.5	6.5	5.8	5.3	4.8	4.3	3.8	3.3	2.8	1.3
100%	8.2	7.4	6.8	6.2	5.6	5.0	4.4	3.8	3.2	2.6

Table 10-3

Surface Area to Drainage Area Ratio for Permanent Pool Sizing to Achieve *90 Percent* TSS Pollutant Removal Efficiency in the *Mountain and Piedmont* Regions, Adapted from Driscoll, 1986

Percent Impervious Cover	Permanent Pool Average Depth (ft)												
	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
10%	0.9	0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4
20%	1.5	1.3	1.1	1.0	1.0	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7
30%	1.9	1.8	1.7	1.5	1.4	1.4	1.3	1.1	1.0	1.0	1.0	0.9	0.9
40%	2.5	2.3	2.0	1.9	1.8	1.7	1.6	1.6	1.5	1.4	1.3	1.2	1.1
50%	3.0	2.8	2.5	2.3	2.0	1.9	1.9	1.8	1.7	1.6	1.6	1.5	1.5
60%	3.5	3.2	2.8	2.7	2.5	2.4	2.2	2.1	1.9	1.9	1.8	1.8	1.7
70%	4.0	3.7	3.3	3.1	2.8	2.7	2.5	2.4	2.2	2.1	2.0	2.0	1.9
80%	4.5	4.1	3.8	3.5	3.3	3.0	2.8	2.7	2.6	2.4	2.3	2.1	2.0
90%	5.0	4.5	4.0	3.8	3.5	3.3	3.0	2.9	2.8	2.7	2.6	2.5	2.4

Table 10-4
Surface Area to Drainage Area Ratio for Permanent Pool Sizing to Achieve *90 Percent* TSS Pollutant Removal Efficiency in the *Coastal Region*, Adapted from Driscoll, 1986

Percent Impervious Cover	Permanent Pool Average Depth (ft)									
	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5'
10%	1.3	1.0	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
20%	2.4	2.0	1.8	1.7	1.5	1.4	1.2	1.0	0.9	0.6
30%	3.5	3.0	2.7	2.5	2.2	1.9	1.6	1.3	1.1	0.8
40%	4.5	4.0	3.5	3.1	2.8	2.5	2.1	1.8	1.4	1.1
50%	5.6	5.0	4.3	3.9	3.5	3.1	2.7	2.3	1.9	1.5
60%	7.0	6.0	5.3	4.8	4.3	3.9	3.4	2.9	2.4	1.9
70%	8.1	7.0	6.0	5.5	5.0	4.5	3.9	3.4	2.9	2.3
80%	9.4	8.0	7.0	6.4	5.7	5.2	4.6	4.0	3.4	2.8
90%	10.7	9.0	7.9	7.2	6.5	5.9	5.2	4.6	3.9	3.3
100%	12	10.0	8.8	8.1	7.3	6.6	5.8	5.1	4.3	3.6

The engineering design of a wet detention basin must include a 10-foot-wide (minimum) vegetated shelf around the full perimeter of the basin. The inside edge of the shelf shall be no deeper than 6" below the permanent pool level, and the outside edge shall be 6" above the permanent pool level. For a 10' wide shelf, the resulting slope is 10:1. With half the required shelf below the water (maximum depth of 6 inches), and half the required shelf above the water, the vegetated shelf will provide a location for a diverse population of emergent wetland vegetation that enhances biological pollutant removal, provides a habitat for wildlife, protects the shoreline from erosion, and improves sediment trap efficiency. A 10' wide shelf also provides a safety feature prior to the deeper permanent pool.

Short-circuiting of the stormwater must be prevented. The most direct way of minimizing short-circuiting is to maximize the length of the flow path between the inlet and the outlet: basins with long and narrow shapes can maximize the length of the flow path. Long and narrow but irregularly shaped wet detention basins may appear more natural and therefore may have increased aesthetic value. If local site conditions prohibit a relatively long, narrow facility, baffles may be placed in the wet detention basin to lengthen the stormwater flow path as much as possible. Baffles must extend to the temporary pool elevation or higher. A minimum length-to-width ratio of 1.5:1 is required, but a flow path of at least 3:1 is recommended. Basin shape should minimize dead storage areas, and where possible the width should expand as it approaches the outlet.

Although larger wet detention basins typically remove more pollutants, a threshold size seems to exist above which further improvement of water quality by sedimentation is negligible. The water treatment volume within a wet detention basin is calculated as the total volume beneath the permanent pool water level, and above the sediment storage volume, including any such volume within the forebay.

e. **Reservoir Routing**

Reservoir routing is determined by using the HydraFlow Hydrographs 2004 Computer Program.

Peak inflow rates (Q) are determined using the SCS Method and HydraFlow computer program. Peak inflow rates are calculated for the 2 year, 5 year, 10 year, 25-year, 50 year, and 100 year storm events and are summarized below.

Q_2 = 64.03 cfs
Q_5 = 111.96 cfs
Q_{10} = 147.20 cfs
Q_{25} = 183.50 cfs
Q_{50} = 222.68 cfs
Q_{100} = 262.30 cfs

The bottom of the wet detention basin has been set at 56.00. The permanent pool has been set at elevation 60.00. Dewatering of the wet detention basin is accomplished by 1 - 6" x 7" dewatering opening at an invert elevation of 60.00, and 1 - 6" x 10" dewatering opening at an invert elevation of 62.00.

For routing calculations, a 4' x 4' square riser structure with the dewatering openings described above is used. The top of the riser is at an elevation of 63.70. The bottom of the wet detention basin is elevation 56.00. The invert of the carrier pipe is 60.00. The top of the levee around the wet detention basin is at an elevation of 67.25 minimum.

Based on the above information the reservoir routing calculations are performed and summarized below.

STORM YEAR	PEAK INFLOW CFS	PEAK OUTFLOW CFS	PEAK ELEV. FEET
2	64.03	1.39	61.41
5	111.96	2.60	62.40
10	147.20	3.85	63.00
25	183.50	5.34	63.68
50	222.68	13.43	64.01
100	262.30	28.39	64.32

Based on these routing calculations, the riser is large enough and the wet detention basin has sufficient storage volume to retain the sediment from 42 disturbed acres within the additional 1 foot of sediment storage, the permanent water quality pool, plus the 25-year storm event from the entire drainage area below the crest of the riser (elev. 63.70).

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	3.321	1	724	9,686	----	------	------	SCC No. 1 Area
2	Manual	16.50	1	725	50,113	----	------	------	DD No. 44
3	Manual	9.427	1	724	29,749	----	------	------	DD No. 47
4	Combine	29.24	1	724	89,548	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	1.158	1	718	2,330	----	------	------	SCC No. 2 Area
6	Combine	29.69	1	724	91,878	4, 5	------	------	SCC No. 2
7	Manual	14.78	1	721	38,723	----	------	------	DD No. 52
8	SCS Runoff	1.843	1	724	5,376	----	------	------	SCC No. 3 Area
9	Combine	45.57	1	723	135,977	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	0.643	1	716	1,118	----	------	------	SCC No. 4 Area
11	Combine	45.67	1	723	137,094	9, 10	------	------	SCC No. 4
12	SCS Runoff	0.749	1	717	1,402	----	------	------	SCC No. 6
13	Manual	16.22	1	721	40,716	----	------	------	DD No. 58
14	SCS Runoff	2.704	1	728	9,481	----	------	------	SCC No. 5 Area
15	Combine	18.76	1	721	51,600	12, 13, 14	------	------	SCC No. 5
16	Combine	64.03	1	722	188,694	11, 15	------	------	Pipe No. 400
17	Reservoir	1.393	1	1178	142,721	16	61.41	133,180	Sed. Basin 4-perm pool
18	Reservoir	21.04	1	738	188,681	16	64.27	62,739	Sed. Basin 4-ES
19	SCS Runoff	1.230	1	717	2,304	----	------	------	SCC No. 7
20	SCS Runoff	4.765	1	740	25,472	----	------	------	SCC No. 8 Area
21	Manual	16.19	1	720	39,372	----	------	------	DD No. 64
22	Manual	9.000	1	721	22,284	----	------	------	DD No. 67
23	Combine	27.97	1	720	89,431	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	1.960	1	722	5,029	----	------	------	SCC No. 9 Area
25	Manual	7.302	1	726	26,068	----	------	------	DD No. 3
26	Combine	36.26	1	721	120,528	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	2.311	1	719	4,884	----	------	------	SCC No. 10 Area
28	SCS Runoff	1.791	1	717	3,356	----	------	------	Area to DD No. 4
29	Combine	39.36	1	720	128,768	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	2.056	1	719	4,346	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	5.804	1	723	16,597	----	------	------	SCC No. 1 Area
2	Manual	28.90	1	724	85,865	----	------	------	DD No. 44
3	Manual	16.52	1	723	50,974	----	------	------	DD No. 47
4	Combine	51.18	1	724	153,436	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	1.982	1	718	3,992	----	------	------	SCC No. 2 Area
6	Combine	51.93	1	724	157,428	4, 5	------	------	SCC No. 2
7	Manual	25.72	1	721	66,350	----	------	------	DD No. 52
8	SCS Runoff	3.221	1	723	9,211	----	------	------	SCC No. 3 Area
9	Combine	79.73	1	722	232,989	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	1.089	1	716	1,915	----	------	------	SCC No. 4 Area
11	Combine	79.94	1	722	234,904	9, 10	------	------	SCC No. 4
12	SCS Runoff	1.275	1	717	2,403	----	------	------	SCC No. 6
13	Manual	28.09	1	721	69,764	----	------	------	DD No. 58
14	SCS Runoff	4.754	1	727	16,246	----	------	------	SCC No. 5 Area
15	Combine	32.66	1	721	88,413	12, 13, 14	------	------	SCC No. 5
16	Combine	111.96	1	722	323,317	11, 15	------	------	Pipe No. 400
17	Reservoir	2.604	1	1099	232,987	16	62.40	230,246	Sed. Basin 4-perm pool
18	Reservoir	44.71	1	735	323,304	16	64.66	106,321	Sed. Basin 4-ES
19	SCS Runoff	2.095	1	717	3,948	----	------	------	SCC No. 7
20	SCS Runoff	8.454	1	740	43,644	----	------	------	SCC No. 8 Area
21	Manual	28.07	1	720	67,462	----	------	------	DD No. 64
22	Manual	15.58	1	721	38,182	----	------	------	DD No. 67
23	Combine	48.95	1	720	153,236	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	3.409	1	721	8,617	----	------	------	SCC No. 9 Area
25	Manual	12.85	1	725	44,666	----	------	------	DD No. 3
26	Combine	63.52	1	721	206,518	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	3.958	1	719	8,368	----	------	------	SCC No. 10 Area
28	SCS Runoff	3.051	1	717	5,750	----	------	------	Area to DD No. 4
29	Combine	69.11	1	720	220,636	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	3.523	1	719	7,447	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	7.636	1	723	21,769	----	------	------	SCC No. 1 Area
2	Manual	38.03	1	724	112,621	----	------	------	DD No. 44
3	Manual	21.77	1	723	66,857	----	------	------	DD No. 47
4	Combine	67.32	1	724	201,247	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	2.582	1	718	5,235	----	------	------	SCC No. 2 Area
6	Combine	68.39	1	723	206,483	4, 5	------	------	SCC No. 2
7	Manual	33.75	1	721	87,025	----	------	------	DD No. 52
8	SCS Runoff	4.238	1	723	12,081	----	------	------	SCC No. 3 Area
9	Combine	105.00	1	722	305,589	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	1.413	1	716	2,512	----	------	------	SCC No. 4 Area
11	Combine	105.27	1	722	308,100	9, 10	------	------	SCC No. 4
12	SCS Runoff	1.658	1	717	3,152	----	------	------	SCC No. 6
13	Manual	36.84	1	720	91,503	----	------	------	DD No. 58
14	SCS Runoff	6.271	1	727	21,308	----	------	------	SCC No. 5 Area
15	Combine	42.87	1	721	115,963	12, 13, 14	------	------	SCC No. 5
.	Combine	147.20	1	722	424,063	11, 15	------	------	Pipe No. 400
17	Reservoir	3.854	1	1015	315,341	16	63.00	292,101	Sed. Basin 4-perm pool
18	Reservoir	57.08	1	735	424,051	16	64.96	139,660	Sed. Basin 4-ES
19	SCS Runoff	2.724	1	717	5,178	----	------	------	SCC No. 7
20	SCS Runoff	11.18	1	740	57,244	----	------	------	SCC No. 8 Area
21	Manual	36.78	1	720	88,483	----	------	------	DD No. 64
22	Manual	20.39	1	721	50,079	----	------	------	DD No. 67
23	Combine	64.39	1	720	200,984	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	4.473	1	721	11,302	----	------	------	SCC No. 9 Area
25	Manual	16.96	1	725	58,583	----	------	------	DD No. 3
26	Combine	83.58	1	721	270,870	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	5.176	1	718	10,975	----	------	------	SCC No. 10 Area
28	SCS Runoff	3.967	1	717	7,542	----	------	------	Area to DD No. 4
29	Combine	91.02	1	720	289,387	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	4.607	1	718	9,768	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	9.518	1	723	27,155	----	------	------	SCC No. 1 Area
2	Manual	47.42	1	724	140,488	----	------	------	DD No. 44
3	Manual	27.17	1	723	83,400	----	------	------	DD No. 47
4	Combine	83.90	1	724	251,043	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	3.195	1	718	6,531	----	------	------	SCC No. 2 Area
6	Combine	85.35	1	723	257,573	4, 5	------	------	SCC No. 2
7	Manual	41.98	1	721	108,558	----	------	------	DD No. 52
8	SCS Runoff	5.282	1	723	15,070	----	------	------	SCC No. 3 Area
9	Combine	130.98	1	722	381,202	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	1.748	1	715	3,133	----	------	------	SCC No. 4 Area
11	Combine	131.32	1	722	384,335	9, 10	------	------	SCC No. 4
12	SCS Runoff	2.049	1	717	3,932	----	------	------	SCC No. 6
13	Manual	45.86	1	720	114,144	----	------	------	DD No. 58
14	SCS Runoff	7.831	1	727	26,580	----	------	------	SCC No. 5 Area
15	Combine	53.43	1	720	144,656	12, 13, 14	------	------	SCC No. 5
16	Combine	183.50	1	721	528,991	11, 15	------	------	Pipe No. 400
17	Reservoir	5.335	1	957	401,061	16	63.68	362,330	Sed. Basin 4-perm pool
18	Reservoir	63.13	1	736	528,978	16	65.31	179,288	Sed. Basin 4-ES
19	SCS Runoff	3.366	1	717	6,459	----	------	------	SCC No. 7
20	SCS Runoff	13.99	1	740	71,408	----	------	------	SCC No. 8 Area
21	Manual	45.70	1	720	110,376	----	------	------	DD No. 64
22	Manual	25.38	1	720	62,470	----	------	------	DD No. 67
23	Combine	80.25	1	720	250,715	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	5.566	1	721	14,099	----	------	------	SCC No. 9 Area
25	Manual	21.20	1	725	73,079	----	------	------	DD No. 3
26	Combine	104.21	1	721	337,892	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	6.425	1	718	13,691	----	------	------	SCC No. 10 Area
28	SCS Runoff	4.902	1	717	9,408	----	------	------	Area to DD No. 4
29	Combine	113.54	1	720	360,991	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	5.719	1	718	12,185	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	11.54	1	723	33,013	----	------	------	SCC No. 1 Area
2	Manual	57.50	1	724	170,794	----	------	------	DD No. 44
3	Manual	32.98	1	723	101,391	----	------	------	DD No. 47
4	Combine	101.72	1	723	305,197	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	3.853	1	717	7,940	----	------	------	SCC No. 2 Area
6	Combine	103.58	1	723	313,137	4, 5	------	------	SCC No. 2
7	Manual	50.81	1	721	131,976	----	------	------	DD No. 52
8	SCS Runoff	6.403	1	723	18,321	----	------	------	SCC No. 3 Area
9	Combine	158.89	1	722	463,434	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	2.107	1	715	3,809	----	------	------	SCC No. 4 Area
11	Combine	159.29	1	722	467,244	9, 10	------	------	SCC No. 4
12	SCS Runoff	2.469	1	716	4,780	----	------	------	SCC No. 6
13	Manual	55.53	1	720	138,768	----	------	------	DD No. 58
14	SCS Runoff	9.509	1	727	32,314	----	------	------	SCC No. 5 Area
15	Combine	64.78	1	720	175,862	12, 13, 14	------	------	SCC No. 5
[illegible]	Combine	222.68	1	721	643,104	11, 15	------	------	Pipe No. 400
17	Reservoir	13.43	1	806	510,544	16	64.01	397,259	Sed. Basin 4-perm pool
18	Reservoir	68.02	1	737	643,092	16	65.72	225,187	Sed. Basin 4-ES
19	SCS Runoff	4.057	1	716	7,853	----	------	------	SCC No. 7
20	SCS Runoff	17.03	1	739	86,813	----	------	------	SCC No. 8 Area
21	Manual	55.27	1	720	134,187	----	------	------	DD No. 64
22	Manual	30.73	1	720	75,947	----	------	------	DD No. 67
23	Combine	97.28	1	720	304,798	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	6.737	1	721	17,140	----	------	------	SCC No. 9 Area
25	Manual	25.75	1	725	88,843	----	------	------	DD No. 3
26	Combine	126.46	1	720	410,782	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	7.763	1	718	16,644	----	------	------	SCC No. 10 Area
28	SCS Runoff	5.909	1	716	11,437	----	------	------	Area to DD No. 4
29	Combine	137.74	1	720	438,863	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	6.909	1	718	14,813	----	------	------	SCC No. 13

Hydrograph Summary Report

Hyd.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	SCS Runoff	13.58	1	723	39,005	----	------	------	SCC No. 1 Area
2	Manual	67.68	1	724	201,792	----	------	------	DD No. 44
3	Manual	38.85	1	723	119,793	----	------	------	DD No. 47
4	Combine	119.84	1	723	360,590	1, 2, 3	------	------	SCC No. 1
5	SCS Runoff	4.522	1	717	9,381	----	------	------	SCC No. 2 Area
6	Combine	122.00	1	723	369,970	4, 5	------	------	SCC No. 2
7	Manual	59.73	1	721	155,930	----	------	------	DD No. 52
8	SCS Runoff	7.536	1	723	21,647	----	------	------	SCC No. 3 Area
9	Combine	187.10	1	722	547,547	6, 7, 8	------	------	SCC No. 3
10	SCS Runoff	2.469	1	715	4,500	----	------	------	SCC No. 4 Area
11	Combine	187.57	1	722	552,046	9, 10	------	------	SCC No. 4
12	SCS Runoff	2.896	1	716	5,647	----	------	------	SCC No. 6
13	Manual	65.30	1	720	163,953	----	------	------	DD No. 58
14	SCS Runoff	11.21	1	727	38,179	----	------	------	SCC No. 5 Area
15	Combine	76.25	1	720	207,780	12, 13, 14	------	------	SCC No. 5
16	Combine	262.30	1	721	759,827	11, 15	------	------	Pipe No. 400
17	Reservoir	28.39	1	758	624,547	16	64.32	431,424	Sed. Basin 4-perm pool
18	Reservoir	71.95	1	739	759,812	16	66.15	273,938	Sed. Basin 4-ES
19	SCS Runoff	4.758	1	716	9,278	----	------	------	SCC No. 7
20	SCS Runoff	20.11	1	739	102,569	----	------	------	SCC No. 8 Area
21	Manual	64.92	1	720	158,541	----	------	------	DD No. 64
22	Manual	36.13	1	720	89,731	----	------	------	DD No. 67
23	Combine	114.48	1	720	360,119	19, 20, 21, 22	------	------	SCC No. 8
24	SCS Runoff	7.919	1	721	20,251	----	------	------	SCC No. 9 Area
25	Manual	30.36	1	725	104,968	----	------	------	DD No. 3
26	Combine	149.02	1	720	485,338	23, 24, 25	------	------	SCC No. 9
27	SCS Runoff	9.112	1	718	19,665	----	------	------	SCC No. 10 Area
28	SCS Runoff	6.930	1	716	13,513	----	------	------	Area to DD No. 4
29	Combine	162.19	1	720	518,516	26, 27, 28	------	------	SCC No. 10
30	SCS Runoff	8.109	1	718	17,502	----	------	------	SCC No. 13

f. Sediment Trapping Efficiency (E&S Manual)

RECOMMENDED SURFACE AREA REQUIREMENTS = 0.01 ACRE PER CFS

Q_{25} = 183.50 cfs

Minimum Surface Area = 0.01 acres x Q_{25}

= 1.835 acres

= 79,933 s.f.

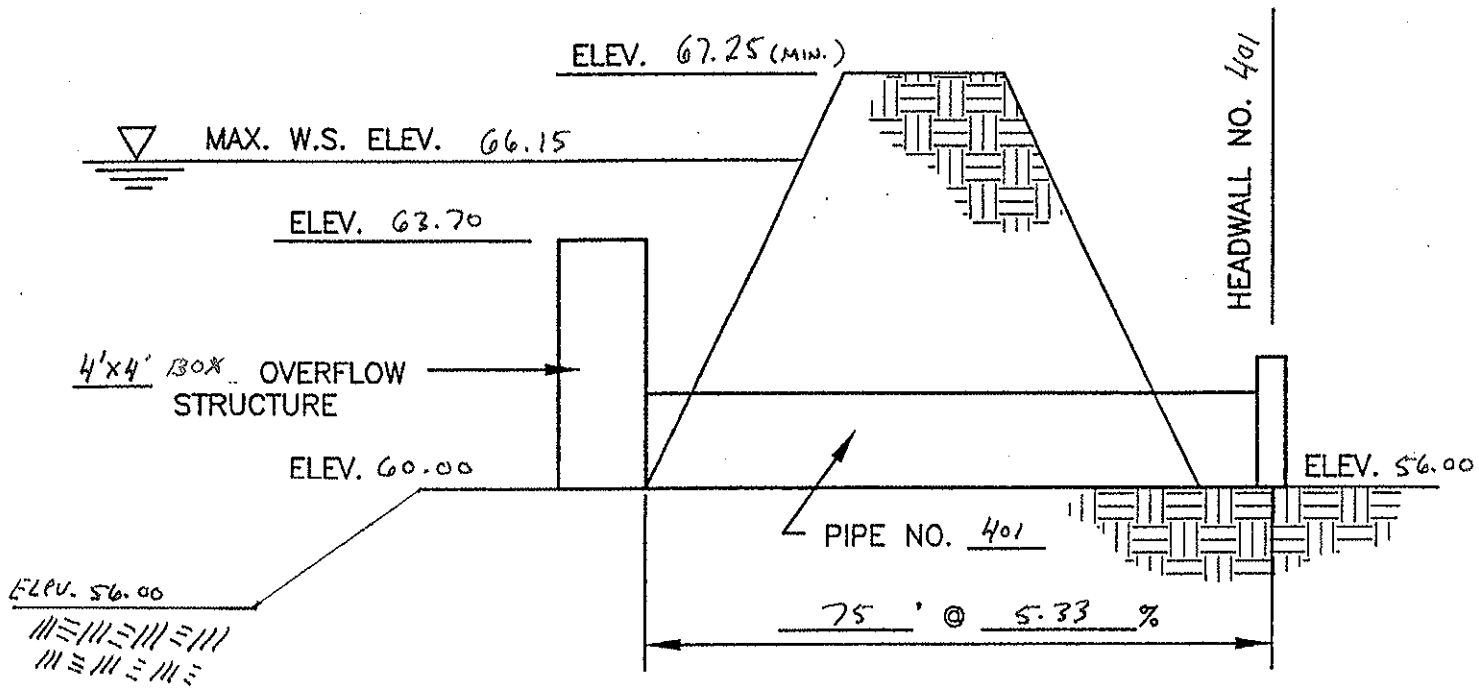
Actual Surface Area At Top of Riser (El. 63.70) =

= 106,351 s.f.

Actual Surface is greater than minimum surface area.

g. Riser Pipe and Carrier Pipe Design

OVERFLOW STRUCTURE NO. 401



DESIGN OF OVERFLOW STRUCTURE AS EMERGENCY SPILLWAY

FLOW (Q) WORST CASE = 100 YEAR STORM EVENT OCCURS WHEN WATER SURFACE ELEVATION AT TOP OF OVERFLOW STRUCTURE AND ALL DEWATERING HOLES ARE PLUGGED

FLOW (Q) MAXIMUM = 72 CFS

HEAD (H) MAXIMUM = MAXIMUM WATER SURFACE ELEVATION FOR WORST CASE FLOW MINUS THE ELEVATION AT THE CREST OF THE OVERFLOW STRUCTURE

= 66.15 − 63.70 = 2.45 FEET

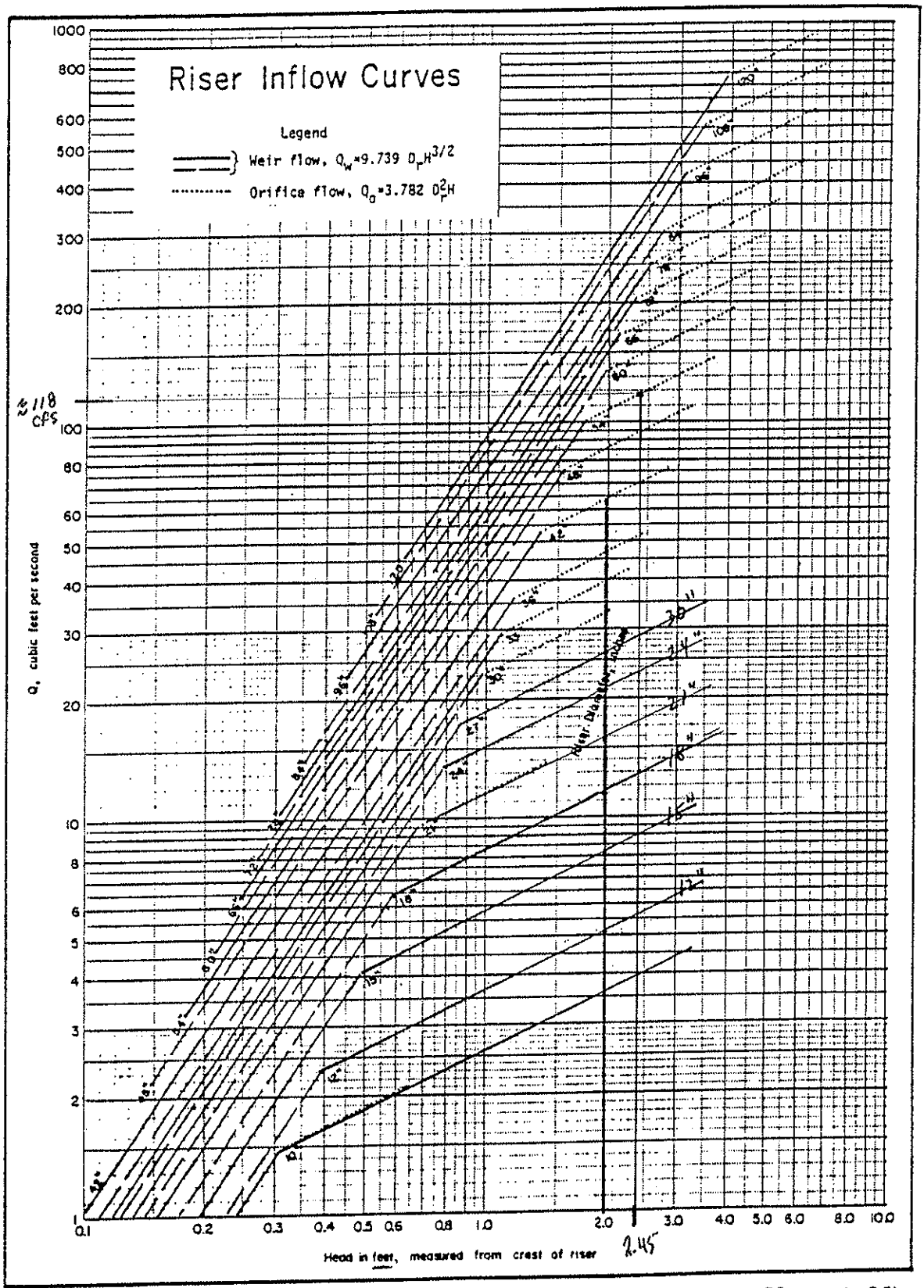
Area 4'x4' = 16 ft²

Equiv. pipe dia. 54" ⇒ 15.9 ft²

BASED ON ABOVE HEAD, USE 4'x4' Box OVERFLOW STRUCTURE

(SEE CHART ON NEXT PAGE)

Entrance to Downdrain & standpipes



Source: USDA-SCS

Plate 1.26h

FIGURE A-10

CARRIER PIPE NO. 401

Q = 72 CFS worst case

Maximum headwater = Top of levee elevation minus 1' freeboard
= 67.25 − 1.00 = 66.25

Head (H) = maximum water elevation allowed minus the centerline elevation at the downstream end of the carrier pipe
= 66.25 − 57.50 = 8.75

Length (L) = 75'

Length Factor = 0.99 for lengths other than 70'

Q (available) = Q from table times length factor
= 114 X 0.99 = 112 CFS

Q (available) must be greater than Q worst case

USE 36 " DIAMETER RCP CARRIER PIPE

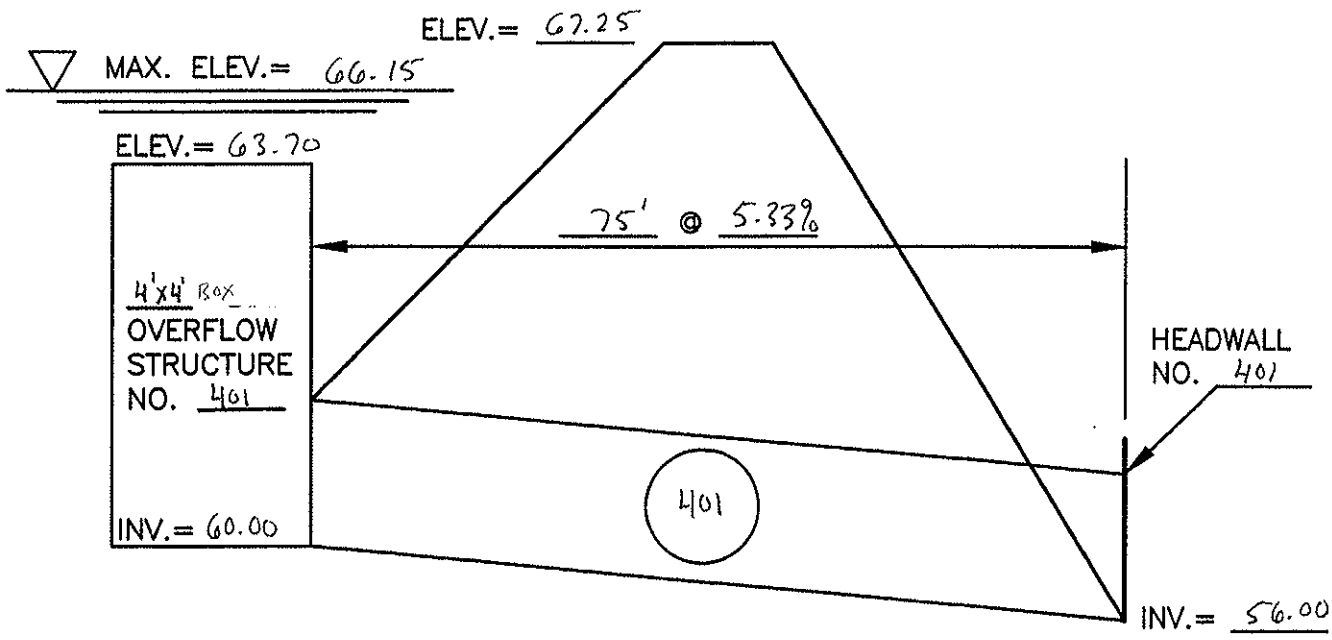


Table 6-25

PIPE FLOW CHART n = 0.025

FOR CORRUGATED METAL PIPE INLET $K_a = K_e + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

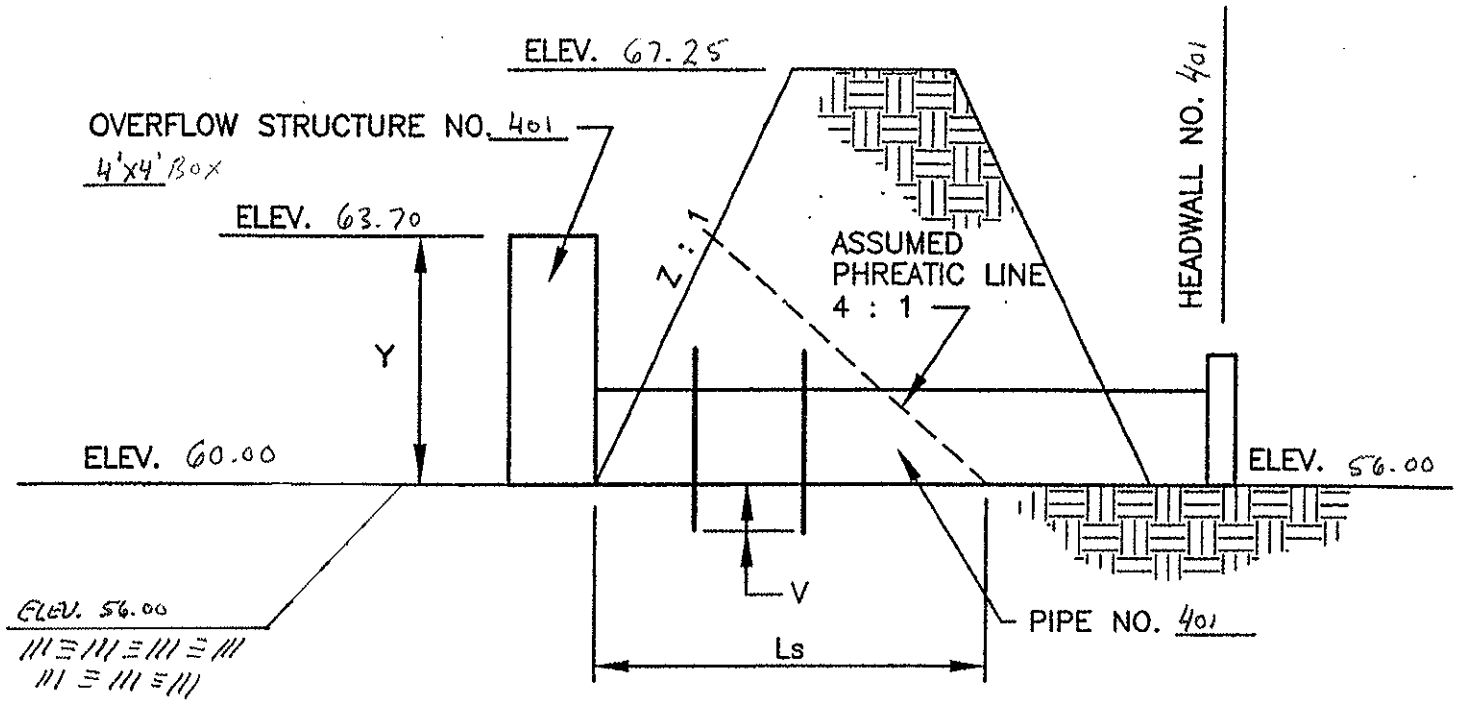
Note correction factors for pipe lengths other than 70 feet

H, in feet	diameter of pipe in inches																	
	12"	15"	18"	21"	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"	102"
1	3.22	5.44	8.29	11.8	15.9	26.0	38.6	53.8	71.4	91.5	114	139	167	197	229	264	302	342
2	4.55	7.69	11.7	16.7	22.5	36.8	54.6	76.0	101	129	161	197	236	278	324	374	427	483
3	5.57	9.42	14.4	20.4	27.5	45.0	66.9	93.1	124	159	198	241	289	341	397	458	523	592
4	6.43	10.9	16.6	23.5	31.8	52.0	77.3	108	143	183	228	278	334	394	459	529	604	683
5	7.19	12.2	18.5	26.3	35.5	58.1	86.4	120	160	205	255	311	373	440	513	591	675	764
6	7.88	13.3	20.3	28.8	38.9	67.7	94.6	132	175	224	280	341	409	482	562	647	739	837
7	8.51	14.4	21.9	31.1	42.0	68.8	102	142	189	242	302	368	441	521	607	699	798	904
8	9.10	15.4	23.5	33.3	44.9	73.5	109	152	202	259	323	394	472	557	685	748	854	966
9	9.65	16.3	24.9	35.3	47.7	78.0	116	161	214	275	342	418	500	590	688	793	905	1025
10	10.2	17.2	26.2	37.2	50.2	82.2	122	170	226	289	361	440	527	622	725	836	954	1080
11	10.7	18.0	27.5	39.0	52.7	86.2	128	178	237	304	379	462	553	653	761	877	1001	1133
12	11.1	18.9	28.7	40.8	55.0	90.1	134	186	247	317	395	482	578	682	794	916	1045	1184
13	11.6	19.6	29.9	42.4	57.3	93.7	139	194	257	330	411	502	601	710	827	953	1088	1232
14	12.0	20.4	31.0	44.1	59.4	97.3	145	201	267	342	427	521	624	738	858	989	1129	1278
15	12.5	21.1	32.1	45.6	61.5	101	150	208	277	354	442	539	646	762	888	1024	1169	1323
16	12.9	21.8	33.2	47.1	63.5	104	155	215	286	366	457	557	667	787	917	1057	1207	1367
17	13.3	22.4	34.2	48.5	65.5	107	159	222	294	377	471	574	688	812	946	1090	1244	1409
18	13.7	23.1	35.2	49.9	67.4	110	164	228	303	388	484	591	708	835	973	1121	1280	1450
19	14.0	23.8	36.1	51.3	69.2	113	168	234	311	399	497	607	727	858	1000	1152	1315	1489
20	14.4	24.3	37.1	52.6	71.0	116	173	240	319	409	510	623	746	880	1026	1182	1350	1528
21	14.7	24.9	38.0	53.9	72.8	119	177	246	327	419	523	638	764	902	1051	1211	1383	1566
22	15.1	25.5	38.9	55.2	74.5	122	181	252	335	429	535	653	782	923	1076	1240	1415	1603
23	15.4	26.1	39.8	56.5	76.2	125	186	258	342	439	547	668	800	944	1100	1268	1447	1639
24	15.8	26.7	40.6	57.7	77.8	127	189	263	350	448	559	682	817	964	1123	1295	1478	1674
25	16.1	27.2	41.5	58.9	79.4	130	193	269	357	458	571	696	834	984	1147	1322	1509	1708
26	16.4	27.7	42.3	60.0	81.0	133	197	274	364	467	582	710	850	1004	1169	1348	1539	1742
27	16.7	28.3	43.1	61.2	82.5	135	201	279	371	476	593	723	867	1023	1192	1373	1568	1775
28	17.0	28.8	43.9	62.3	84.1	138	204	285	378	484	604	737	883	1041	1214	1399	1597	1808
29	17.3	29.3	44.7	63.4	85.5	140	208	290	384	493	615	750	898	1060	1235	1423	1625	1840
30	17.6	29.8	45.4	64.5	87.0	142	212	294	391	501	625	763	913	1078	1256	1448	1653	1871
L in feet	Correction Factors For Other Pipe Lengths																	
20	1.30	1.24	1.21	1.18	1.15	1.12	1.10	1.08	1.07	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.03
30	1.22	1.18	1.15	1.13	1.12	1.09	1.08	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02
40	1.15	1.13	1.11	1.10	1.08	1.07	1.05	1.05	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02
50	1.09	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01
60	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	.96	.97	.97	.97	.98	.98	.98	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99
90	.93	.94	.94	.95	.95	.96	.97	.97	.98	.98	.98	.98	.98	.99	.99	.99	.99	.99
100	.90	.91	.92	.93	.93	.95	.95	.96	.97	.97	.97	.98	.98	.98	.98	.98	.98	.99
120	.84	.86	.87	.89	.90	.91	.93	.94	.94	.95	.96	.96	.96	.97	.97	.97	.97	.98
140	.80	.82	.83	.85	.86	.88	.90	.91	.92	.93	.94	.94	.95	.95	.96	.96	.96	.97
160	.76	.78	.80	.82	.83	.86	.88	.89	.90	.91	.92	.93	.94	.94	.95	.95	.95	.96

Source: USDA - SCS

h. Anti-Seep Collar Design

ANTI – SEEP COLLAR DESIGN



Ls = LENGTH IN SATURATION ZONE

Y = OVERFLOW STRUCTURE HEIGHT = 3.70' FEET

Z = INSIDE SLOPE OF LEVEE = 3

PIPE SLOPE = 5.33 % = 0.0533 FEET/FEET

$$Ls = Y (Z + 4) \left(1 + \frac{\text{PIPE SLOPE}}{0.25 - \text{PIPE SLOPE}} \right)$$

Ls = 33 FEET

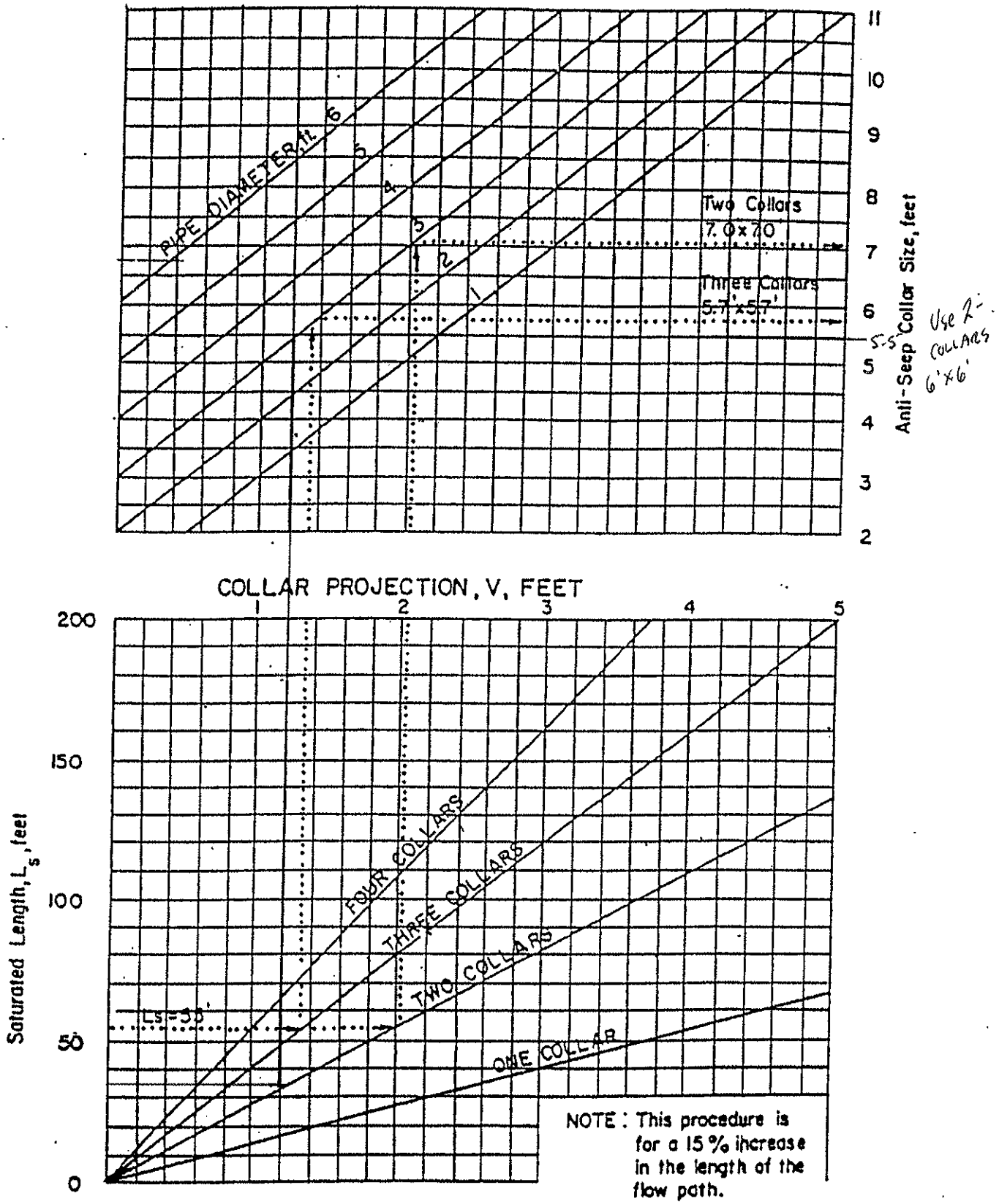
FROM ANTI – SEEP COLLAR DESIGN CHART ON THE NEXT PAGE :

V = COLLAR PROJECTION = 1.2 FEET

DIMENSIONS OF 12" THICK COLLAR = 6.0' x 6.0'

NUMBER OF REQUIRED COLLARS = 2

ANTI-SEEP COLLAR DESIGN



i. Riser Base Foundation Design

RISER BASE FOUNDATION DESIGN

A certain volume of concrete will be used to overcome the buoyancy of an empty overflow structure and carrier pipe that are below the assumed phreatic water surface. This volume is equal to:

4' x 4' Box Overflow Structure
= (L)(W)(h)(62.4)
= (4.83)(4.83)(3.70)(62.4)

= 5,386 #

L = W = 4' inside = 4.83' outside
h = height = 3.7'
R_2 = outside radius = 22" = 1.83'
r_2 = inside radius = 18" = 1.50'
Ls= length in saturation zone = 33'

36" Carrier Pipe

$= 3.1416(R_2^2)(Ls)(62.4)$

$= 3.1416(1.83)(1.83)(33)(62.4)$

= 21,665 #

TOTAL WEIGHT
= 27,051 # x 1.2 (SAFETY FACTOR)

= 32,461 #

TOTAL REVISED VOLUME OF CONCRETE =
TOTAL WEIGHT / WEIGHT OF CONC. IN WATER

= 32,461 /87.6 pcf (87.6 pcf = Wt. of conc. in submerged water)

= 371 C.F.

This volume of concrete will be made up from six areas.

1. Overflow Structures
2. Anti-Seep Collars
3. Carrier Pipe
4. Overflow Structure Base
5. Carrier Pipe Encasement
6. Weight of Saturated Soil Directly Above Carrier Pipe

1. Overflow Structure

$= (L^2 - l^2)\,h$ — L = outside dimension of box = 4.83'; l = inside dimension of box = 4'

$= (4.83^2 - 4.0^2)(3.70)$ — h = height = 3.70'

$= \underline{27}$ C.F.

2. Anti-seep collars = area of square collar around carrier pipe x 12" thick x # of collars

$= [(\underline{6.0'} \times \underline{6.0'}) - (3.1416)(R_2^2)]$ — R_2 = outside radius of carrier pipe = 22" = 1.83'

x 1' x 2

$= \underline{51}$ C.F.

3. Carrier Pipe

$= 3.1416(R_2^2 - r_2^2)\,Ls$ — R_2 = outside radius = 22" = 1.83'; r_2 = inside radius = 18" = 1.5'

$= \underline{114}$ C.F. — Ls = length of carrier pipe in saturation zone = 33'

4. Overflow Structure Base = Volume to handle riser bouyance x 1.2

= (L)(W)h(62.4)(1.2)/weight of conc. in water — L = W = 4.83' outside; h = height = 3.70'

$= (4.83)(4.83)(3.70)(62.4)(1.2)/87.6$

$= \underline{74}$ C.F.

Use 8.5' x 9.0' x 1 = 76 C.F.

5. Carrier Pipe Encasement

Must extend 5' into dam. The distance from the overflow structure to the dam is equal to 11 feet. Therefore, encasement length will be 16 feet.

Use 3.7' x 5.0' x 16' long

Carrier Pipe Encasement Volume = 127 C.F.

6. Weight of Saturated Soil in the Length of Saturation =

   a. Weight of Soil = 100 lbs/c.f.
   b. Weight of Saturated Soil = 100 lbs/c.f. – 62.4 lbs/c.f. = 37 lbs/c.f.
   c. Volume of Soil in Length of Saturation over Carrier Pipe = 0.27 s.f. x 3.66 ft. = 1.0 c.f.
   d. 1.0 c.f. x 37 lbs/c.f. = 37 lbs.
   e. 37 lbs. ÷ 87.6 lbs/c.f. = 0.42 c.f. (equivalent of submerged concrete)

TOTAL REQUIRED VOLUME = 371 C.F.

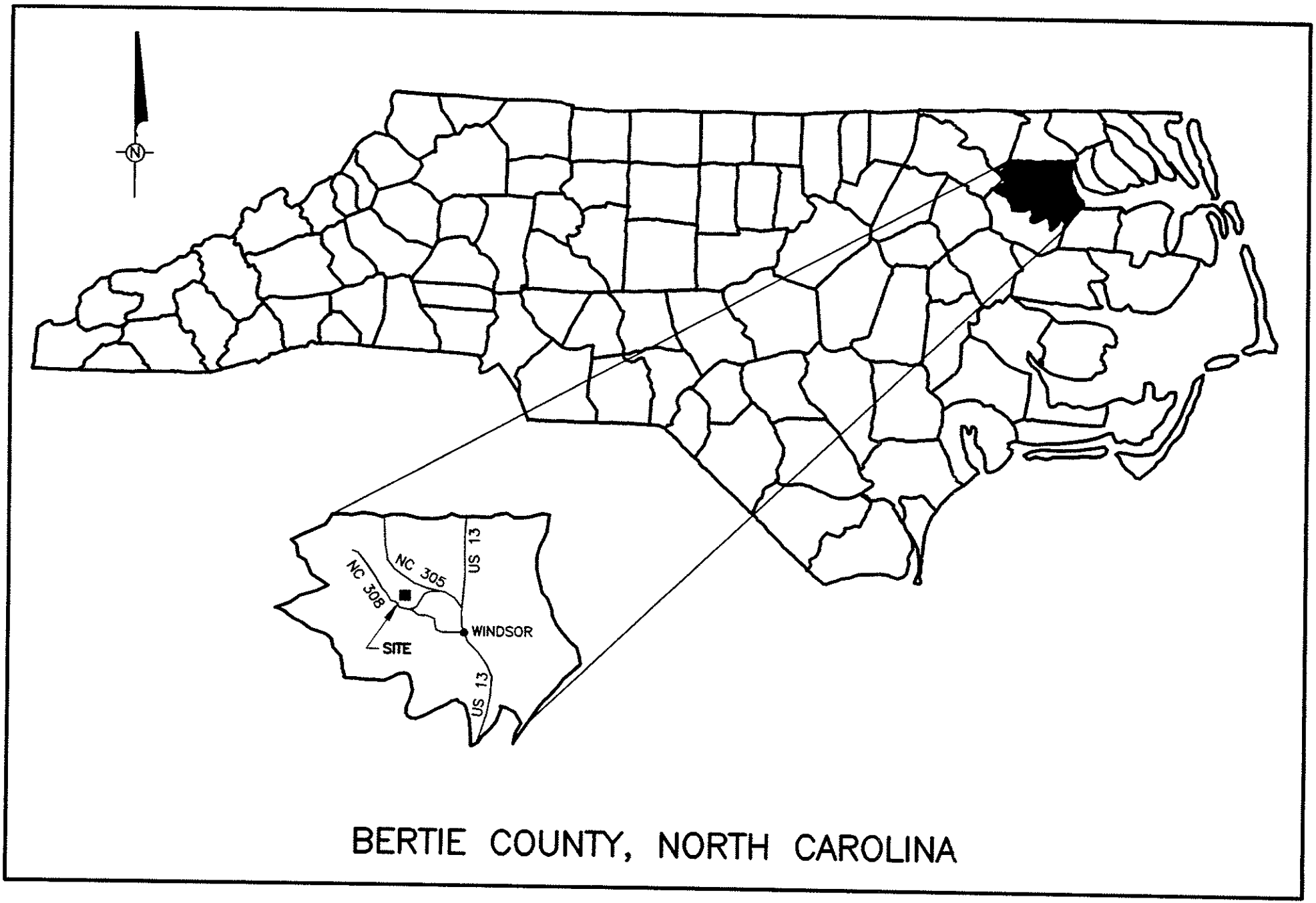
Actual Total Volume

Overflow Structure	=	27 C.F.
Anti-Seep Collars	=	51 C.F.
Carrier Pipe	=	114 C.F.
Overflow Structure Base	=	76 C.F.
Carrier Pipe Encasement	=	127 C.F.
Weight Saturated Soil	=	0 C.F.

TOTAL ACTUAL VOLUME = 395 C.F.

5. APPENDIX

a. Location Map



BERTIE COUNTY, NORTH CAROLINA

VII. LEACHATE DESIGN CALCULATIONS

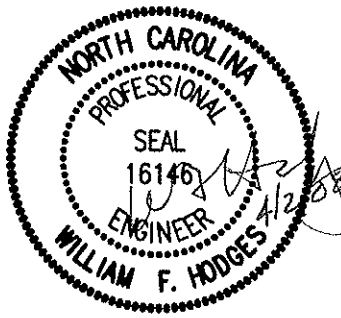
LEACHATE CALCULATIONS

EAST CAROLINA REGIONAL MSW LANDFILL – PHASE 5
BERTIE COUNTY, NORTH CAROLINA

FOR

REPUBLIC SERVICES OF NORTH CAROLINA, LLC
dba
EAST CAROLINA ENVIRONMENTAL

APRIL 2008



HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
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TEL: (478) 743-7175 **FAX: (478) 743-1703**

LEACHATE CALCULATIONS

EAST CAROLINA REGIONAL MSW LANDFILL – PHASE 5
BERTIE COUNTY, NORTH CAROLINA

FOR

REPUBLIC SERVICES OF NORTH CAROLINA, LLC
dba
EAST CAROLINA ENVIRONMENTAL

APRIL 2008

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1.1 Leachate Flow Calculations

LEACHATE FLOW ESTIMATES

EAST CAROLINA REGIONAL MSW LANDFILL - PHASE 5 – (CELLS No. 13 and 14) Leachate flow estimates were made utilizing the Hydraulic Evaluation of Landfill Performance, HELP, program developed by the U.S. Army Corps of Engineers.

In addition to using the HELP Program, a review of the historical leachate production rates for the site was conducted. The historical data included leachate storage tank levels, leachate pumping rates, leachate recirculation rates, leachate disposal rates, on-site precipitation, and estimates of evaporation. Based on this data, this site produces leachate at a rate ranging between 3,356 to 6,787cf/acre per year, or (25,105 to 50,767 gal/acre per year). The average leachate production rate at this site, based on historical data, is approximately 4,782 cf/acre per year, or (35,769 gal/acre per year). This data was used to influence the assumptions and input parameters in the HELP Model. Below is a list of assumptions and input parameters used in the HELP Model:

- Synthetically generated precipitation, temperature, evapotranspiration, and solar radiation data was based on coefficients for Raleigh, North Carolina.
- A design storm, 25 yr., 24 hr. for Bertie County, North Carolina – (6.80 inches) was input into the synthetically generated precipitation data.
- Evaporative zone depth = 22.0 in., for fair condition with clayey soil.
- Maximum leaf index area = 3.5, good stand of grass. Although vegetative cover of the landfill area will vary as landfill construction progresses, a good stand of grass was used in the calculations to replicate the historical leachate generation rates measured at the facility.
- Growing season, average wind speed, and relative humidity was based on Raleigh, North Carolina.
- Intermediate cover – material texture was chosen based on USCS soil classification and hydraulic conductivity of representative on-site soils. The subsurface at East Carolina Regional MSW Landfill consist of four distinguishable hydraulic units. The uppermost unit consists of silty clay, the second unit consists of silty sand, the third unit consists of sandy fat clay, and the fourth unit consists mainly of silty sand. The hydraulic conductivity of these soils range from 9.0×10^{-4} cm/sec to 3.7×10^{-8} cm/sec. Soil texture number 25 with a hydraulic conductivity of 3.6×10^{-6} cm/sec and a USCS classification of CL was chosen from a list of default soils provided by HELP. This soil was chosen based upon the predetermined on-site hydraulic conductivities and the availability of on-site clay.
- Run-off is calculated by HELP using the Curve Number method. The curve number was calculated by HELP using soil texture of the intermediate cover, vegetative cover condition of the top layer, a slope surface, and slope length. A good stand of grass, 5% slope and a slope length of 200 feet was chosen.
- Maximum leachate drainage length is 90 feet.

Using these assumptions, the HELP Model simulation predicted leachate volumes slightly larger than actual site production.

Climate information was based on the Raleigh, North Carolina numbers listed in the HELP Model and modified by synthetically generating data using weather information for Raleigh, North Carolina from the National Oceanic and Atmospheric Administration Publication entitled Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days.

Calculations were completed for the differing conditions in Cells No. 13 and 14. The results were evaluated to determine the worst case leachate flow volumes and worst case head on the liner. The calculations include a 24 hour, 25-year storm event.

Based on the HELP Model evaluations, the total leachate production for the site was estimated. The worst case condition occurs when 116.45 acres of landfill footprint has an average waste height of 45 feet with intermediate cover in place over the waste.

Based on these HELP Model runs, the peak daily head on the liner does not exceed 12" and the maximum monthly average leachate flow equals 362,636 gallons. This corresponds to 4,995 cubic feet per acre per year, which is higher than actual site production rates and correlates closely to the historical records (3,356 to 6,787 c.f./Ac/yr.) The maximum daily leachate flow at the facility equals 41,944 gallons. These values are conservative estimates which may be reduced through effective stormwater management practices.

Run No. (Output Data File)	Description	Avg. Monthly Flow (gal)	Peak Daily Flow (gal)	Avg. Annual Head on Liner (in.)	Peak Daily Head (in.)
EC-15	East Carolina Phase 5 – One Lift 15' Waste	195,112	25,181	1.61	7.88
EC-45	East Carolina Phase 5 – Four Lifts 45' Waste	362,636	41,944	2.97	11.59
EC-100	East Carolina Phase 5 – 100' Waste	362,636	41,860	2.97	11.57
EC-100C	East Carolina Phase 5 – 130' Waste Capped	0.65	0.07	0.00	0.00

Based on the worst case scenario, the two (2) existing leachate storage tanks with a combined capacity of ± 412,000 gallons will provide approximately 34 days of storage capacity.

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**               FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                **
**                                                                              **
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PRECIPITATION DATA FILE:     C:\HELPmode\TEMP\EC-15.D4
TEMPERATURE DATA FILE:       C:\HELPmode\TEMP\EC-15.D7
SOLAR RADIATION DATA FILE:   C:\HELPmode\TEMP\EC-15.D13
EVAPOTRANSPIRATION DATA:     C:\HELPmode\TEMP\EC-15.D11
SOIL AND DESIGN DATA FILE:   C:\HELPmode\TEMP\EC-15.D10
OUTPUT DATA FILE:            C:\HELPMODE\TEMP\EC-15.OUT


TIME:   9: 1     DATE:   3/11/2008


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     TITLE:  EAST CAROLINA PHASE 5 ONE LIFT 15' WASTE

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


                                  LAYER  1
                                  --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  25
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.3730 VOL/VOL
          WILTING POINT                =      0.2660 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3672 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.359999990000E-05 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    180.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2878 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                                  LAYER  3
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                TYPE 2 - LATERAL DRAINAGE LAYER
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MATERIAL TEXTURE NUMBER 5

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1465	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	90.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	8.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

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

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #25 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 300. FEET.

SCS RUNOFF CURVE NUMBER	=	96.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.579	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.954	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.962	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	69.983	INCHES
TOTAL INITIAL WATER	=	69.983	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	86	
END OF GROWING SEASON (JULIAN DATE)	=	310	

EVAPORATIVE ZONE DEPTH = 22.0 INCHES
AVERAGE ANNUAL WIND SPEED = 7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.55	3.43	3.69	2.91	3.67	3.66
4.38	4.44	3.29	2.73	2.87	3.14

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.60	41.60	49.30	59.50	67.20	73.90
77.70	77.00	71.00	59.70	50.00	42.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.47	3.08	4.00	2.56	4.09	3.80
	4.25	5.33	2.64	2.79	2.67	2.96
STD. DEVIATIONS	1.87	1.31	1.47	1.40	1.99	1.91
	1.99	3.59	1.69	2.01	1.62	1.49
RUNOFF						
TOTALS	1.710	1.230	1.643	0.871	1.773	1.506
	1.685	2.653	1.203	1.190	1.198	1.235
STD. DEVIATIONS	1.418	0.883	0.981	0.710	1.449	1.099
	1.230	2.574	1.033	1.286	1.010	0.987
EVAPOTRANSPIRATION						
TOTALS	1.104	1.468	2.497	2.196	3.405	2.904
	2.591	2.546	1.445	1.078	1.007	0.818
STD. DEVIATIONS	0.214	0.245	0.353	0.805	0.746	0.965
	0.939	0.970	0.730	0.441	0.177	0.152
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0473	0.0438	0.0590	0.0723	0.0785	0.0741
	0.0729	0.0684	0.0617	0.0592	0.0530	0.0505
STD. DEVIATIONS	0.0305	0.0311	0.0399	0.0573	0.0613	0.0559
	0.0533	0.0487	0.0428	0.0401	0.0351	0.0327
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0002	0.0002	0.0002	0.0002	0.0003	0.0003

	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002
	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	1.2109	1.2292	1.5108	1.9082	2.0052	1.9598
	1.8659	1.7512	1.6327	1.5154	1.4020	1.2936
STD. DEVIATIONS	0.7810	0.8737	1.0219	1.5044	1.5583	1.4744
	1.3639	1.2463	1.1339	1.0280	0.9296	0.8386

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	41.65	(7.508)	151171.4	100.00
RUNOFF	17.898	(5.2610)	64968.25	42.977
EVAPOTRANSPIRATION	23.058	(2.5370)	83700.29	55.368
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.74049	(0.49852)	2687.974	1.77810
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00259	(0.00159)	9.414	0.00623
AVERAGE HEAD ON TOP OF LAYER 4	1.607	(1.079)		
CHANGE IN WATER STORAGE	-0.054	(1.0140)	-194.56	-0.129

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	6.80	24684.000
RUNOFF	6.305	22885.9004
DRAINAGE COLLECTED FROM LAYER 3	0.00796	28.90918
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000025	0.09039
AVERAGE HEAD ON TOP OF LAYER 4	6.208	
MAXIMUM HEAD ON TOP OF LAYER 4	7.878	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	33.9 FEET	
SNOW WATER	1.99	7221.5942

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3687
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1801

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.9137	0.3261
2	50.7422	0.2819
3	3.4714	0.1446
4	0.0000	0.0000
5	10.2480	0.4270
SNOW WATER	0.000	

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**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                    DEVELOPED BY ENVIRONMENTAL LABORATORY                     **
**                      USAE WATERWAYS EXPERIMENT STATION                       **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
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PRECIPITATION DATA FILE:     C:\HELPmode\TEMP\EC.D4
TEMPERATURE DATA FILE:       C:\HELPmode\TEMP\EC.D7
SOLAR RADIATION DATA FILE:   C:\HELPmode\TEMP\EC.D13
EVAPOTRANSPIRATION DATA:     C:\HELPmode\TEMP\EC.D11
SOIL AND DESIGN DATA FILE:   C:\HELPmode\TEMP\EC-45.D10
OUTPUT DATA FILE:            C:\HELPMODE\TEMP\EC-45.OUT


TIME:   8:53     DATE:   3/11/2008


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     TITLE:  EAST CAROLINA PHASE 5, FOUR LIFTS 45' WASTE

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


                                  LAYER  1
                                  --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  25
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.3730 VOL/VOL
          WILTING POINT                =      0.2660 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3654 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.359999990000E-05 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.



                                  LAYER  2
                                  --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    540.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2914 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC



                                  LAYER  3
                                  --------

                TYPE 2 - LATERAL DRAINAGE LAYER
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MATERIAL TEXTURE NUMBER 5

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1516	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	90.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	8.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

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

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #25 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 300. FEET.

SCS RUNOFF CURVE NUMBER	=	96.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.989	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.954	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.962	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	175.636	INCHES
TOTAL INITIAL WATER	=	175.636	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	86	
END OF GROWING SEASON (JULIAN DATE)	=	310	

EVAPORATIVE ZONE DEPTH = 22.0 INCHES
AVERAGE ANNUAL WIND SPEED = 7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.55	3.43	3.69	2.91	3.67	3.66
4.38	4.44	3.29	2.73	2.87	3.14

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.60	41.60	49.30	59.50	67.20	73.90
77.70	77.00	71.00	59.70	50.00	42.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.47	3.08	4.00	2.56	4.09	3.80
	4.25	5.33	2.64	2.79	2.67	2.96
STD. DEVIATIONS	1.87	1.31	1.47	1.40	1.99	1.91
	1.99	3.59	1.69	2.01	1.62	1.49
RUNOFF						
TOTALS	1.649	1.166	1.532	0.773	1.538	1.323
	1.504	2.416	1.044	1.097	1.132	1.192
STD. DEVIATIONS	1.367	0.842	0.929	0.648	1.316	0.999
	1.146	2.467	0.915	1.222	0.968	0.955
EVAPOTRANSPIRATION						
TOTALS	1.047	1.449	2.487	2.350	4.246	2.485
	2.785	2.735	1.660	1.071	0.906	0.727
STD. DEVIATIONS	0.249	0.247	0.345	0.788	0.799	1.031
	1.003	1.023	0.815	0.404	0.154	0.164
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0816	0.0816	0.1176	0.1445	0.1533	0.1411
	0.1357	0.1249	0.1109	0.1049	0.0927	0.0875
STD. DEVIATIONS	0.0394	0.0438	0.0586	0.0825	0.0878	0.0769
	0.0706	0.0625	0.0537	0.0494	0.0426	0.0393
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0003	0.0003	0.0004	0.0005	0.0005	0.0005

	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003
STD. DEVIATIONS	0.0001	0.0001	0.0002	0.0002	0.0003	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	2.0902	2.2911	2.9996	3.7690	3.8641	3.6913
	3.4487	3.1845	2.9280	2.6833	2.4535	2.2423
STD. DEVIATIONS	1.0094	1.2210	1.4790	2.0697	2.1199	1.9443
	1.7536	1.5709	1.4067	1.2586	1.1249	1.0072

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	41.65	(7.508)	151171.4	100.00
RUNOFF	16.364	(5.0107)	59401.60	39.294
EVAPOTRANSPIRATION	23.949	(2.6270)	86936.37	57.508
LATERAL DRAINAGE COLLECTED FROM LAYER 3	1.37627	(0.66436)	4995.870	3.30477
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00458	(0.00200)	16.625	0.01100
AVERAGE HEAD ON TOP OF LAYER 4	2.970	(1.406)		
CHANGE IN WATER STORAGE	-0.049	(1.0587)	-179.10	-0.118

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	6.80	24684.000
RUNOFF	6.113	22189.7891
DRAINAGE COLLECTED FROM LAYER 3	0.01327	48.15352
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000037	0.13573
AVERAGE HEAD ON TOP OF LAYER 4	9.616	
MAXIMUM HEAD ON TOP OF LAYER 4	11.587	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	40.5 FEET	
SNOW WATER	1.99	7221.5942

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3685
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1801

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	4.1179	0.3432
2	155.9595	0.2888
3	3.8303	0.1596
4	0.0000	0.0000
5	10.2480	0.4270
SNOW WATER	0.000	

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**                                                                  **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**                  USAE WATERWAYS EXPERIMENT STATION               **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY       **
**                                                                  **
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PRECIPITATION DATA FILE:     C:\HELPmode\TEMP\EC.D4
TEMPERATURE DATA FILE:       C:\HELPmode\TEMP\EC.D7
SOLAR RADIATION DATA FILE:   C:\HELPmode\TEMP\EC.D13
EVAPOTRANSPIRATION DATA:     C:\HELPmode\TEMP\EC.D11
SOIL AND DESIGN DATA FILE:   C:\HELPmode\TEMP\EC-100.D10
OUTPUT DATA FILE:            C:\HELPMODE\TEMP\EC-100.OUT


TIME:   9: 5     DATE:   3/11/2008


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     TITLE:  EAST CAROLINA PHASE 5, 100' WASTE

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


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  25
          THICKNESS                    =     12.00   INCHES
          POROSITY                     =      0.4370 VOL/VOL
          FIELD CAPACITY               =      0.3730 VOL/VOL
          WILTING POINT                =      0.2660 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3654 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.359999990000E-05 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =   1200.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2917 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                                LAYER  3
                                --------

                TYPE 2 - LATERAL DRAINAGE LAYER
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MATERIAL TEXTURE NUMBER 5

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1516	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	90.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	8.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

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

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #25 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	96.90	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.989	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.954	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.962	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	368.356	INCHES
TOTAL INITIAL WATER	=	368.356	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310

EVAPORATIVE ZONE DEPTH = 22.0 INCHES
AVERAGE ANNUAL WIND SPEED = 7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.55	3.43	3.69	2.91	3.67	3.66
4.38	4.44	3.29	2.73	2.87	3.14

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.60	41.60	49.30	59.50	67.20	73.90
77.70	77.00	71.00	59.70	50.00	42.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.47	3.08	4.00	2.56	4.09	3.80
	4.25	5.33	2.64	2.79	2.67	2.96
STD. DEVIATIONS	1.87	1.31	1.47	1.40	1.99	1.91
	1.99	3.59	1.69	2.01	1.62	1.49
RUNOFF						
TOTALS	1.649	1.166	1.532	0.773	1.538	1.323
	1.504	2.416	1.044	1.097	1.132	1.192
STD. DEVIATIONS	1.367	0.842	0.929	0.648	1.316	0.999
	1.146	2.467	0.915	1.222	0.968	0.955
EVAPOTRANSPIRATION						
TOTALS	1.047	1.449	2.487	2.350	4.246	2.485
	2.785	2.735	1.660	1.071	0.906	0.727
STD. DEVIATIONS	0.249	0.247	0.345	0.788	0.799	1.031
	1.003	1.023	0.815	0.404	0.154	0.164
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0816	0.0816	0.1172	0.1443	0.1534	0.1412
	0.1358	0.1250	0.1110	0.1049	0.0928	0.0876
STD. DEVIATIONS	0.0395	0.0437	0.0584	0.0817	0.0880	0.0771
	0.0708	0.0627	0.0539	0.0495	0.0427	0.0394
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0003	0.0003	0.0004	0.0005	0.0005	0.0005

	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003
STD. DEVIATIONS	0.0001	0.0001	0.0002	0.0002	0.0003	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	2.0911	2.2893	2.9908	3.7631	3.8663	3.6938
	3.4510	3.1866	2.9299	2.6850	2.4551	2.2436
STD. DEVIATIONS	1.0111	1.2193	1.4732	2.0533	2.1234	1.9486
	1.7576	1.5745	1.4101	1.2615	1.1276	1.0096

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	41.65	(7.508)	151171.4	100.00
RUNOFF	16.364	(5.0107)	59401.60	39.294
EVAPOTRANSPIRATION	23.949	(2.6270)	86936.37	57.508
LATERAL DRAINAGE COLLECTED FROM LAYER 3	1.37627	(0.66405)	4995.864	3.30477
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00458	(0.00199)	16.625	0.01100
AVERAGE HEAD ON TOP OF LAYER 4	2.970	(1.406)		
CHANGE IN WATER STORAGE	-0.049	(1.0585)	-179.10	-0.118

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	6.80	24684.000
RUNOFF	6.113	22189.7891
DRAINAGE COLLECTED FROM LAYER 3	0.01324	48.05742
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000037	0.13553
AVERAGE HEAD ON TOP OF LAYER 4	9.601	
MAXIMUM HEAD ON TOP OF LAYER 4	11.570	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	40.5 FEET	
SNOW WATER	1.99	7221.5942

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3685
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1801

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	4.1179	0.3432
2	348.6795	0.2906
3	3.8303	0.1596
4	0.0000	0.0000
5	10.2480	0.4270
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE        **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)        **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY          **
**                     USAE WATERWAYS EXPERIMENT STATION            **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY      **
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PRECIPITATION DATA FILE:     C:\HELPmode\TEMP\EC.D4
TEMPERATURE DATA FILE:       C:\HELPmode\TEMP\EC.D7
SOLAR RADIATION DATA FILE:   C:\HELPmode\TEMP\EC.D13
EVAPOTRANSPIRATION DATA:     C:\HELPmode\TEMP\EC.D11
SOIL AND DESIGN DATA FILE:   C:\HELPmode\TEMP\EC-100C.D10
OUTPUT DATA FILE:            C:\HELPMODE\TEMP\EC-100C.OUT


TIME:   8:50     DATE:   3/13/2008


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     TITLE:  EAST CAROLINA PHASE 5, 130' WASTE CAPPED

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


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  25
          THICKNESS                     =      24.00   INCHES
          POROSITY                      =       0.4370 VOL/VOL
          FIELD CAPACITY                =       0.3730 VOL/VOL
          WILTING POINT                 =       0.2660 VOL/VOL
          INITIAL SOIL WATER CONTENT    =       0.3948 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =  0.359999990000E-05 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                  FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------

                  TYPE 2 - LATERAL DRAINAGE LAYER
                      MATERIAL TEXTURE NUMBER  20
          THICKNESS                     =       0.20   INCHES
          POROSITY                      =       0.8500 VOL/VOL
          FIELD CAPACITY                =       0.0100 VOL/VOL
          WILTING POINT                 =       0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT    =       0.0100 VOL/VOL
          EFFECTIVE SAT. HYD. COND.     =   10.0000000000     CM/SEC
          SLOPE                         =      25.00   PERCENT
          DRAINAGE LENGTH               =      80.0    FEET


                                LAYER  3
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TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

THICKNESS	=	0.04	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.3999999993000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	7.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 23

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

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 25

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.3730	VOL/VOL
WILTING POINT	=	0.2660	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3730	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.359999990000E-05	CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1560.00	INCHES
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.	=	0.100000005000E-02	CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 5

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4570	VOL/VOL
FIELD CAPACITY	=	0.1310	VOL/VOL
WILTING POINT	=	0.0580	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1310	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	90.0	FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	8.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 9

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 16

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

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #25 WITH A GOOD STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	87.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	22.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	8.628	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.614	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	5.852	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	491.163	INCHES
TOTAL INITIAL WATER	=	491.163	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM RALEIGH NORTH CAROLINA

STATION LATITUDE	=	35.87 DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50
START OF GROWING SEASON (JULIAN DATE)	=	86
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	22.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	7.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	66.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	78.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

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

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

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

3.55	3.43	3.69	2.91	3.67	3.66
4.38	4.44	3.29	2.73	2.87	3.14

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

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.60	41.60	49.30	59.50	67.20	73.90
77.70	77.00	71.00	59.70	50.00	42.00

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR RALEIGH NORTH CAROLINA
AND STATION LATITUDE = 35.87 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.47	3.08	4.00	2.56	4.09	3.80
	4.25	5.33	2.64	2.79	2.67	2.96
STD. DEVIATIONS	1.87	1.31	1.47	1.40	1.99	1.91
	1.99	3.59	1.69	2.01	1.62	1.49
RUNOFF						
TOTALS	1.136	0.622	0.877	0.357	0.974	0.721
	0.869	1.684	0.686	0.702	0.721	0.689
STD. DEVIATIONS	1.244	0.687	0.768	0.439	1.145	0.800
	0.864	2.121	0.800	0.935	0.785	0.867
EVAPOTRANSPIRATION						
TOTALS	1.262	1.587	2.513	2.481	4.363	3.085
	3.424	3.317	2.135	1.179	0.951	0.881
STD. DEVIATIONS	0.237	0.271	0.416	0.842	0.817	1.275
	1.280	1.265	0.930	0.426	0.164	0.175
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	1.1797	0.9313	0.8437	0.3840	0.0645	0.0067
	0.0006	0.0013	0.0421	0.0172	0.2366	0.7441
STD. DEVIATIONS	0.6614	0.7019	0.5664	0.3604	0.1420	0.0282
	0.0018	0.0033	0.1849	0.0897	0.5319	0.6019
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 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
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 3

AVERAGES	0.0056	0.0049	0.0041	0.0019	0.0003	0.0000
	0.0000	0.0000	0.0002	0.0001	0.0012	0.0036
STD. DEVIATIONS	0.0032	0.0036	0.0027	0.0018	0.0007	0.0001
	0.0000	0.0000	0.0009	0.0004	0.0026	0.0029

DAILY AVERAGE HEAD ON TOP OF LAYER 8

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

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	41.65	(7.508)	151171.4	100.00
RUNOFF	10.038	(4.4309)	36439.66	24.105
EVAPOTRANSPIRATION	27.178	(3.3478)	98657.41	65.262
LATERAL DRAINAGE COLLECTED FROM LAYER 2	4.45152	(1.56328)	16159.022	10.68921
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.018	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.002	(0.001)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.00000	(0.00000)	0.009	0.00001
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.00000	(0.00000)	0.009	0.00001
AVERAGE HEAD ON TOP OF LAYER 8	0.000	(0.000)		
CHANGE IN WATER STORAGE	-0.023	(0.8746)	-84.76	-0.056

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	6.80	24684.000
RUNOFF	6.104	22159.0488
DRAINAGE COLLECTED FROM LAYER 2	0.12245	444.51019
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00048
AVERAGE HEAD ON TOP OF LAYER 3	0.018	
MAXIMUM HEAD ON TOP OF LAYER 3	0.001	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 7	0.00000	0.00008
PERCOLATION/LEAKAGE THROUGH LAYER 9	0.000000	0.00003
AVERAGE HEAD ON TOP OF LAYER 8	0.000	
MAXIMUM HEAD ON TOP OF LAYER 8	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	1.99	7221.5942

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4353
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2660

*** 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	8.7749	0.3656
2	0.0020	0.0100
3	0.0000	0.0000
4	8.2980	0.4610
5	4.4760	0.3730
6	455.5200	0.2920
7	3.1440	0.1310
8	0.0000	0.0000
9	10.2480	0.4270
SNOW WATER	0.000	

****
****

1.2 Leachate Collection Pipe Design

The 8" diameter leachate collection pipes in the cells were evaluated to determine the case where the greatest flow would be anticipated. This location is immediately upstream of the sideslope riser in Cell No. 13. At this point, approximately 8.5 acres of base liner leachate collection contributes to the flow. Results of the HELP Model indicate maximum flows of 360 gallons per day per acre of contributing base liner, for a total flow at this point of 3,060 gallons per day.

Utilizing the Flow Master computer program for 8" diameter pipe, the capacity of this pipe is:

$$Q = 0.65 \text{ cfs} = 292 \text{ gpm}$$

At a minimum post-settlement slope of 0.81%, the velocity (v) in the 8" diameter leachate collection pipe will be 2.46 feet per second, which exceeds two (2) feet per second recommended minimum velocity.

The capacity of the 8" diameter pipe is 292 gpm, and the actual worst case flow is 4.2 gpm, for a Factor of Safety of 70.

In summary, the 8" diameter leachate collection pipe is adequate for the anticipated flow.

EAST CAROLINA REGIONAL MSWLF PHASE 5
Worksheet for Circular Channel

Project Description	
Project File	untitled.fm2
Worksheet	8" LEACHATE COLLECTION PIPE
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Full Flow Capacity

Input Data		
Mannings Coefficient	0.015	
Channel Slope	0.008100	ft/ft
Diameter	6.96	in

Results		
Depth	0.58	ft
Discharge	0.65	cfs
Flow Area	0.26	ft²
Wetted Perimeter	1.82	ft
Top Width	0.00	ft
Critical Depth	0.40	ft
Percent Full	100.00	
Critical Slope	0.012355	ft/ft
Velocity	2.46	ft/s
Velocity Head	0.09	ft
Specific Energy	FULL	ft
Froude Number	FULL	
Maximum Discharge	0.70	cfs
Full Flow Capacity	0.65	cfs
Full Flow Slope	0.008100	ft/ft

1.3 Burial Design of Leachate Collection Pipe

Leachate Collection Pipe in the East Carolina Regional MSW Landfill serves as one of the conveyance devices whereby leachate is gravity drained. The leachate collection pipe is encased in ASTM No. 57 gravel encasement. This gravel encasement serves the dual purpose of bedding and a secondary means of leachate transport. The open spaces in the gravel provide an additional porous transport pathway.

In order to assure that the leachate collection pipe does not collapse, wall crushing and wall buckling calculations should be performed. Wall crushing would theoretically occur when the stress in a pipe wall, due to the external vertical pressure, exceeds the long-term compressive strength of the pipe material. Wall buckling is a longitudinal wrinkling of the pipe wall. Wall buckling can be forced to occur over the long term in non-pressurized pipe if the total external soil pressure is allowed to exceed the pipe-soil system's critical buckling pressure.

A report entitled "Summary of HDPE Pipe Stress Analysis and Ring Deflection Considerations" has been prepared by Bunnell-Lammons Engineering, Inc. and dated February 21, 2008 for use in determining the factor of safety against wall crushing and wall buckling for varying SDR's of leachate pipe under varying waste heights. A sample calculation is included in the report along with charts showing the results.

The allowable factor of safety for wall crushing should be a minimum of 1.5 and the allowable factor of safety for wall buckling should be a minimum of 1.8. The greatest depth of waste over a leachate pipe in Cells No. 13 and 14 is approximately 139'. An SDR 11 HDPE leachate collection pipe will be used in Cells No. 13 and 14 which yields a 4.3 factor of safety against the wall crushing and a 4.4 factor of safety against wall buckling.

SUMMARY OF HDPE PIPE STRESS ANALYSIS AND RING DEFLECTION CONSIDERATIONS

Date: February 21, 2008
Prepared By: Jeff Helvey, P. E.
Reviewed By: Dan Bunnell, P. E.

HDPE pipe analysis typically includes calculation of wall crushing and buckling stresses. The analysis yields a pipe SDR for a selected pipe diameter to provide a selected factor of safety against failure.

Design by ring deflection limits the ratio of the vertical change in diameter divided by the original diameter of the pipe. For small depths of embedment the load on the pipe can be calculated from the soil prism above the pipe. However, for deep embedment such as encountered in landfills, the stress estimated using the soil prism above the pipe greatly over estimates the actual stress on the pipe. As a result, the deflection calculated by the Modified Iowa (Spangler) formula is about 3 times the measured deflection. The Modified Iowa formula neglects the redistribution of stresses or arching that occurs because of differences in stiffness between the pipe and the backfill material.[1] For relatively thick wall SDR pipe, the literature indicates that deflections calculated using a thick tube analysis are in good agreement with measured deflections.[1]

ASTM[5] says that polyethylene pipes made to this specification may deflect or otherwise distort without kinking or buckling and remain structurally stable up to 20 % or more of the vertical diameter. Table x2.1 indicates a conservative allowable deflection, based on a given SDR for a factor of safety of at least 2.

Richardson[3] does not compute ring deflection, but bases SDR selection on crushing and buckling computations.

Zansinger and Gartung[4] suggest that the structural performance of the pipe is governed by the interaction with the surrounding soil. Driscopipe[6] indicates the elastic behavior of the soil or stone around the pipe may be used to approximate the pipe deflection.

CONCLUSIONS:

Based on these findings, it is suggested that the appropriate SDR for a given pipe be selected based on crushing and buckling analysis. Stresses should be estimated considering the three dimensional waste mound configuration and side slopes rather than the soil prism above the pipe. Ring deflection should not be a governing consideration.

Pipeline design must select a suitable standard dimension ratio (SDR) and specify the backfill conditions to obtain the desired performance of the system. Pipe wall crushing occurs when external vertical pressure causes the compressive stress in the pipe wall to exceed the long-term compressive strength of the pipe material. Pipe wall buckling is a longitudinal wrinkling of the pipe wall. Buckling can occur in the non-pressurized pipe if the total external pressure exceeds the critical buckling pressure of the pipe.

Design Method and example: (Ref. DRISCO PIPE design manual, applicable equations attached)

1. **Determine the total pressure at the top of the pipe: (sump in this example)**

$P_t = P_s + P_l + P_i$

P_t: Total Pressure
P_s: Total Static Pressure
P_l: Total Live Pressure
P_i: Total Internal Pressure

$P_l = 0$ (No Live Load)
$P_i = 0$ (Gravity Flow Pipe)
$P_s = P_{de} + P_{we} + P_b$

P_{de}: Static load pressure of dry or slightly moist soil
P_{we}: Static load pressure of wet, saturated soil under the water table
P_b: Static load pressure due to stationary structures

P_{we}: Soil and waste are moist but not saturated. Top of pipe is above leachate. Therefore $P_{we} = 0$
P_b: Not structures. Therefore $P_b = 0$
P_{de}: Varies with waste height (80' in this example).

$P_{de} = (H_{waste} - 4'_{waste}) \times \gamma_{waste} + H_{\text{leachate collection stone}} \times \gamma_{stone} + H_{\text{soil cover}} \times \gamma_{\text{soil cover}}$

$H_{waste} = 80'$
$\gamma_{waste} = 70$ pcf
$H_{\text{leachate collection stone}} = 4'$
$\gamma_{stone} = 150$ pcf
$H_{\text{soil cover}} = 2'$
$\gamma_{\text{soil cover}} = 120$ pcf

For this example, $P_{de} = 6{,}160$ psf $= 43$ psi

$P_t = P_s = P_{de}$ (for this example).

Total Pressure (P_t) = 43 psi

2. **Calculate Factor of Safety against Wall Crushing:**

Wall Crushing occurs when total pressure (P_t) exceeds Actual Compressive Pressure (S_a).

$S_a = [(SDR - 1)/2] \times P_t$

S_a: Actual Compressive Pressure (in this example, under 80' of waste)
SDR: Standard Dimension Ratio (SDR 17 in this example)
P_t: Total Pressure (calculated in step 1)

$P_t = 43$ psi
SDR = 17

$S_a = 344$ psi

FS against wall crushing equals the compressive strength of HDPE pipe, 1500 psi, divided by the Actual Compressive Pressure, S_a.

FS = 4.4 (should be equal to or greater than 1.5).

3. Calculate Factor of Safety against Wall Buckling:

Buckling occurs when total pressure (P_t) exceeds critical buckling soil pressure (P_{cb}).

$P_{cb} = 0.8\sqrt{(E' \times P_c)}$

P_{cb}: Critical buckling pressure
P_c: Critial collapse differential pressure
E': Soil Modulus. In this case, 3,000 psi for coarse grained soils (leachate collection stone).

$P_c = 2.32 \times E / SDR^3$

E: Tensile Modulus of Elasticity. In the case of buried pipe in landfills, use 28,200 psi. This value corresponds to an elastic modulus for HDPE pipe (PE 3608) at 50 years and 73° F. See Table 1: Typical Elastic Modulus for DriscoPlex PE 3608 (attached) in Book 2 Chapter 5 in the Performance Pipe Engineering Manual. First Addition, 2003.

$P_c = 13.3$ psi
$P_{cb} = 160$ psi

FS against wall buckling equals the Critical Buckling Soil Pressure (P_{cb}) divided by the Total Pressure (P_t).

FS = 3.7 (should be equal to or greater than 1.8).

APPENDIX

REFERENCES:
(HDPE Pipe Stress)

1. Brachman, Rowe, Moore & Tognon, Laboratory Investigation of the Effect of Coarse Stone Backfill on the Performance of Leachate Collection Pipe, *Sixth International Conference on Geosynthetics*, 1998.

2. Brachman, Hoop Compression Testing of HDPE Leachate Collection Pipe, *Conference Proceedings for Geosynthetics 97*, 1997.

3. Richardson, Design of Waste Containment Liner and Final Closure Systems, ASCE Course Notes

4. Zanzinger and Gartung, HDPE – Geopipes, Soil – Structure Interaction, *Sixth International Conference on Geosynthetics*, 1998.

5. ASTM F 714, *Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.*

6. Driscopipe Burial Design (with updates from the Chevron Phillips Chemical Company Design Manual – 2003)

HDPE LEACHATE PIPE WALL CRUSHING & BUCKLING ANALYSES - 50 YR DESIGN LIFE (73° F)

Bunnell-Lammons Engineering, Inc.
January 2008

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Leachate Pipe (SDR 9)

SDR 9										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	13	22	42	51	64	76	100	124	149	173
Wall Crushing (psi)	50	89	167	206	254	303	400	497	594	692
Factor of Safety against Wall Crushing	**30.0**	**16.9**	**9.0**	**7.3**	**5.9**	**5.0**	**3.8**	**3.0**	**2.5**	**2.2**
Critical Collapse Differential Pressure (psi)	90	90	90	90	90	90	90	90	90	90
Total Buckling Pressure (psi)	415	415	415	415	415	415	415	415	415	415
Factor of Safety against Wall Buckling	**33.2**	**18.7**	**10.0**	**8.1**	**6.5**	**5.5**	**4.2**	**3.3**	**2.8**	**2.4**

Leachate Pipe (SDR 11)

SDR 11										
Waste Height (feet)	20	40	80	100	125	139	150	200	250	300	350
Total External Pressure (psi)	13	22	42	51	64	76		100	124	149	173
Wall Crushing (psi)	63	111	208	257	318	378		500	622	743	865
Factor of Safety against Wall Crushing	**24.0**	**13.5**	**7.2**	**5.8**	**4.7**	**4.3**	**4.0**	**3.0**	**2.4**	**2.0**	**1.7**
Critical Collapse Differential Pressure (psi)	49	49	49	49	49	49		49	49	49	49
Total Buckling Pressure (psi)	307	307	307	307	307	307		307	307	307	307
Factor of Safety against Wall Buckling	**24.6**	**13.8**	**7.4**	**6.0**	**4.8**	**4.4**	**4.1**	**3.1**	**2.5**	**2.1**	**1.8**

Leachate Pipe (SDR 13)

SDR 13										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	13	22	42	51	64	76	100	124	149	173
Wall Crushing (psi)	75	133	250	308	381	454	600	746	892	1038
Factor of Safety against Wall Crushing	**20.0**	**11.3**	**6.0**	**4.9**	**3.9**	**3.3**	**2.5**	**2.0**	**1.7**	**1.4**
Critical Collapse Differential Pressure (psi)	30	30	30	30	30	30	30	30	30	30
Total Buckling Pressure (psi)	239	239	239	239	239	239	239	239	239	239
Factor of Safety against Wall Buckling	**19.1**	**10.8**	**5.7**	**4.7**	**3.8**	**3.2**	**2.4**	**1.9**	**1.6**	**1.4**

See Attached Bibliography for References

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Leachate Pipe (SDR 17)

SDR 17										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	13	22	42	51	64	76	100	124	149	173
Wall Crushing (psi)	100	178	333	411	508	606	800	994	1189	1383
Factor of Safety against Wall Crushing	**15.0**	**8.4**	**4.5**	**3.6**	**3.0**	**2.5**	**1.9**	**1.5**	**1.3**	**1.1**
Critical Collapse Differential Pressure (psi)	13	13	13	13	13	13	13	13	13	13
Total Buckling Pressure (psi)	160	160	160	160	160	160	160	160	160	160
Factor of Safety against Wall Buckling	**12.8**	**7.2**	**3.8**	**3.1**	**2.5**	**2.1**	**1.6**	**1.3**	**1.1**	**0.9**

Leachate Pipe (SDR 21)

SDR 21										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	13	22	42	51	64	76	100	124	149	173
Wall Crushing (psi)	125	222	417	514	635	757	1000	1243	1486	1729
Factor of Safety against Wall Crushing	**12.0**	**6.8**	**3.6**	**2.9**	**2.4**	**2.0**	**1.5**	**1.2**	**1.0**	**0.9**
Critical Collapse Differential Pressure (psi)	7	7	7	7	7	7	7	7	7	7
Total Buckling Pressure (psi)	116	116	116	116	116	116	116	116	116	116
Factor of Safety against Wall Buckling	**9.3**	**5.2**	**2.8**	**2.3**	**1.8**	**1.5**	**1.2**	**0.9**	**0.8**	**0.7**

Leachate Pipe (SDR 26)

SDR 26										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	13	22	42	51	64	76	100	124	149	173
Wall Crushing (psi)	156	278	521	642	794	946	1250	1554	1858	2161
Factor of Safety against Wall Crushing	**9.6**	**5.4**	**2.9**	**2.3**	**1.9**	**1.6**	**1.2**	**1.0**	**0.8**	**0.7**
Critical Collapse Differential Pressure (psi)	4	4	4	4	4	4	4	4	4	4
Total Buckling Pressure (psi)	85	85	85	85	85	85	85	85	85	85
Factor of Safety against Wall Buckling	**6.8**	**3.8**	**2.0**	**1.6**	**1.3**	**1.1**	**0.8**	**0.7**	**0.6**	**0.5**

See Attached Bibliography for References

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Sumps (SDR 11)

SDR 11										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	14	23	43	53	65	77	101	125	150	174
Wall Crushing (psi)	68	117	214	263	323	384	506	627	749	870
Factor of Safety against Wall Crushing	**22.0**	**12.9**	**7.0**	**5.7**	**4.6**	**3.9**	**3.0**	**2.4**	**2.0**	**1.7**
Critical Collapse Differential Pressure (psi)	49	49	49	49	49	49	49	49	49	49
Total Buckling Pressure (psi)	307	307	307	307	307	307	307	307	307	307
Factor of Safety against Wall Buckling	**22.6**	**13.2**	**7.2**	**5.9**	**4.8**	**4.0**	**3.0**	**2.4**	**2.1**	**1.8**

Sumps (SDR 13)

SDR 13										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	14	23	43	53	65	77	101	125	150	174
Wall Crushing (psi)	82	140	257	315	388	461	607	753	898	1044
Factor of Safety against Wall Crushing	**18.4**	**10.7**	**5.8**	**4.8**	**3.9**	**3.3**	**2.5**	**2.0**	**1.7**	**1.4**
Critical Collapse Differential Pressure (psi)	30	30	30	30	30	30	30	30	30	30
Total Buckling Pressure (psi)	239	239	239	239	239	239	239	239	239	239
Factor of Safety against Wall Buckling	**17.6**	**10.2**	**5.6**	**4.6**	**3.7**	**3.1**	**2.4**	**1.9**	**1.6**	**1.4**

Sumps (SDR 17)

SDR 17										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	14	23	43	53	65	77	101	125	150	174
Wall Crushing (psi)	109	187	342	420	517	614	809	1003	1198	1392
Factor of Safety against Wall Crushing	**13.8**	**8.0**	**4.4**	**3.6**	**2.9**	**2.4**	**1.9**	**1.5**	**1.3**	**1.1**
Critical Collapse Differential Pressure (psi)	13	13	13	13	13	13	13	13	13	13
Total Buckling Pressure (psi)	160	160	160	160	160	160	160	160	160	160
Factor of Safety against Wall Buckling	**11.7**	**6.9**	**3.7**	**3.0**	**2.5**	**2.1**	**1.6**	**1.3**	**1.1**	**0.9**

See Attached Bibliography for References

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Sumps (SDR 21)

SDR 21										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	14	23	43	53	65	77	101	125	150	174
Wall Crushing (psi)	136	233	428	525	647	768	1011	1254	1497	1740
Factor of Safety against Wall Crushing	**11.0**	**6.4**	**3.5**	**2.9**	**2.3**	**2.0**	**1.5**	**1.2**	**1.0**	**0.9**
Critical Collapse Differential Pressure (psi)	7	7	7	7	7	7	7	7	7	7
Total Buckling Pressure (psi)	116	116	116	116	116	116	116	116	116	116
Factor of Safety against Wall Buckling	**8.6**	**5.0**	**2.7**	**2.2**	**1.8**	**1.5**	**1.2**	**0.9**	**0.8**	**0.7**

Sumps (SDR 26)

SDR 26										
Waste Height (feet)	20	40	80	100	125	150	200	250	300	350
Total External Pressure (psi)	14	23	43	53	65	77	101	125	150	174
Wall Crushing (psi)	170	292	535	656	808	960	1264	1568	1872	2175
Factor of Safety against Wall Crushing	**8.8**	**5.1**	**2.8**	**2.3**	**1.9**	**1.6**	**1.2**	**1.0**	**0.8**	**0.7**
Critical Collapse Differential Pressure (psi)	4	4	4	4	4	4	4	4	4	4
Total Buckling Pressure (psi)	85	85	85	85	85	85	85	85	85	85
Factor of Safety against Wall Buckling	**6.2**	**3.6**	**2.0**	**1.6**	**1.3**	**1.1**	**0.8**	**0.7**	**0.6**	**0.5**

See Attached Bibliography for References

1.4 Sideslope Riser Pump Design

Sideslope riser pumps will be used to withdraw leachate from the sumps future Cells No. 13 and 14. The HELP Model calculations indicate a peak daily flow of 360 gal/ac/day. Using this data the peak daily flow in Cell No. 13 will be 4,016 gallons per day or 2.79 gallons per minute and the peak daily flow of Cell No. 14 will be 3,058 gallons per day or 2.12 gallons per minute.

1. Pump Design Demonstration

The sump in Cell No. 14 is located the furthest distance to the leachate tanks. The force main length is approximately 3,397 feet. The sump pump design must account for the static head, the total equivalent pipe length and the system head. A sample calculation is provided which demonstrates proper pump selection.

Static Head:	
Force main discharge elevation	88.00
Sump bottom elevation	58.00
Static Head	30.00

Equivalent Pipe Length:

Pipe/Fitting	Equivalent Pipe	Qty.	2"	6"
2" pipe	207'	-	207'	
2" 90° bend	5.5'	2	11'	
2" tee	11'	1	11'	
2" ball valve	2'	1	2'	
2" check valve	13'	1	13'	
2"x6" red.	5'	1	5'	
6" pipe	3,190'	-		3,190'
6" tee	35'	4		140'
6" 90° bend	16'	4		64'
6" check valve	40'	1		40'
		Totals	**249'**	**3,434'**

Current to equivalent pipe size:

$$L_{2"} = 3{,}434' \left(\frac{2"}{6"}\right)^{4.78} + 249'$$

$L_{2"} = 18' + 249' = 267'$ (2" pipe equivalent)

System Head:

Q	Static	H_f *	TDH
0	30.00	0	30.0
10	30.00	0.72	30.72
20	30.00	2.62	32.62
40	30.00	9.52	39.52
60	30.00	20.04	50.04
75	30.00	30.35	60.35
80	30.00	34.17	64.17

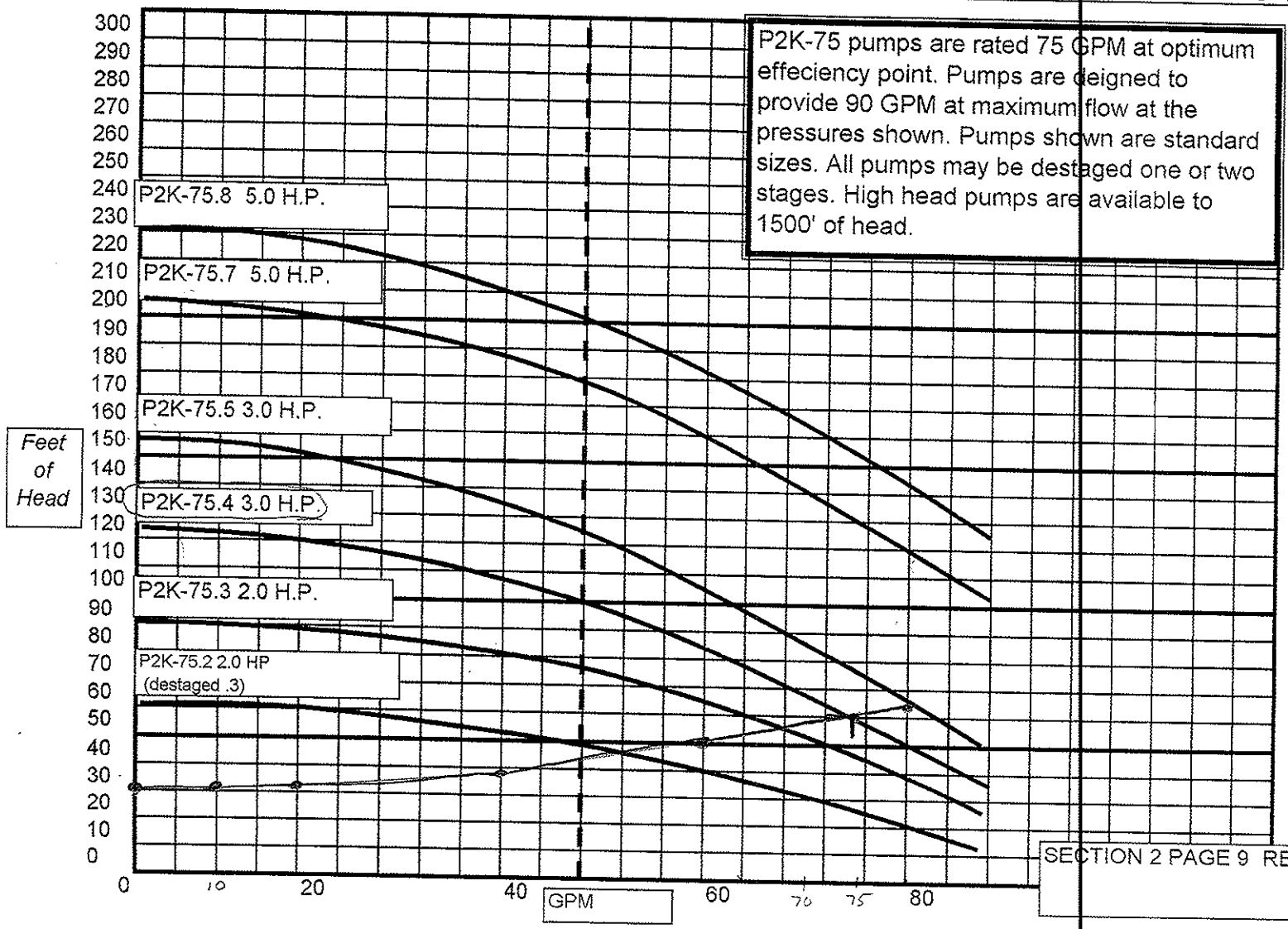
* Use C = 140 for HDPE pipe

Pump Selection:

Make: GunnCo Sidesloper Pump (curve attached)
Model: PZK-75.4
Design Point: 75 gpm @ 60.35 TDH
Horsepower: 3.0 hp

This calculation demonstrates that a standard production leachate sump pump will perform satisfactorily. The sump pump for each cell shall be designed using the same calculation method.

GunnCo *Sidesloper* ™ *Pumps* *Model P2K-75 Series 3, 4, 5, 7, & 8 stage pumps*



P2K-75 pumps are rated 75 GPM at optimum effeciency point. Pumps are deigned to provide 90 GPM at maximum flow at the pressures shown. Pumps shown are standard sizes. All pumps may be destaged one or two stages. High head pumps are available to 1500' of head.

All pumps are 304 stainless steel with Teflon bearings and seals. Motors are Franklin Electric Super Stainless or High Thrust Series motors with stainless casing. Power cables are heavy duty continous length. Pumps are mounted in patented wheeled carrier with stainless steel casing and self lubricating UHMW wheels.

Actual pump length may vary with voltage requirments and riser pipe size & SDR should be provided for optimum operation in riser.

VIII. REPORT OF GEOTECHNICAL ANALYSES

BLE INC.

BUNNELL-LAMMONS ENGINEERING, INC.

GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

REPORT OF GEOTECHNICAL ANALYSES

PHASE 5 CONSTRUCTION

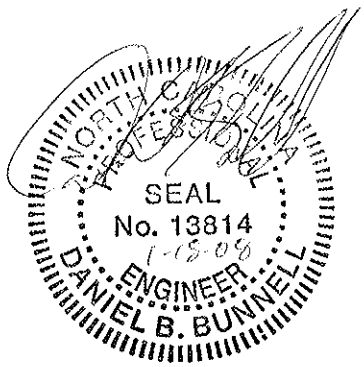
EAST CAROLINA REGIONAL MSW LANDFILL
BERTIE COUNTY, NORTH CAROLINA

Prepared for:

Hodges, Harbin. Newberry and Tribble, Inc.
Macon, Georgia

Prepared by:

Bunnell-Lammons Engineering, Inc.
Greenville, South Carolina



January 9, 2008

BLE Project Number J07-1001-56

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS

January 9, 2008

Mr. William F. Hodges, P. E.
Hodges, Harbin, Newberry & Tribble, Inc.
484 Mulberry Street
Suite 265
Macon, Georgia 31201

Subject: **Report of Geotechnical Analyses**
Phase 5 Construction
East Carolina Regional MSW Landfill
Bertie County, North Carolina
BLE Project No. J07-1001-56

Dear Mr. Hodges:

Bunnell-Lammons Engineering, Inc. (BLE) has performed geotechnical-engineering analyses in support of the design of the proposed Phase 5 of the East Carolina Regional MSW Landfill. This letter documents our understanding of the planned expansion and reports our analysis of subgrade settlement and stability of the waste slope as well as the base liner system and the closure cap system for the planned facility.

Project Information:

The planned Phase 5 of the landfill will encompass an area of approximately 24.6 acres of solid waste disposal in proposed Cells 13 and 14. Design of the Subtitle D municipal landfill facility is currently in progress, by Hodges, Harbin, Newberry & Tribble, Inc. A digital copy of drawings and details of the planned top of clay and top of closure cap system, prepared by Hodges, Harbin, Newberry & Tribble, Inc., have been provided for our use. The base liner system will consist of a 24-inch thick compacted clay liner ($k \leq 1x10^{-7}$ cm/sec) overlain by a 60-mil flexible geomembrane liner (FML). The geomembrane liner will be overlain by a 24-inch thick protective cover layer. The interior side slopes of the bottom liner system will be at an inclination of 4:1 (horizontal to vertical) or flatter. Structural fill slopes of the embankments forming the edge of the landfill are planned to be at a maximum inclination of 3H : 1V (horizontal to vertical).

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FAX (864) 288-4430

The final cover system (cap) will incorporate, in order of decreasing elevation: a 6-inch thick topsoil layer, an 18-inch thick protective cover soil layer, a geonet drainage composite, a geomembrane, an 18-inch thick low permeability soil cap ($k \leq 1x10^{-5}$ cm/sec), and a layer of intermediate cover soil over the waste. The maximum inclination of the cap slopes will be 3.5H : 1V (horizontal to vertical). The calculations included in this package consider a potential maximum cap elevation of 310 feet MSL; however, the estimated subgrade settlement versus waste height trend line may be used to extrapolate settlement resulting from greater waste heights.

Results of Analysis:

The analysis of landfill - subgrade soil interaction was based on the planned design configuration and the geotechnical data presented in the Site Hydrogeologic Characterization Report, prepared by BLE and dated, January 28, 1999, the Design Hydrogeologic Report, Phase Five, prepared by Golder Associates, and dated July 2007 and Design Hydrogeologic Reports prepared for each of the existing landfill phases. The soil compressibility parameters were developed from the soil test borings, laboratory test data and the results of a full-scale load test performed at the site in 1996. The analysis was performed and reviewed by registered professional engineers specializing in geotechnical engineering of municipal solid waste landfills. Copies of the various analyses are attached.

Analysis was performed to estimate the maximum subgrade settlements due to the final waste configuration. The subgrade profile generally consists of coastal plain sediment with generally relatively uniform horizontal stratification of clay, sand and silt consistent with subsurface conditions encountered in the previous landfill phases. The site is not in a seismic impact area. Settlement analysis was performed using both elastic modulus and consolidation procedures as appropriate. While some variations of structural fill height and individual soil layer thickness occur from boring to boring, due to the general uniformity of the conditions and the broad load application, the resulting subgrade settlements will generally vary with the load intensity resulting from the height of waste. The estimated subgrade settlement is presented on the attached graph of subgrade settlement versus height of waste. The estimated maximum settlement magnitudes are consistent with that of prior phases at the East Carolina Regional MSW Landfill and are considered tolerable to the liner system, and will not impact the performance of the landfill structural components.

Analyses were also performed considering static conditions for slope stability and interface friction for the conditions indicated below.

- global slope stability
- base liner system stability:
- cap slopes

The resulting factors of safety were computed to be 1.5 or more. The specific analyses are attached.

In conclusion, the above analyses indicate that the landfill configuration will be stable and provide appropriate factors of safety.

Bunnell-Lammons Engineering, Inc. appreciates the opportunity to provide professional geotechnical services on this project. If you have any questions concerning this report or the attached calculations, please contact us.

Sincerely,

BUNNELL-LAMMONS ENGINEERING, INC.

Gary L. Weekley, P. E.
Senior Engineer
Registered NC # 8251

NORTH CAROLINA PROFESSIONAL SEAL 8251 1-18-08 ENGINEER GARY L. WEEKLEY

Daniel B. Bunnell, P. E.
Principal Engineer
Registered NC # 13814

NORTH CAROLINA PROFESSIONAL SEAL No. 13814 1-18-08 ENGINEER DANIEL B. BUNNELL

Attachments

TABLE OF CONTENTS
GEOTECHNICAL CALCULATIONS

PHASE 5 - CELLS NO. 13 & 14
EAST CAROLINA REGIONAL MSW LANDFILL
BERTIE COUNTY, NORTH CAROLINA
BLE Project No. J07-1001-56

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Base Liner Separation	2
Global Slope Stability Analyses	
Summary of Stability Analysis	3
Stability Profile Plan Location	4
Schematic for Stability Analyses	5
Stability Analysis Results	
Waste Slope	
Static, Circular, Total Stress	6
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Foundation	
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Static, Circular, Total Stress	14
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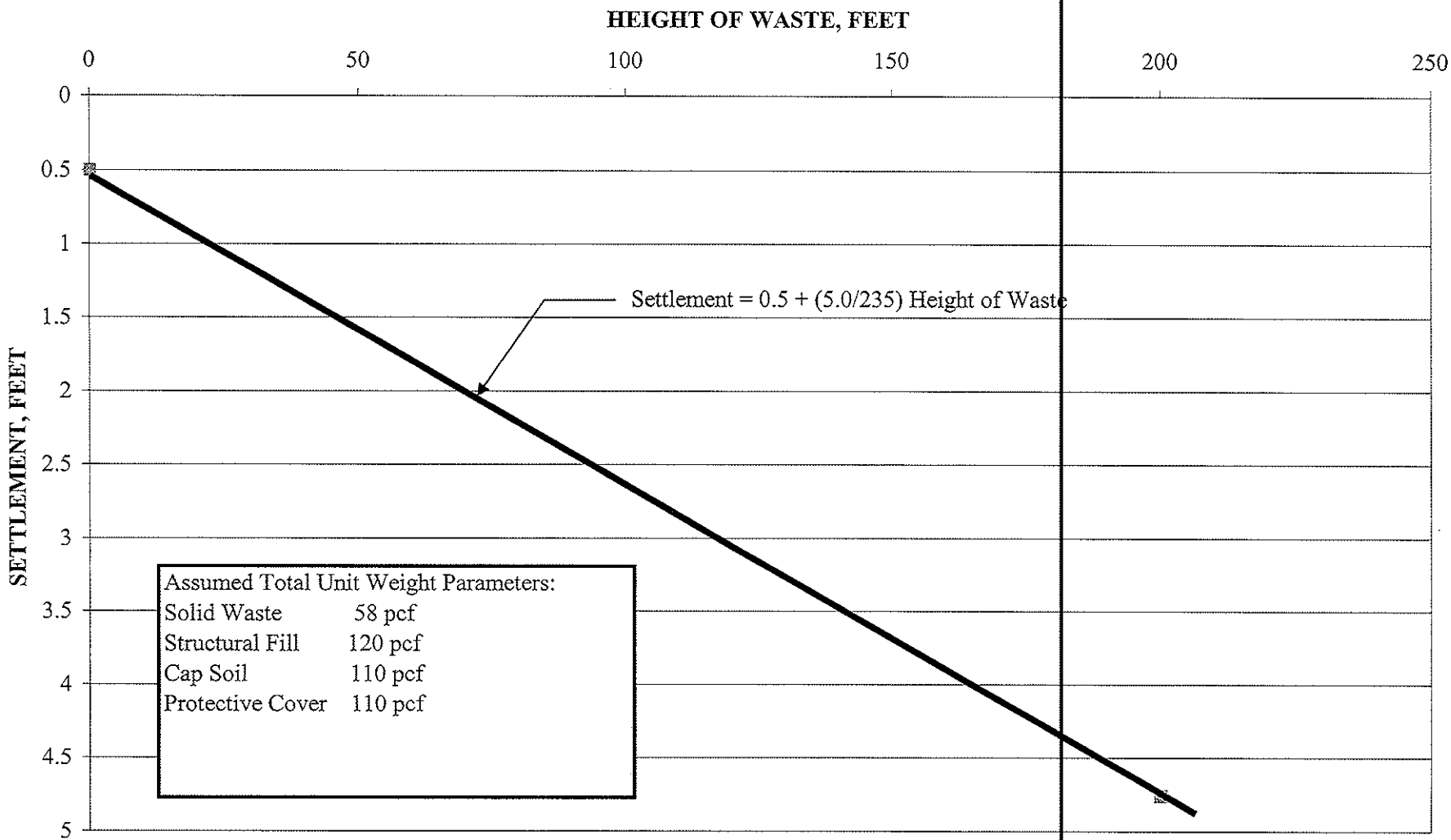
SETTLEMENT

ESTIMATED SUBGRADE SETTLEMENT VERSUS WASTE HEIGHT

EAST CAROLINA REGIONAL LANDFILL
BERTIE COUNTY, NORTH CAROLINA
BLE Project No. J07-1001-56



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BASE LINER SEPARATION

GEOTECHNICAL ANALYSIS - PHASE 5

EAST CAROLINA REGIONAL MSW LANDFILL

BERTIE COUNTY, NORTH CAROLINA

BLE Project No. J07-1001-56

December 2007

Boring	Settlement: Bottom of clay to bottom of Layer 1 Feet	Clay[1] Subgrade Elevation (FML-2.0 Feet) Feet	Groundwater Elevation (Bottom of Layer 1 + 1 foot) Feet	Groundwater Separation with Clay Subgrade[2] Feet
GW-14	0.6	64	40.0	23.4
PZ-10A	0.5	72	61.0	10.5
PZ-72A	0.8	80	52.0	27.2
PZ-73A	0.6	66	48.0	17.5
PZ-107B	0.4	61	45.5	15.1
PZ-108	0.6	69	49.0	19.4
PZ-109B	0.6	72	55.2	16.2
PZ-111	0.2	60	52.7	7.1
PZ-112	0.5	63	47.0	15.5
PZ-113	0.6	70	47.7	21.7
PZ-115B	0.2	87	51.0	35.8
PZ-116	0.3	63	49.0	13.7
PZ-117B	0.4	66	45.7	19.9
PZ-120	0.1	84	52.0	31.9
PZ-121	0.1	79	49.5	29.4

1 Assumed regulatory liner system with 2.0-foot thick compacted clay liner.

2 Clay subgrade = FML Elevation - 2.0 Feet.

GLOBAL SLOPE STABILITY

SUMMARY OF STABILITY ANALYSIS

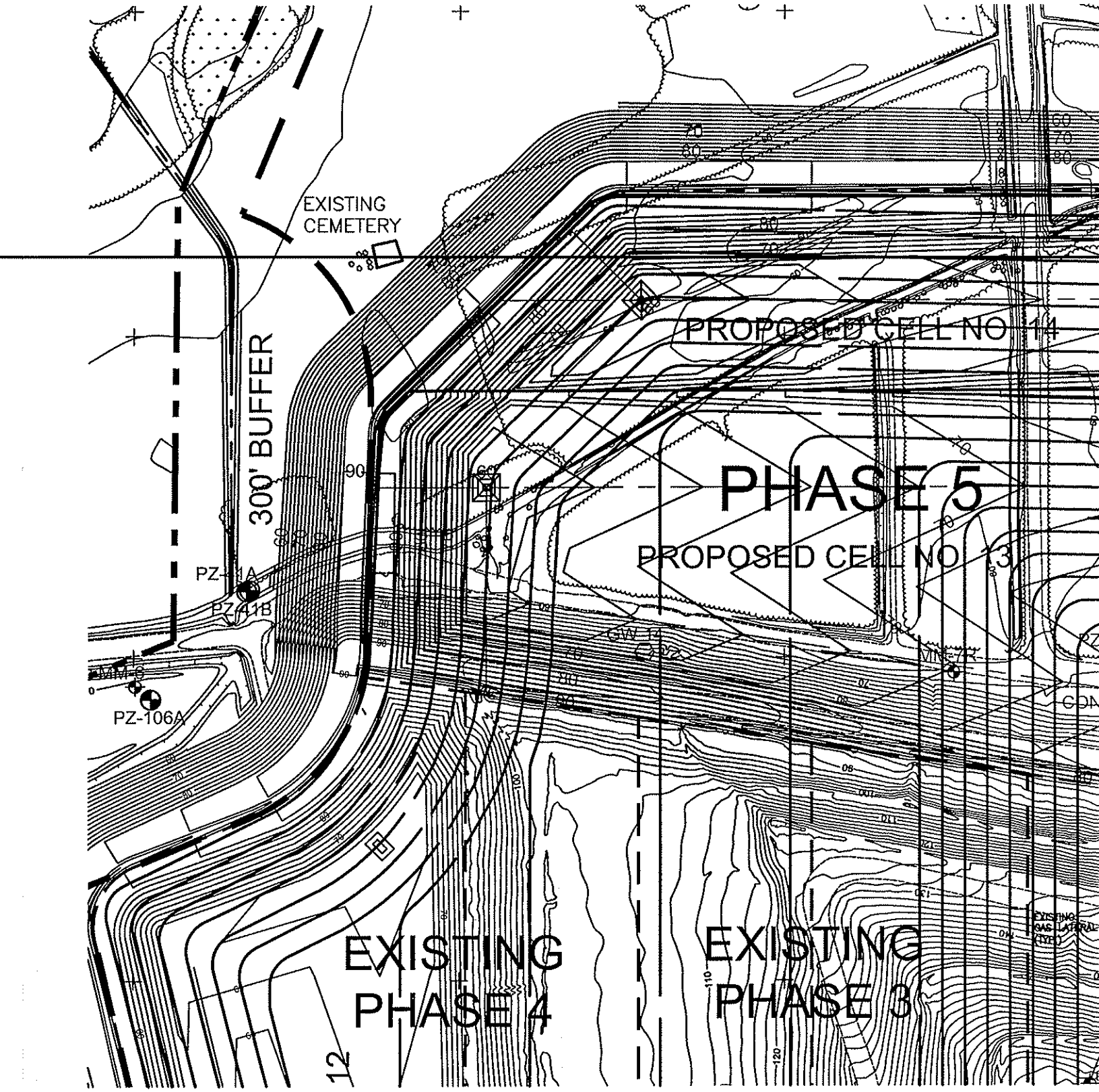
CONSTRUCTION OF PHASE 5 - CELLS NO. 13 AND 14
EAST CAROLINA REGIONAL MSW LANDFILL
BERTIE COUNTY, NORTH CAROLINA

BLE Project No. J07-1001-56

	Factor of Safety	
	Static Analysis	
Slope Stability	Total Stress	Effective Stress
Waste Slope (3.5H:1V)		
Circular	2.4	2.4
Sliding Block	2.5	2.5
Foundation (Deep-Seated)		
Circular	2.1	2.5
Sliding Block	1.7	2.4
Fill Slope (3H:1V)		
Circular	1.9	2.2
Sliding Block	2.4	2.2
Drainage Berm (Flooded)		
Circular	--	1.3
Sliding Block	--	1.3

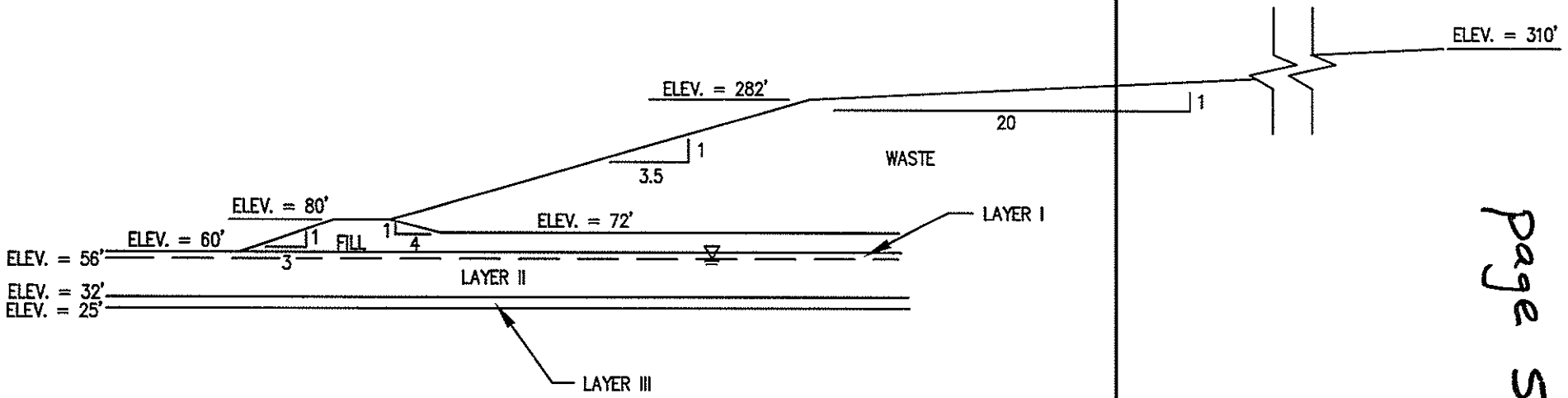
Geomembrane and cap elevations were obtained from HHNT Dwg. ECP-FG dated 11-9-07

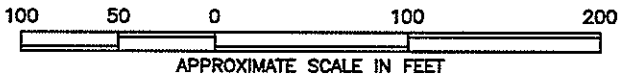
Peak ground (bedrock) acceleration (2006) of 0.056g at site does not require a seismic analysis.


EXISTING
CEMETERY
300' BUFFER
PROPOSED CELL NO. 14
PHASE 5
PROPOSED CELL NO. 13
PZ-101A
PZ-101B
PZ-106A
EXISTING
PHASE 4
EXISTING
PHASE 3

SHEAR STRENGTH PARAMETERS

	TOTAL STRESS		EFFECTIVE STRESS		UNIT WEIGHT
	FRICTION ANGLE, ϕ	C (psf)	FRICTION ANGLE, ϕ	C (psf)	(pcf)
SOLID WASTE	30°	200	30°	200	58
FILL	22°	200	26°	100	120
LAYER I	15°	100	30°	50	115
LAYER II	28°	0	34°	0	110
LAYER III	10°	500	20°	200	110





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CHECKED:	GLW	CAD:	ECLF56-SACS		
APPROVED:		JOB NO:	J07-1001-56		

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PHONE: (864)288-1265 FAX: (864)288-4430

FIGURE

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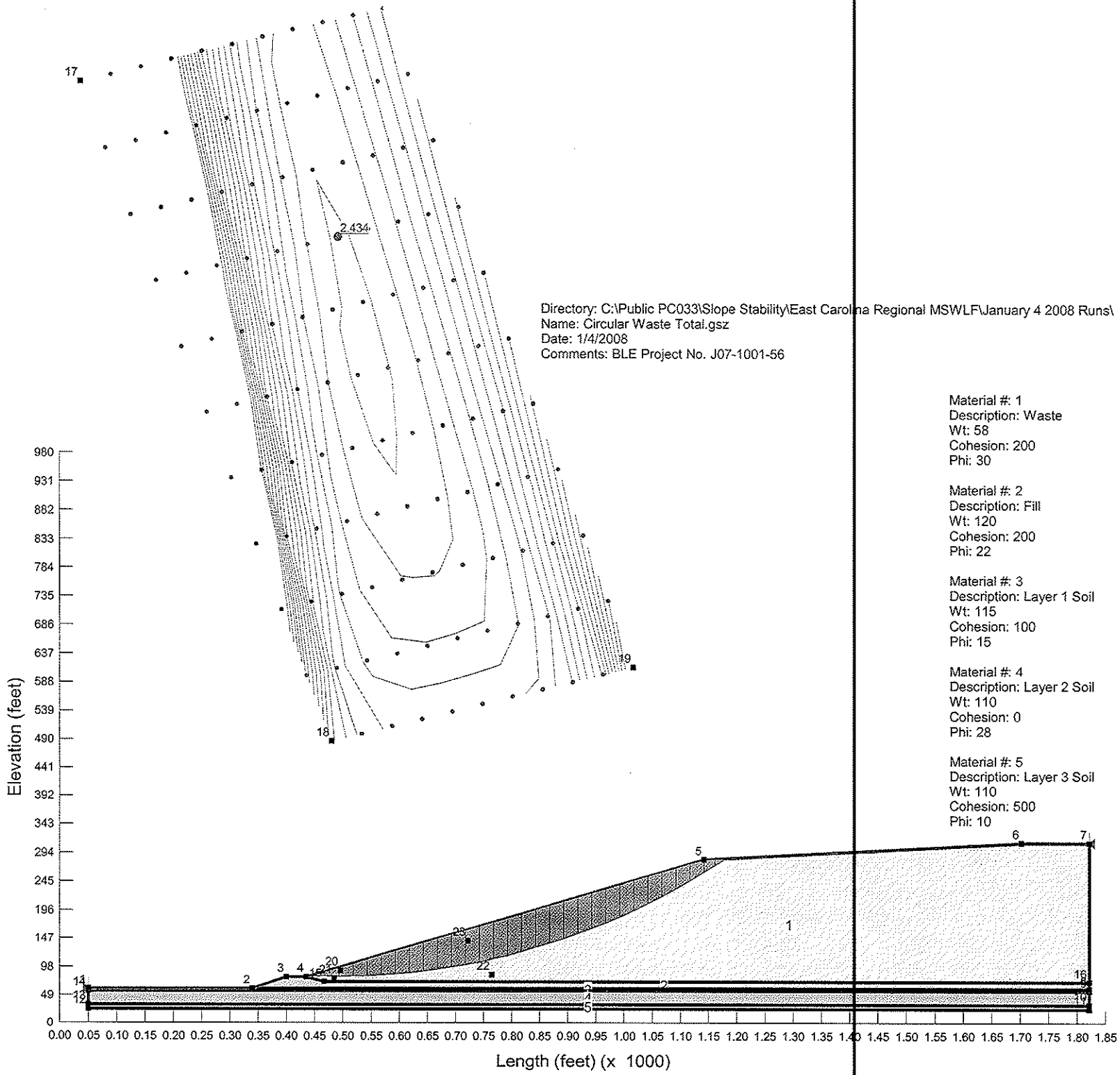
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Description: Layer 1 Soil
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Cohesion: 100
Phi: 15
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Description: Layer 2 Soil
Wt: 110
Cohesion: 0
Phi: 28
Material #: 5
Description: Layer 3 Soil
Wt: 110
Cohesion: 500
Phi: 10
Elevation (feet)
980
931
882
833
784
735
686
637
588
539
490
441
392
343
294
245
196
147
98
49
0
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00 1.05 1.10 1.15 1.20 1.25 1.30 1.35 1.40 1.45 1.50 1.55 1.60 1.65 1.70 1.75 1.80 1.85
Length (feet) (x 1000)

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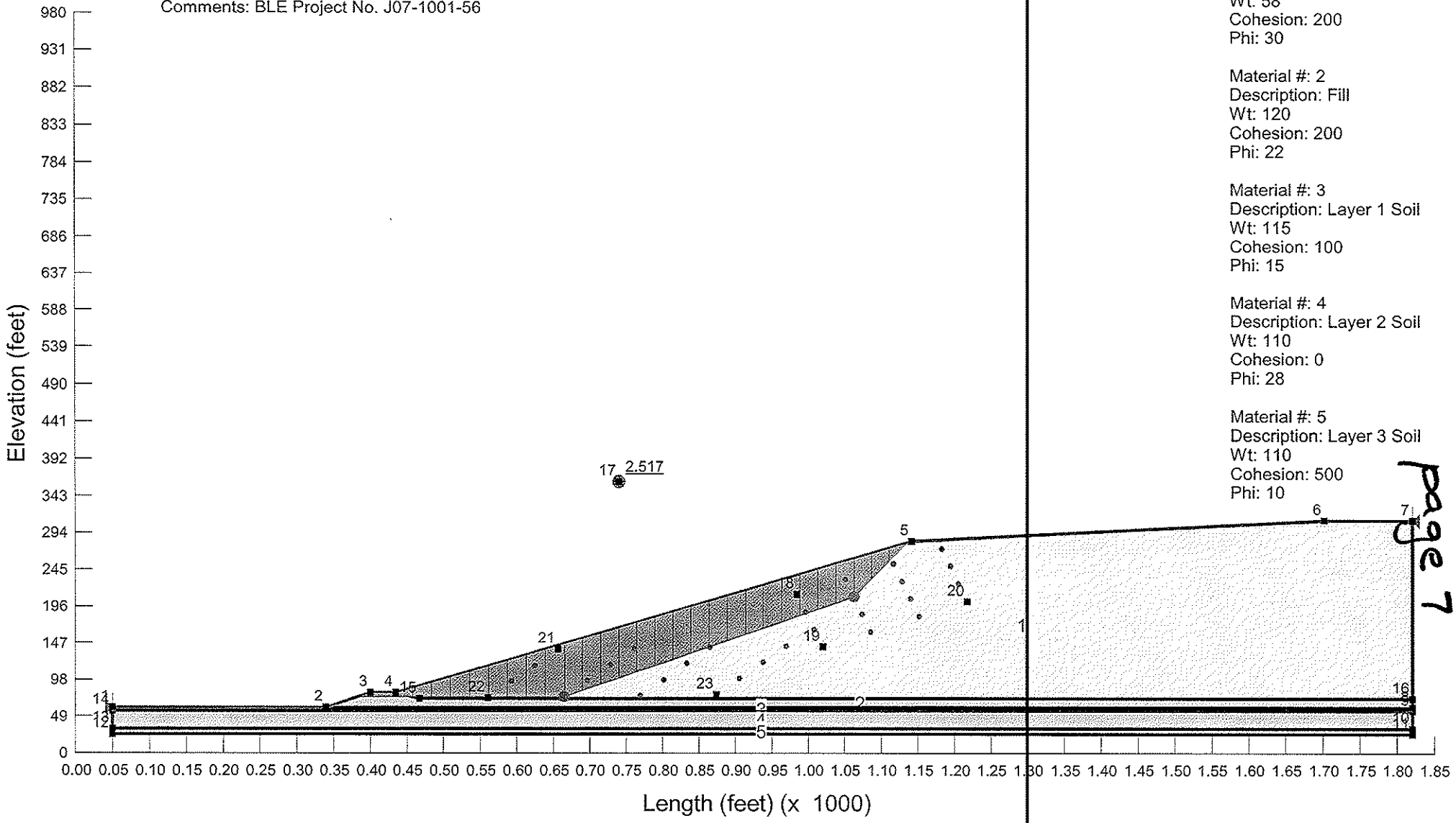

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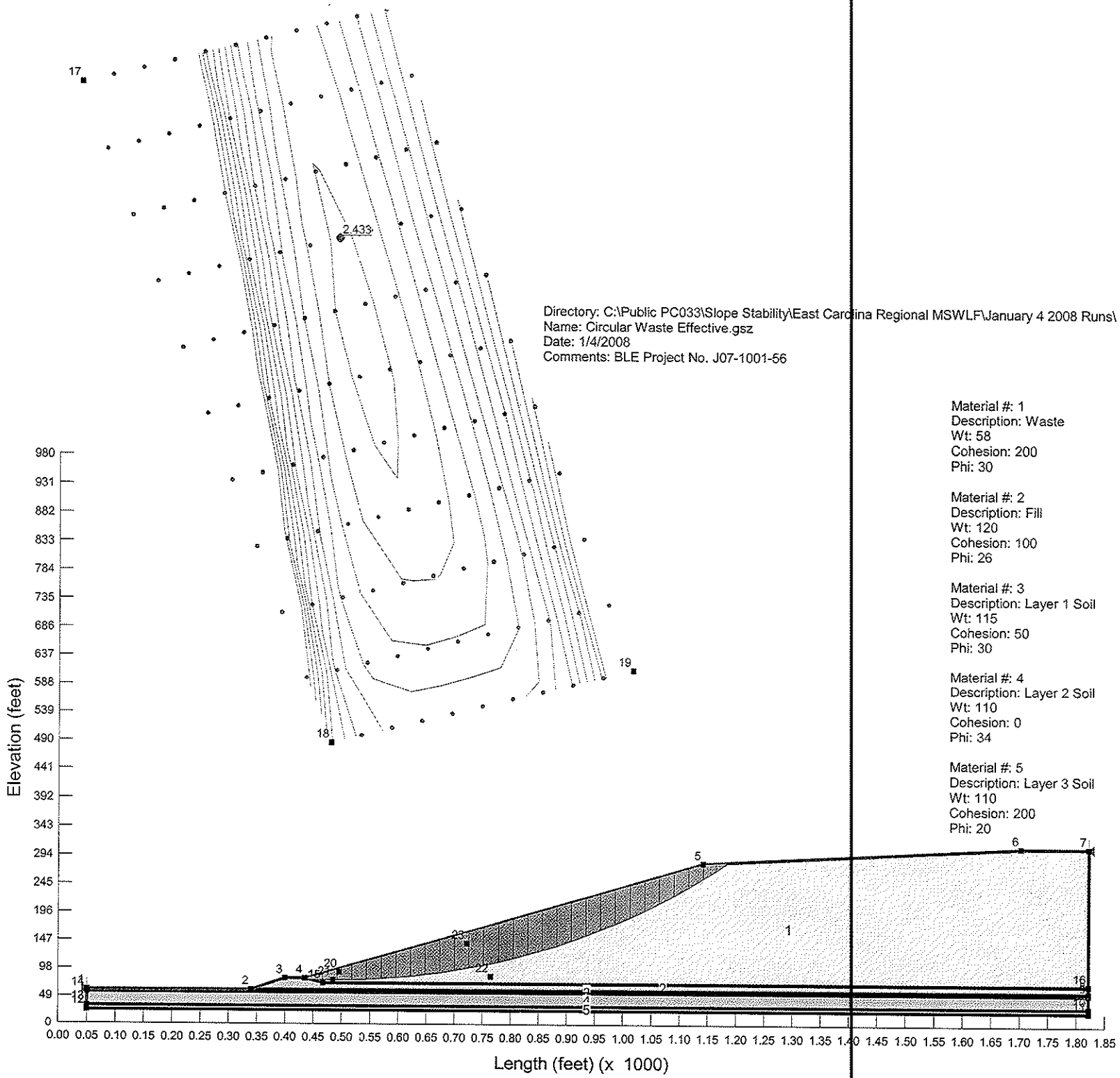
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Description: Layer 2 Soil
Wt: 110
Cohesion: 0
Phi: 34
Material #: 5
Description: Layer 3 Soil
Wt: 110
Cohesion: 200
Phi: 20
2.433
Elevation (feet)
980
931
882
833
784
735
686
637
588
539
490
441
392
343
294
245
196
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98
49
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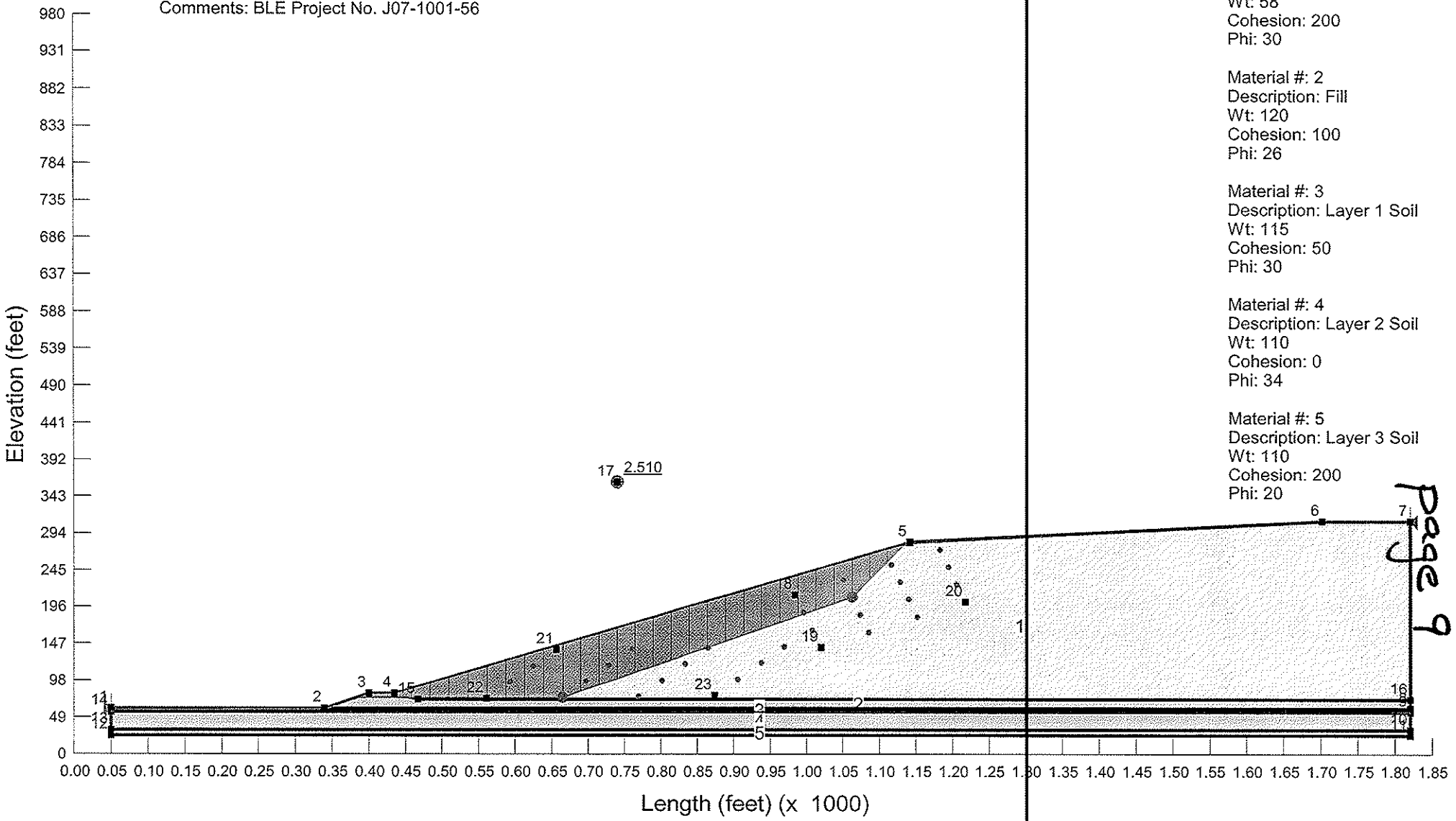

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Cohesion: 200
Phi: 20

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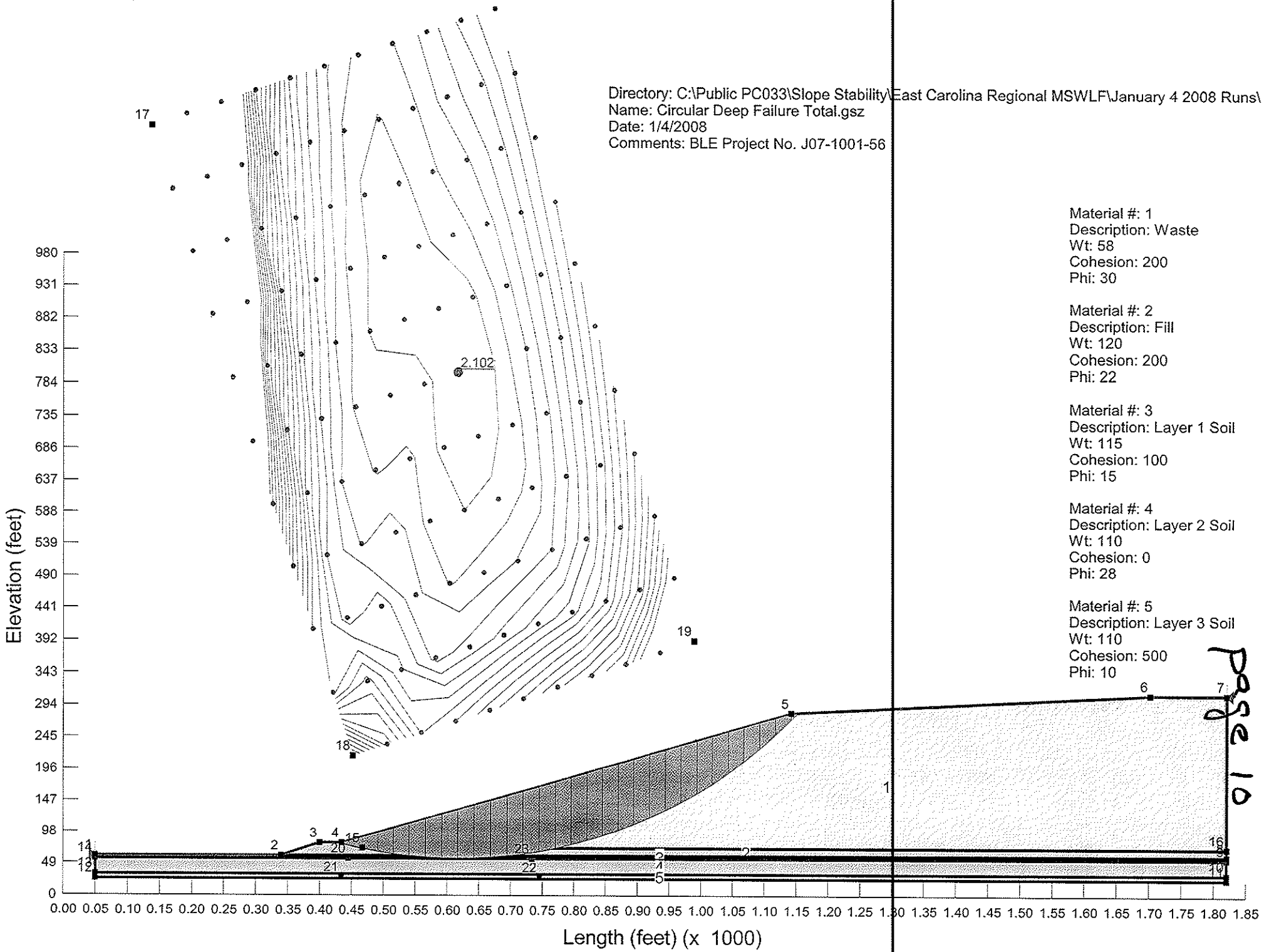
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Cohesion: 0
Phi: 28
Material #: 5
Description: Layer 3 Soil
Wt: 110
Cohesion: 500
Phi: 10
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Elevation (feet)
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931
882
833
784
735
686
637
588
539
490
441
392
343
294
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196
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Length (feet) (x 1000)

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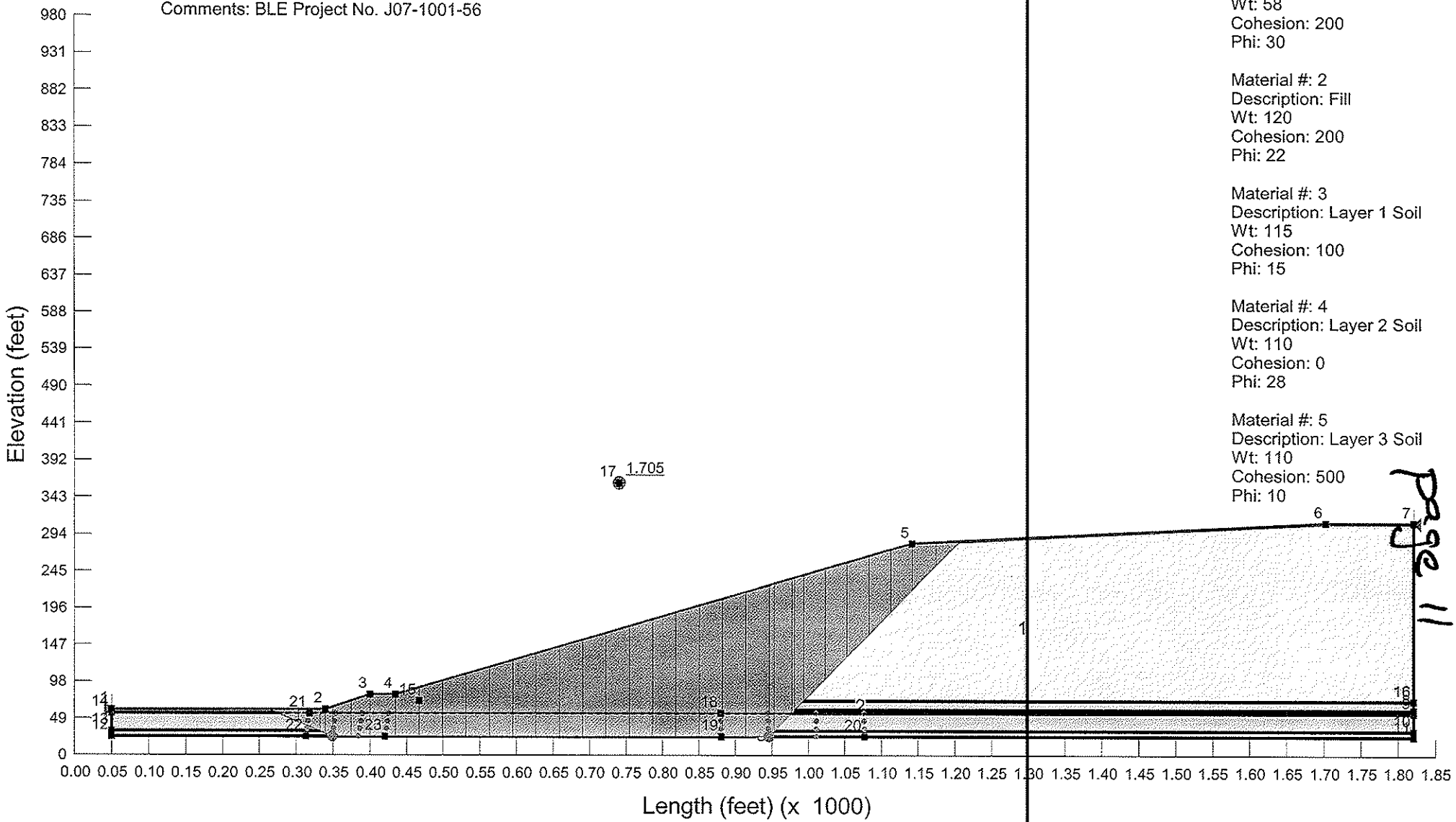

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Cohesion: 500
Phi: 10

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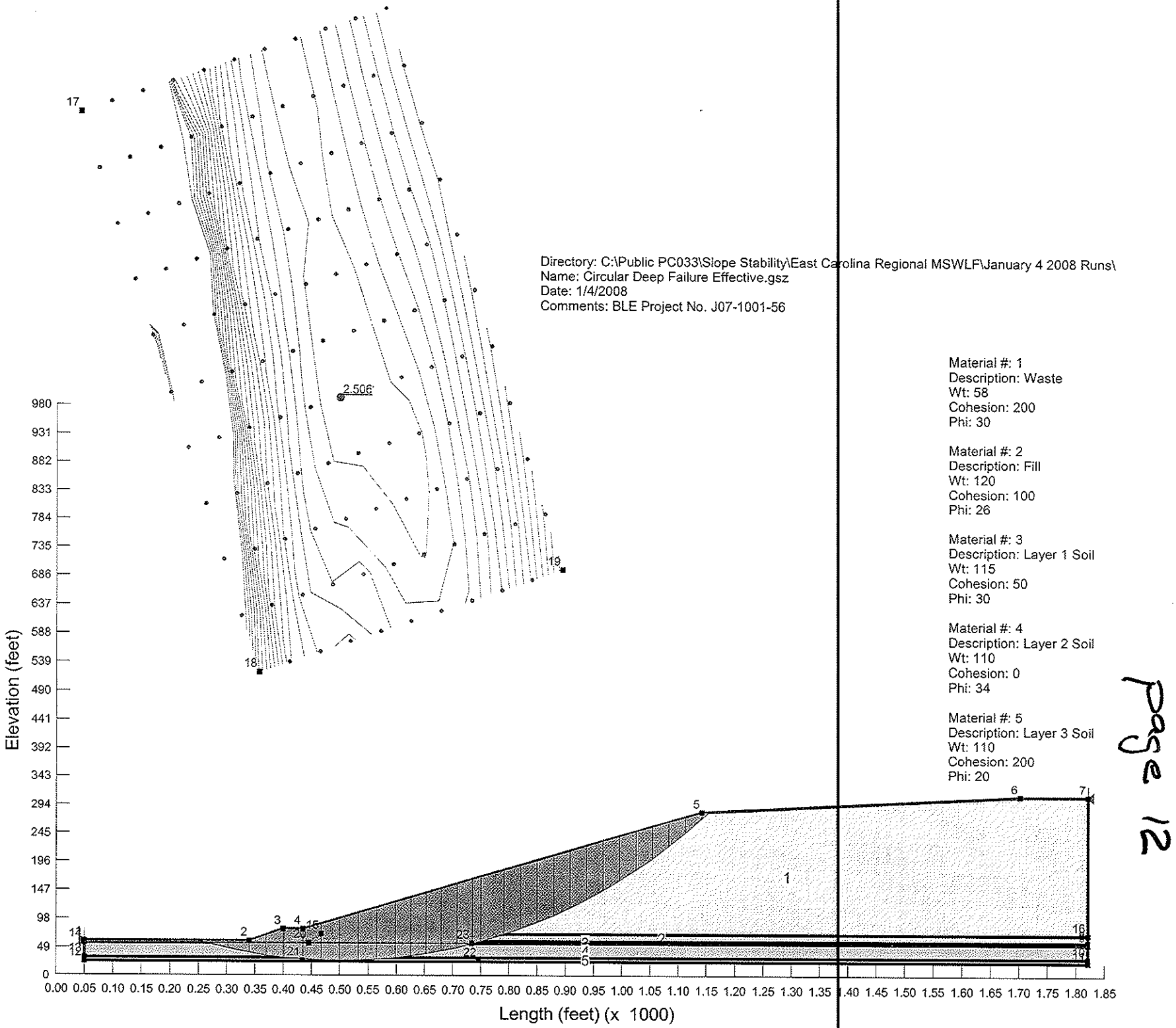
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Elevation (feet)
Length (feet) (x 1000)

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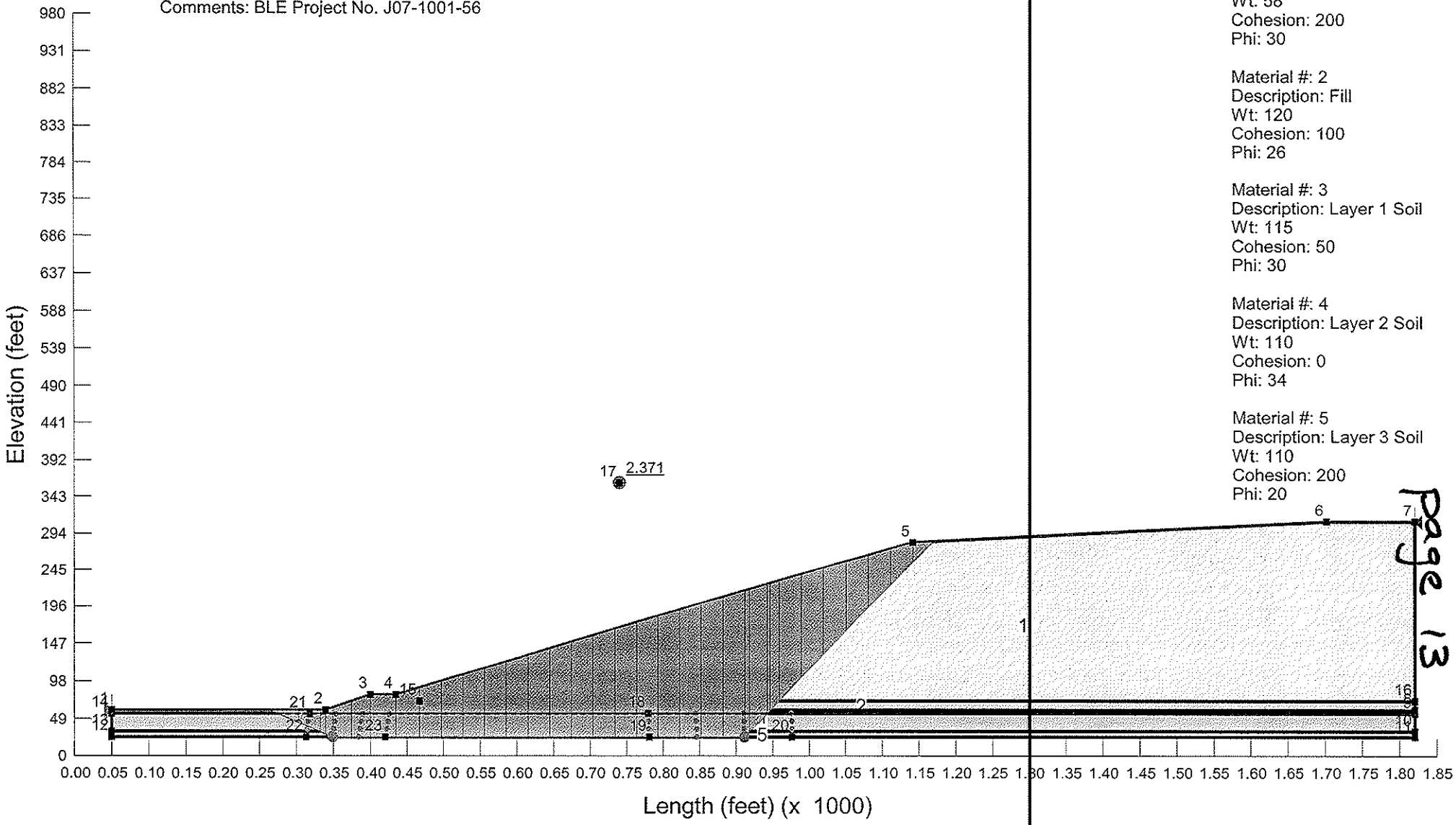
Date: 1/4/2008
Comments: BLE Project No. J07-1001-56



Material #: 1
Description: Waste
Wt: 58
Cohesion: 200
Phi: 30

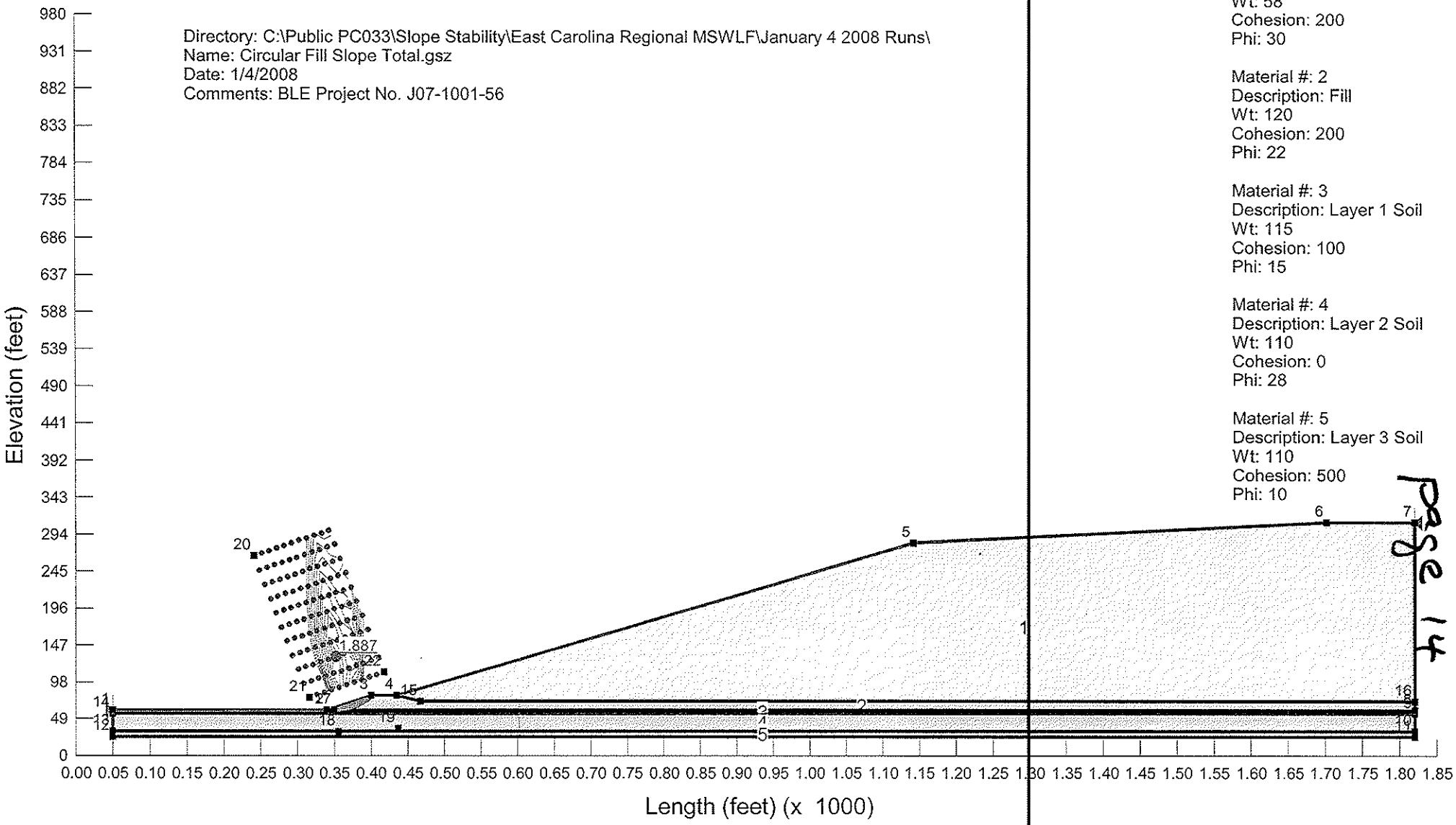
Material #: 2
Description: Fill
Wt: 120
Cohesion: 100
Phi: 26

Material #: 3
Description: Layer 1 Soil
Wt: 115
Cohesion: 50
Phi: 30

Material #: 4
Description: Layer 2 Soil
Wt: 110
Cohesion: 0
Phi: 34

Material #: 5
Description: Layer 3 Soil
Wt: 110
Cohesion: 200
Phi: 20

Page 13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Name: Circular Fill Slope Total.gsz
Date: 1/4/2008
Comments: BLE Project No. J07-1001-56
Material #: 1
Description: Waste
Wt: 58
Cohesion: 200
Phi: 30
Material #: 2
Description: Fill
Wt: 120
Cohesion: 200
Phi: 22
Material #: 3
Description: Layer 1 Soil
Wt: 115
Cohesion: 100
Phi: 15
Material #: 4
Description: Layer 2 Soil
Wt: 110
Cohesion: 0
Phi: 28
Material #: 5
Description: Layer 3 Soil
Wt: 110
Cohesion: 500
Phi: 10
Elevation (feet)
980
931
882
833
784
735
686
637
588
539
490
441
392
343
294
245
196
147
98
49
0
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00 1.05 1.10 1.15 1.20 1.25 1.30 1.35 1.40 1.45 1.50 1.55 1.60 1.65 1.70 1.75 1.80 1.85
Length (feet) (x 1000)
1.887

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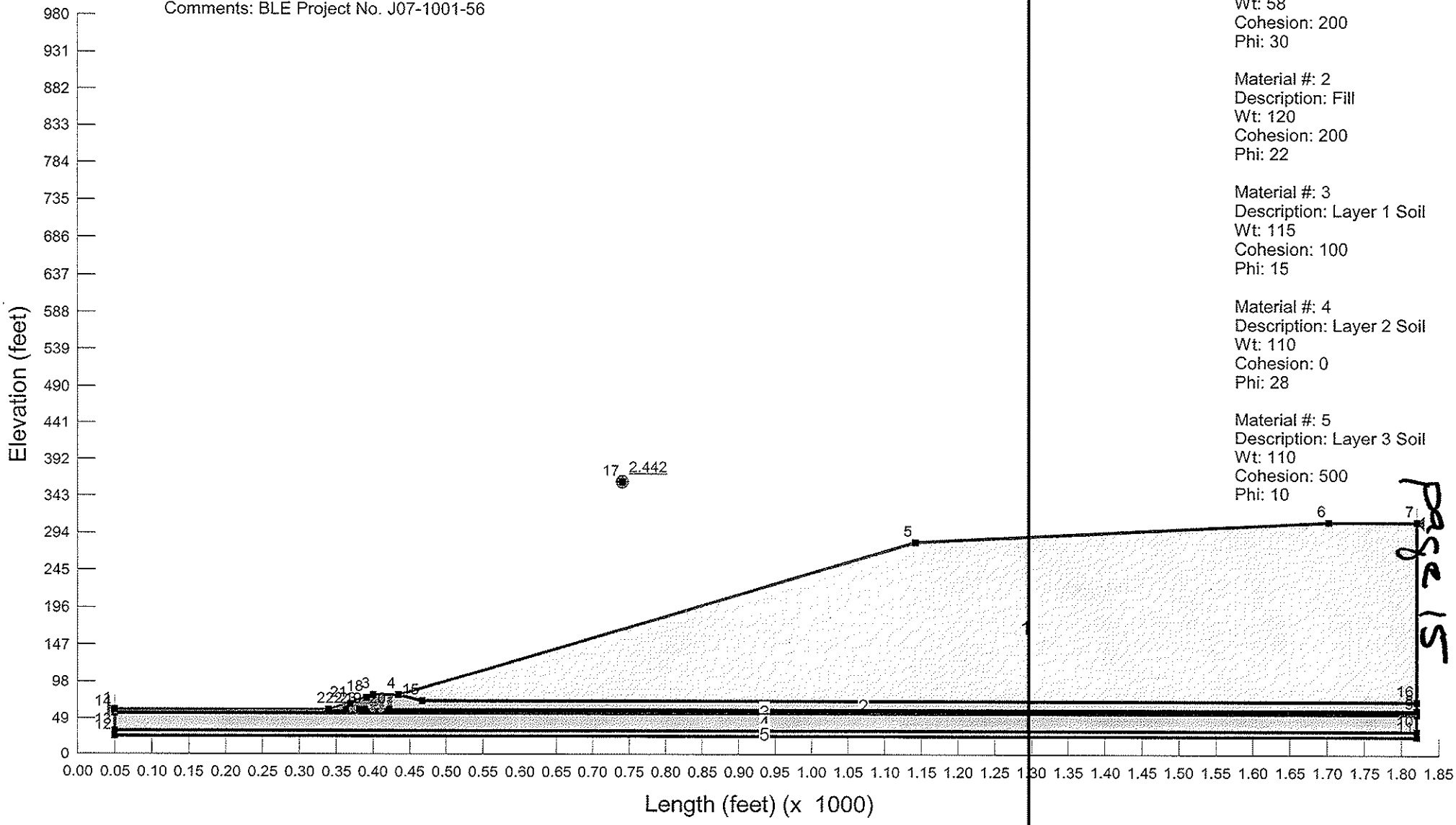
Directory: C:\Public PC033\Slope Stability\East Carolina Regional MSWLF\January 4 2008 Runs\
Name: Block Fill Total.gsz
Date: 1/4/2008
Comments: BLE Project No. J07-1001-56



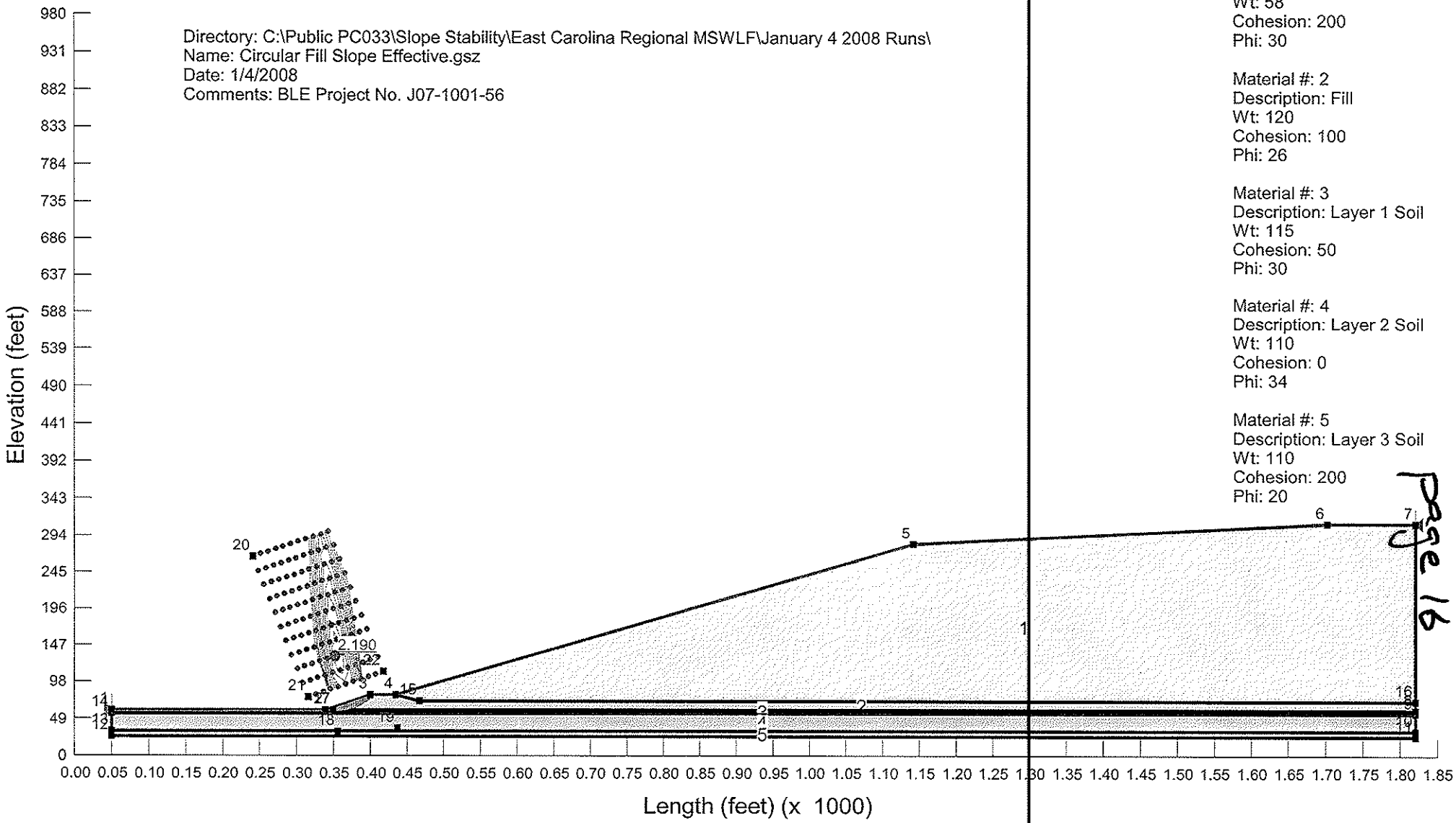
Material #: 1
Description: Waste
Wt: 58
Cohesion: 200
Phi: 30

Material #: 2
Description: Fill
Wt: 120
Cohesion: 200
Phi: 22

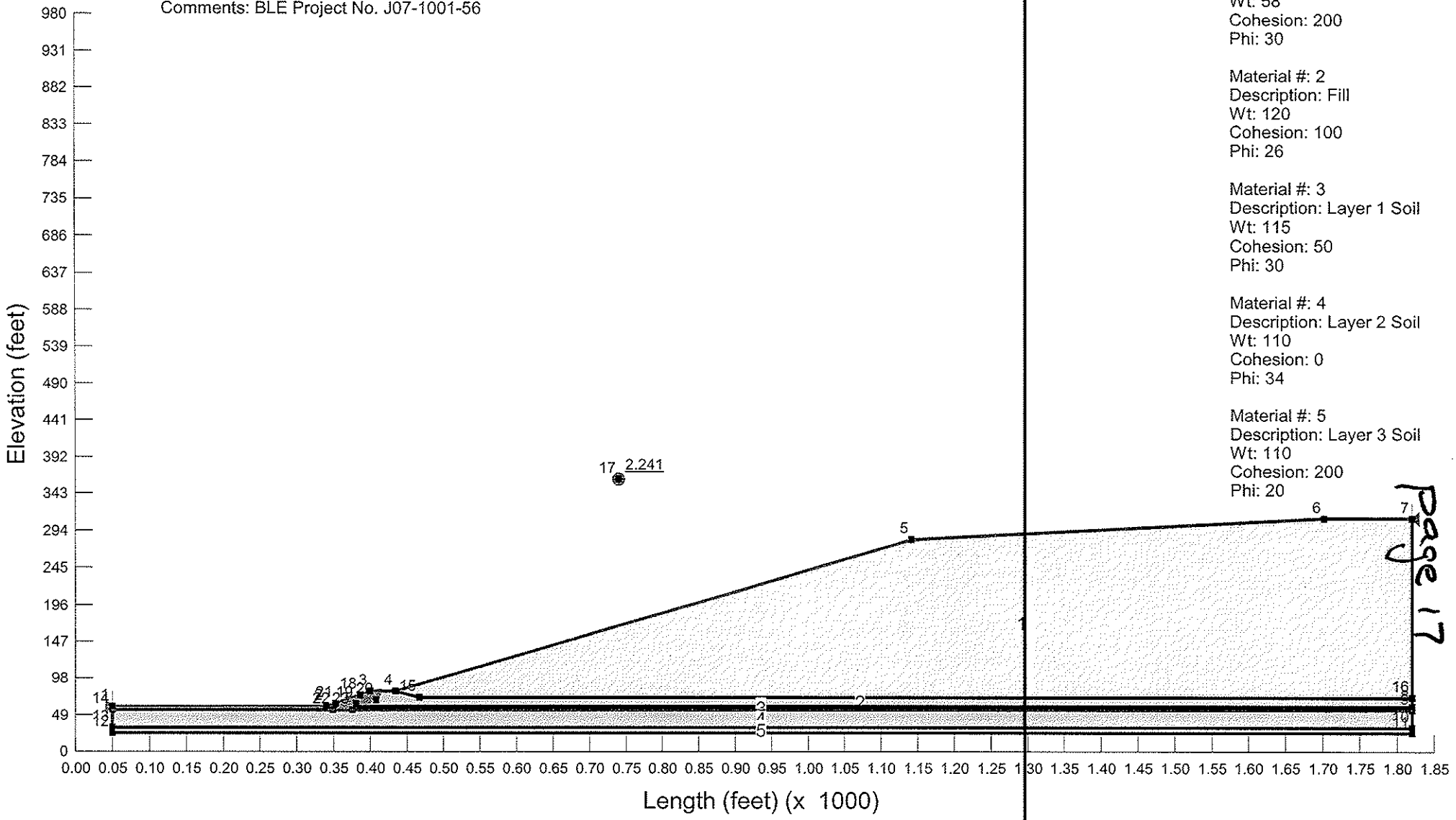
Material #: 3
Description: Layer 1 Soil
Wt: 115
Cohesion: 100
Phi: 15

Material #: 4
Description: Layer 2 Soil
Wt: 110
Cohesion: 0
Phi: 28

Material #: 5
Description: Layer 3 Soil
Wt: 110
Cohesion: 500
Phi: 10


Directory: C:\Public PC033\Slope Stability\East Carolina Regional MSWLF\January 4 2008 Runs\
Name: Circular Fill Slope Effective.gsz
Date: 1/4/2008
Comments: BLE Project No. J07-1001-56
Material #: 1
Description: Waste
Wt: 58
Cohesion: 200
Phi: 30
Material #: 2
Description: Fill
Wt: 120
Cohesion: 100
Phi: 26
Material #: 3
Description: Layer 1 Soil
Wt: 115
Cohesion: 50
Phi: 30
Material #: 4
Description: Layer 2 Soil
Wt: 110
Cohesion: 0
Phi: 34
Material #: 5
Description: Layer 3 Soil
Wt: 110
Cohesion: 200
Phi: 20
Elevation (feet)
980
931
882
833
784
735
686
637
588
539
490
441
392
343
294
245
196
147
98
49
0
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50 0.55 0.60 0.65 0.70 0.75 0.80 0.85 0.90 0.95 1.00 1.05 1.10 1.15 1.20 1.25 1.30 1.35 1.40 1.45 1.50 1.55 1.60 1.65 1.70 1.75 1.80 1.85
Length (feet) (x 1000)

Directory: C:\Public PC033\Slope Stability\East Carolina Regional MSWLF\January 4 2008 Runs\
Name: Block Fill Effective.gsz
Date: 1/4/2008
Comments: BLE Project No. J07-1001-56



Material #: 1
Description: Waste
Wt: 58
Cohesion: 200
Phi: 30

Material #: 2
Description: Fill
Wt: 120
Cohesion: 100
Phi: 26

Material #: 3
Description: Layer 1 Soil
Wt: 115
Cohesion: 50
Phi: 30

Material #: 4
Description: Layer 2 Soil
Wt: 110
Cohesion: 0
Phi: 34

Material #: 5
Description: Layer 3 Soil
Wt: 110
Cohesion: 200
Phi: 20

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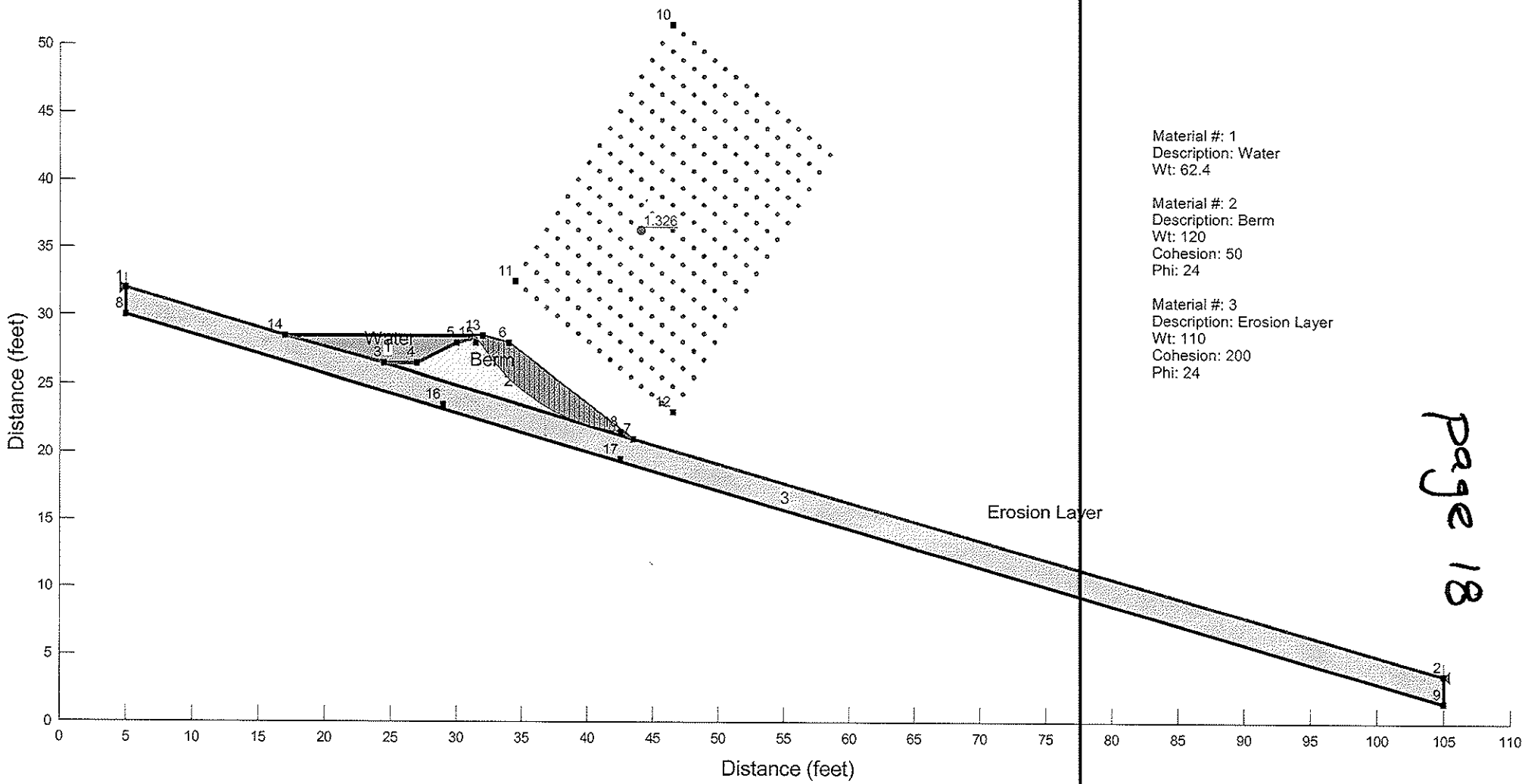
Title: East Carolina Regional MSWLF Phase 5 - Side Slope Berm
Directory: C:\Public PC033\Slope Stability\East Carolina Regional MSWLF\January 4 2008 Runs\Berm Circular.gsz
Comments: BLE Project No. J07-1001-56
Date: 1/4/2008
Time: 10:49:19 AM



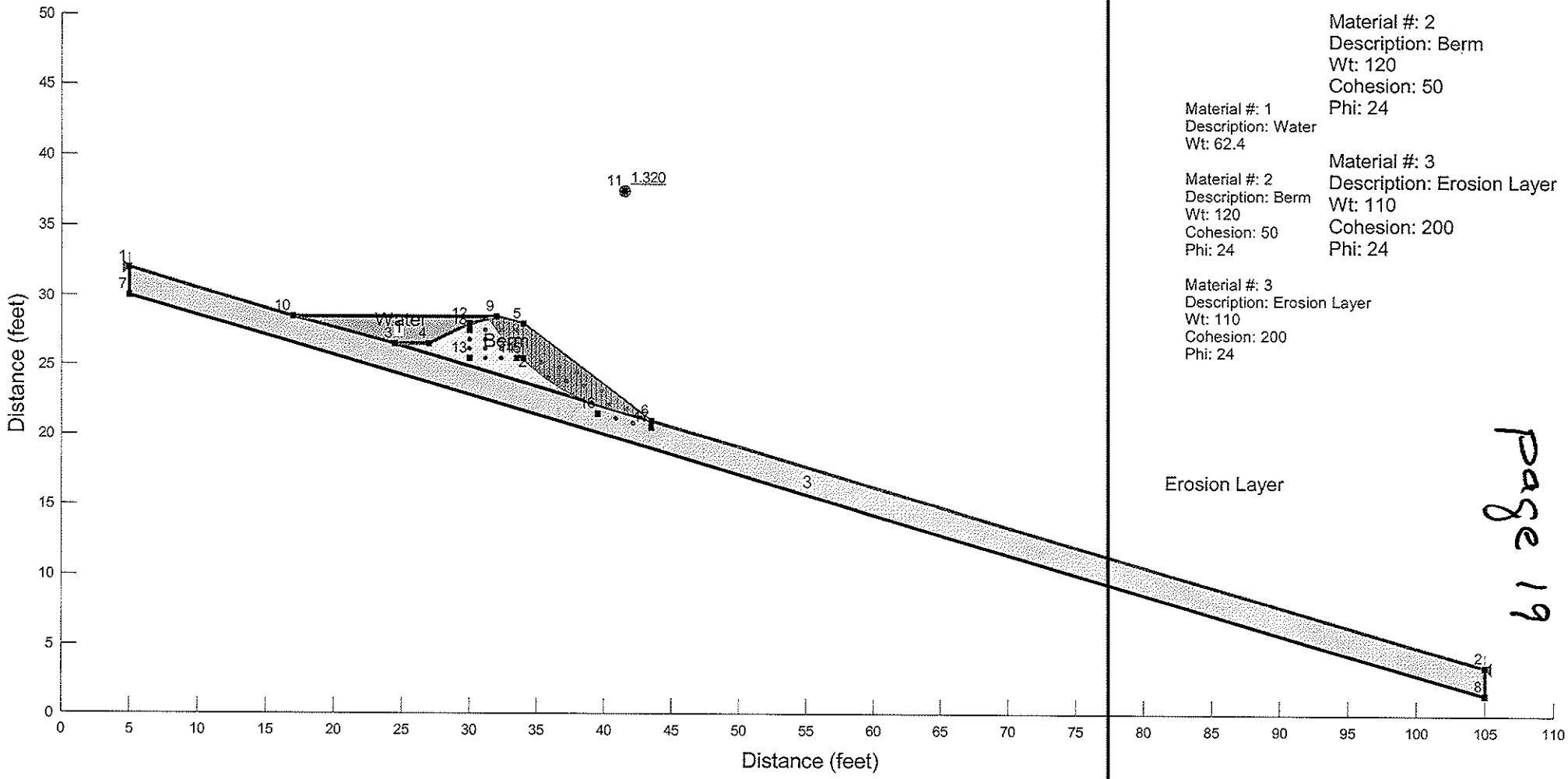
Material #: 1
Description: Water
Wt: 62.4

Material #: 2
Description: Berm
Wt: 120
Cohesion: 50
Phi: 24

Material #: 3
Description: Erosion Layer
Wt: 110
Cohesion: 200
Phi: 24

Description: East Carolina Regional MSWLF Phase 5 - Side Slope Berm
File Name: Berm Block.gsz
Last Saved Date: 1/4/2008
Last Saved Time: 10:46:00 AM
Seismic Coefficient (0.1g): horz: 0, vert: 0

Title: East Carolina Regional MSWLF Phase 5 - Side Slope Berm
Directory: C:\4\2008\PC033\Slope Stability\East Carolina Regional MSWLF\January 4 2008 Runs\Berm Block.gsz
Comments: BLE Project No. J07-1001-56
Date: 1/4/2008
Time: 10:46:00 AM



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BASE LINER STABILITY

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS
GREENVILLE, SOUTH CAROLINA · ASHEVILLE, NORTH CAROLINA

JOB NO. 107-1001-56 SHEET 1 OF 3
PHASE _____ TASK _____
JOB NAME EAST CAROLINA PHASE V
BY JUSTIN GOSS DATE 1/7/2007
CHECKED BY G. Weekley DATE 1-7-08

STABILITY OF COVER SOIL FINITE SLOPE

REFERANCE: KOERNER, ROBERT M. L.: DESIGNING WITH GEOSYNTHETICS, 4th ED.; PRENTICE HALL: UPPER SADDLE RIVER, NJ, 1999; pg. 478-483.

W_A = TOTAL WEIGHT OF ACTIVE WEDGE
W_P = TOTAL WEIGHT OF PASSIVE WEDGE
N_A = EFFECTIVE FORCE NORMAL TO THE FAILURE PLANE OF THE ACTIVE WEDGE
N_P = EFFECTIVE FORCE NORMAL TO THE FAILURE PLANE OF THE PASSIVE WEDGE
γ = UNIT WEIGHT OF THE COVER SOIL
h = THICKNESS OF THE COVER SOIL
L = LENGTH OF SLOPE MEASURED ALONG GEOMEMBRANE
β = SOIL SLOPE ANGLE BENEATH GEOMEMBRANE
ϕ = FRICTION ANGLE OF COVER SOIL
δ = INTERFACE FRICTION ANGLE BETWEEN COVER SOIL AND GEOMEMBRANE
C_a = ADHESIVE FORCE BETWEEN COVER SOIL OF THE ACTIVE WEDGE AND THE GEOMEMBRANE
c_a = ADHESION BETWEEN COVERSOIL OF THE ACTIVE WEDGE AND GEOMEMBRANE

$$a = (W_A - N_A \cos\beta)\cos\beta$$

$$b = -[W_A - N_A \cos\beta)\sin\beta \tan\phi + (N_A \tan\delta + C_a)\sin\beta\cos\beta + [\sin\beta(C + W_P \tan\phi)]$$

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

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS
GREENVILLE, SOUTH CAROLINA • ASHEVILLE, NORTH CAROLINA

JOB NO. 107-1001-56 SHEET 2 OF 3
PHASE _____ TASK _____
JOB NAME EAST CAROLINA PHASE V
BY JUSTIN GOSS DATE 1/7/2008
CHECKED BY G. Wookey DATE 1-7-08

— $W_A = \gamma h^2 \left(\frac{L}{h} - \frac{1}{\sin\beta} - \frac{\tan\beta}{2} \right)$

$120 \times 2^2 \left(\frac{113.5}{2} - \frac{1}{\sin(14)} - \frac{\tan(14)}{2} \right)$

$W_A = 25196.0$ lb/ft

— $N_A = W_A \cos\beta$

$= 25196.0 * \cos(14)$

$N_A = 24447.6 \frac{lb}{ft}$

— $W_p = \frac{\gamma h^2}{\sin 2\beta}$

$= \frac{120 \times 2^2}{\sin[2(14)]}$

$W_p = 1022.4$ lb/ft

— $a = (W_A - N_A \cos\beta)\cos\beta$

$(25196.0 - 24447.6\cos(14))\cos(14)$

$a = 1430.8 \frac{lb}{ft}$

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

$= -2551.7 \frac{lb}{ft}$

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

$= (24447.6\tan(21) + 0)\sin^2(14)\tan(30)$

$C = 317.1 \frac{lb}{ft}$

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS
GREENVILLE, SOUTH CAROLINA • ASHEVILLE, NORTH CAROLINA

JOB NO. 07-1001-56 SHEET 3 OF 3
PHASE _____ TASK _____
JOB NAME EAST CAROLINA PHASE V
BY JUSTIN GOSS DATE 1/7/2008
CHECKED BY G. Wakley DATE 1-7-08

STABILITY OF COVER SOIL
FINITE SLOPE

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{2551.7 + \sqrt{2551.7^2 - 4(1430.8)(317.1)}}{2(1430.8)}$$

$FS = \boxed{1.6} \geq 1.5$ ∴ OK AGAINST SLIDING

CAP STABILITY

BLE INC.
BUNNELL-LAMMONS ENGINEERING, INC.
GEOTECHNICAL, ENVIRONMENTAL AND CONSTRUCTION MATERIALS CONSULTANTS
GREENVILLE, SOUTH CAROLINA • ASHEVILLE, NORTH CAROLINA

JOB NO. J07-1001 SHEET ____ OF ____
PHASE 56 TASK ____
JOB NAME East Carolina MSW LF
BY Gary Weekley DATE 1-7-08
CHECKED BY DAN BUNNELL DATE 1-7-08

Stability of Final Cover Veneer Against Sliding

Reference: Matasovic, N (1991) Selection of Method for Seismic Slope Stability Analysis "Proceedings of Second International Conference on Recent Advances in Geotechnical Earthquake Engineering & Soil Dynamics, St. Louis, Volume 2, pages 1057-1062

$$FS = \frac{C/(\gamma z \cos^2\beta) + \tan\phi\,(1 - \gamma_w (z - d_w)/(\gamma z))}{\tan\beta}$$

FS = Factor of Safety (1.5 minimum)
C = Cohesion of Cover Layer (40 psf)
γ = Unit Weight of Cover Layer (120 pcf)
z = Depth to Failure Surface (2 Feet)
β = Slope Angle (3.5:1V, or 15.9°)
ϕ = Interface Friction Angle of assumed Failure Surface (20°)
γ_w = Unit Weight of Water
d_w = Depth of Seepage Surface (1.0 Foot)

$$FS = \frac{40/(120 \times 2 \times \cos^2 15.9^\circ) + \tan 20^\circ\,(1 - 62.4(2 - 1.0)/(120 \times 2))}{\tan 15.9^\circ}$$

$$FS = \frac{0.180 + 0.269}{0.285} = 1.58 > 1.5 \quad \text{OK}$$

IX. ENGINEERING PLANS

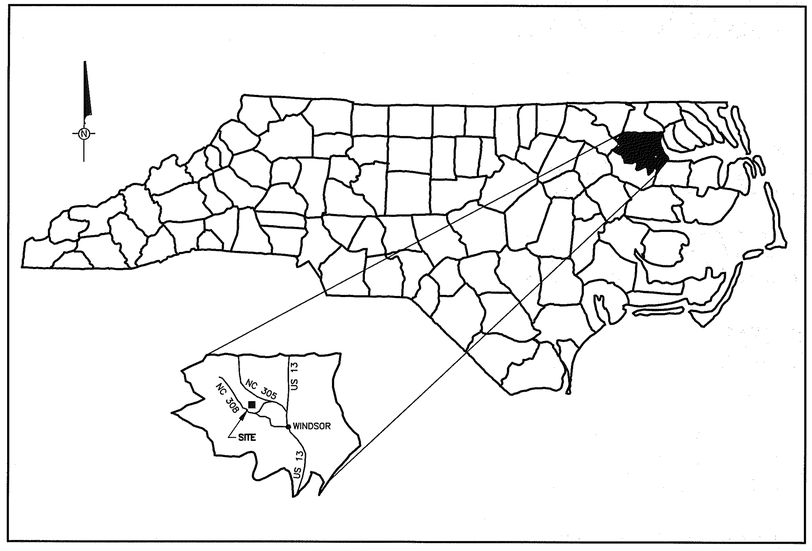
PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR

EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA , LLC

BERTIE COUNTY, NORTH CAROLINA

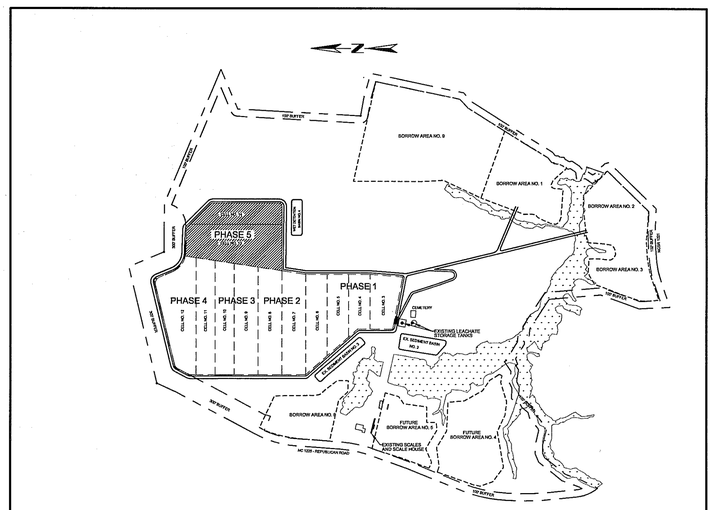
APRIL, 2008



BERTIE COUNTY, NORTH CAROLINA

OWNER AND OPERATOR

EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
1922 REPUBLICAN ROAD
AULANDER, NORTH CAROLINA 27805
252-348-3322



PROJECT SITE LOCATION
NOT TO SCALE

HODGES, HARBIN, NEWBERRY
& TRIBBLE, INC.

484 MULBERRY STREET, SUITE 265 - MACON, GEORGIA 31201
P.O. BOX 974 - MACON, GEORGIA 31202
(478) 743-7175

NORTH CAROLINA PROFESSIONAL SEAL 16146 ENGINEER WILLIAM F. HODGES 4/4/08

NORTH CAROLINA PROFESSIONAL SEAL 15742 ENGINEER H. LOWRY TRIBBLE, JR. 4/4/08

REVISION HISTORY

DATE	SHEET NO.

EDP4-TS
4-4-08

INDEX TO DRAWINGS

SHEET NO.	DESCRIPTION
-	TITLE SHEET
1	INDEX TO DRAWINGS AND LEGEND
2	BOUNDARY SURVEY
3	EXISTING TOPOGRAPHICAL SURVEY
4	TOP OF CLAY LINER GRADING PLAN
5	LEACHATE COLLECTION PLAN
6	FINAL GRADING PLAN
7	FINAL DRAINAGE PLAN
8	EROSION CONTROL PLAN
9	ENVIRONMENTAL MONITORING PLAN
10	CENTERLINE PROFILES
11	LANDFILL - CROSS SECTION A
12	LANDFILL - CROSS SECTION B
13	SEQUENCE OF FILL - CELL NO. 13
14	SEQUENCE OF FILL - CELL NO. 14
15	SEQUENCE OF FILL - PHASE 5 FINAL GRADES
16	GENERAL CONSTRUCTION DETAILS
17-18	LINER AND LEACHATE SYSTEM DETAILS
19	MISCELLANEOUS DETAILS

NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 866,800.00, E 2,571,191.63
ELEV. = 63.88

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 867,341.41, E 2,570,659.21
ELEV. = 63.78

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALE HOUSE
N 866,355.17, E 2,570,278.99
ELEV. = 56.64

LOCAL COORDINATE SYSTEM

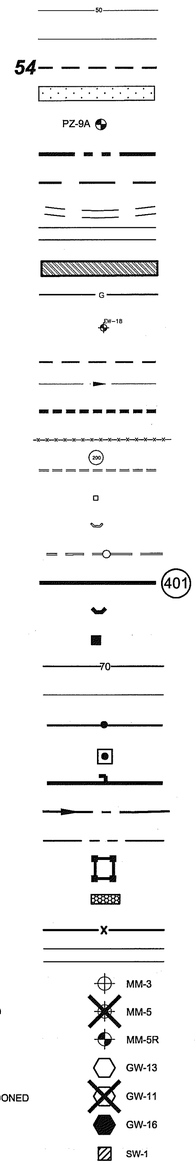
HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11220.50, E 6155.61

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11802.03, E 5667.35

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST
OF SCALE HOUSE
ELEV. = 56.64

LEGEND

EXISTING 10' CONTOUR
EXISTING 2' CONTOUR
EXISTING GROUNDWATER CONTOUR
JURISDICTIONAL WETLANDS
SOIL BORING OR PIEZOMETER
PROPERTY LINE
BUFFER LINE
EXISTING UNPAVED ROAD
EXISTING PAVED ROAD
EXISTING BUILDING
EXISTING GAS LINE
EXISTING GAS WELL
EXISTING EDGE OF CELL
EXISTING DITCH LINE
BORROW AREA
EXISTING FENCE
EXISTING STORM PIPE
EXISTING DROP INLET
EXISTING HEADWALL
EXISTING LEACHATE MANHOLE AND PIPE
PROPOSED STORM PIPE
PROPOSED HEADWALL
PROPOSED DROP INLET
PROPOSED 10' CONTOUR
PROPOSED 2' CONTOUR
PROPOSED LEACHATE PIPE & AIR RELEASE VALVE
PROPOSED LEACHATE CLEANOUT
PROPOSED SIDE SLOPE DOWNDRAIN PIPE AND RISER
PROPOSED SIDE SLOPE BERMS
PROPOSED STORM WATER CONVEYANCE CHANNEL
PROPOSED DROP INLET PROTECTION
PROPOSED OUTLET PROTECTION
PROPOSED SILT FENCE
PROPOSED ACCESS ROAD
APPROXIMATE LOCATION OF EXISTING METHANE MONITORING POINT
APPROXIMATE LOCATION OF EXISTING METHANE MONITORING POINT TO BE ABANDONED
APPROXIMATE LOCATION OF PROPOSED METHANE MONITORING POINT
APPROXIMATE LOCATION OF EXISTING GROUNDWATER MONITORING WELL
APPROXIMATE LOCATION OF EXISTING GROUNDWATER MONITORING WELL TO BE ABANDONED
APPROXIMATE LOCATION OF PROPOSED GROUNDWATER MONITORING WELL
APPROXIMATE LOCATION OF EXISTING SURFACE WATER MONITORING POINT



INDEX TO DRAWINGS AND LEGEND

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG. ECP5-NT	EDIT 4-1-08
SCALE	NOT TO SCALE	SHEET 1 OF 19	
DATE	APRIL, 2008		

Compiled Plat for :

REPUBLIC SERVICES of NORTH CAROLINA, L.L.C.

d.b.a. East Carolina Environmental

A portion of the Spruill Farms, Inc. property
along the east side of N.C. Secondary Road 1225
Snakebite Township, Bertie County, North Carolina
Deed Reference Book 704 Page 315, Book 706 Page 898,
Book 549 Page 346, Book 675 Page 227,
Book 716 Page 677, and Book 725 Page 655.
Plat Cabinet A Slides 1094, 1095, and 1121.
Plat Cabinet B Slides 28, 36, and 81.

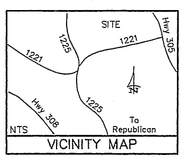
Surveyed by Thomas J. Fields, PLS-2906, on January 17, 1994
thru November 13, 1995.

REVISED & UPDATED on February 19, 2001.

TOTAL AREA = 662.59 Acres ±
by D.M.D.
(including area within Bunch Cemetery)

400 0 400
Scale Is In Feet
1"= 400'

From the office of
WRIGHT & FIELDS LAND SURVEYING
303 WEST SPRING STREET
TROY, N.C. 27371



VICINITY MAP

No horizontal control within 2000 feet.

MAGNETIC NORTH
Bearings based on local coordinates supplied at site

Curve Data along center of NCSR 1225

CURVE	DELTA	RADIUS	ARC	CHORD	TANGENT	CHORD BRG
1	33°24'50"	587.81	342.80	337.96	176.43	S 21°29'17" E
2	9°40'28"	3842.00	650.96	650.19	326.26	S 00°42'12" W
3	14°18'27"	2000.57	499.57	498.27	251.09	S 13°27'20" W
4	2°48'38"	12174.49	597.21	597.15	298.67	N 19°22'28" E
5	11°28'08"	1833.79	366.00	365.39	183.61	N 10°19'01" E
6	23°34'38"	1396.59	574.70	570.65	291.47	S 16°04'03" W
7	5°34'13"	2922.38	284.39	284.28	142.31	N 24°20'38" E
8	5°18'12"	7201.84	666.61	666.38	333.54	N 18°09'46" E
9	5°50'10"	1123.35	114.42	114.37	57.26	N 11°00'03" E

Bearings & Distances along old marked and painted lines adjacent to Mill Branch and another small branch

LINE	BEARING	DISTANCE
27	N 56°45'09" W	321.27
28	N 56°59'28" W	169.99
29	N 84°11'57" W	109.99
30	N 30°25'14" W	91.46
31	S 59°55'54" W	30.70
32	N 84°55'07" W	35.03
33	N 56°42'25" W	63.46
34	N 59°26'26" W	171.12
35	S 69°16'03" W	83.39
36	N 19°32'21" W	33.44
37	S 55°11'09" W	76.59
38	N 81°03'05" W	168.60
39	S 62°39'46" W	77.59
40	N 86°43'47" W	117.72
41	S 33°09'45" W	120.11
42	S 62°12'07" W	49.08
43	S 38°45'10" W	120.49
44	S 73°48'49" W	95.01
45	S 52°31'59" W	82.07
46	S 49°40'47" W	97.95
47	S 68°47'05" W	79.40
48	N 76°23'29" W	211.38
49	N 88°51'29" W	111.70
50	S 66°14'18" W	76.38
51	S 37°40'50" W	190.55
52	S 39°12'04" W	182.63
53	S 19°52'22" W	232.01
54	S 26°19'56" W	258.02

Bearings & Distances around the Bunch Cemetery

LINE	BEARING	DISTANCE
55	S 84°10'06" E	78.04
56	S 05°50'51" W	56.69
57	N 84°08'54" W	78.04
58	N 05°50'55" E	56.66

containing 0.10 Acre ±

Bearings & Distances along center of NCSR 1221

LINE	BEARING	DISTANCE
19	N 86°24'39" W	50.05
20	N 87°16'44" W	105.01
21	N 88°29'36" W	118.05
22	S 88°09'36" W	178.50
23	S 85°35'15" W	209.21
24	S 80°17'27" W	141.50
25	S 73°21'07" W	155.73
26	S 71°13'39" W	358.63

Bearings & Distances along small branch

LINE	BEARING	DISTANCE
1	S 50°13'41" W	64.84
2	S 04°08'16" W	48.25
3	S 64°20'45" W	16.53
4	S 05°27'07" W	67.97
5	S 61°54'56" W	30.58
6	S 29°30'07" W	64.24
7	S 10°32'19" E	38.72
8	S 32°42'12" W	119.94
9	S 47°46'17" W	53.78
9A	S 44°41'09" W	18.34
10	S 82°29'41" W	31.12
11	S 14°38'49" E	57.81
12	S 46°42'58" W	26.06
13	S 32°55'29" W	73.40

Bearings & Distances along Mill Branch

14	S 30°19'39" E	44.00
15	S 53°15'01" E	75.70
16	S 38°17'29" E	63.40
17	S 41°20'26" E	58.92
18	S 15°00'04" E	54.75

Job No. 2001-22

Katherine S. Burden
D.B. 554 Pg. 55
plat recorded at
D.B. 686 Pg. 837

Willie W. Tripp & wife,
Evelyn B. Tripp
D.B. 613 Pg. 258
plat recorded at
D.B. 602 Pg. 585

Lease Agreement
D.B. 744 Pg. 337
Plat Cabinet B
Slide 172

34.12 Acres ±

Spruill Farms, Inc.
Hoggard Tract
D.B. 483 Pg. 396
Item No. 31
D.B. 212 Pg. 390
Map Book 8 Page 24

Hubert Cherry
D.B. 760 Pg. 753
D.B. 603 Pg. 226
plat recorded at
D.B. 438 Pg. 110
Tract A

Spruill Farms, Inc.
Joe Pritchard Farm Tract
D.B. 483 Pg. 396
Item No. 19
D.B. 209 Pg. 599
Map Book 8 Page 24

East Carolina Environmental
D.B. 706 Pg. 898
Plat Cabinet A Slide 1121

East Carolina Environmental
D.B. 725 Pg. 655
Plat Cabinet B Slide 81

East Carolina Environmental
D.B. 716 Pg. 677
Plat Cabinet B Slide 36

East Carolina Environmental
D.B. 705 Pg. 49
1.28 Acres ±

Weyerhaeuser Company
D.B. 549 Pg. 346

Weyerhaeuser Company
N.C. Pulp Company
Simon Cherry Tract
D.B. 394 Pg. 480
Map Book 1 Page 159

Charles R. Newsom
D.B. 695 Pg. 149
Map Book 2 Page 77

Mildred P. Bazemore
"Patsy Tract"
D.B. 314 Pg. 498

Mildred P. Bazemore
"Gardner Land"
D.B. 351 Pg. 580

James W. Watson
D.B. 694 Pg. 656

Vanderbilt Cherry, Sr.
D.B. 777 Pg. 148

James A. Garriss,
Theophilus M. Garriss, Jr.
and Theodora F. Garriss Oyelowo
D.B. 701 Pg. 776

William W. Pritchett, Jr.
D.B. 689 Pg. 237
(remainder)

Bianka, Inc.
D.B. 709 Pg. 835

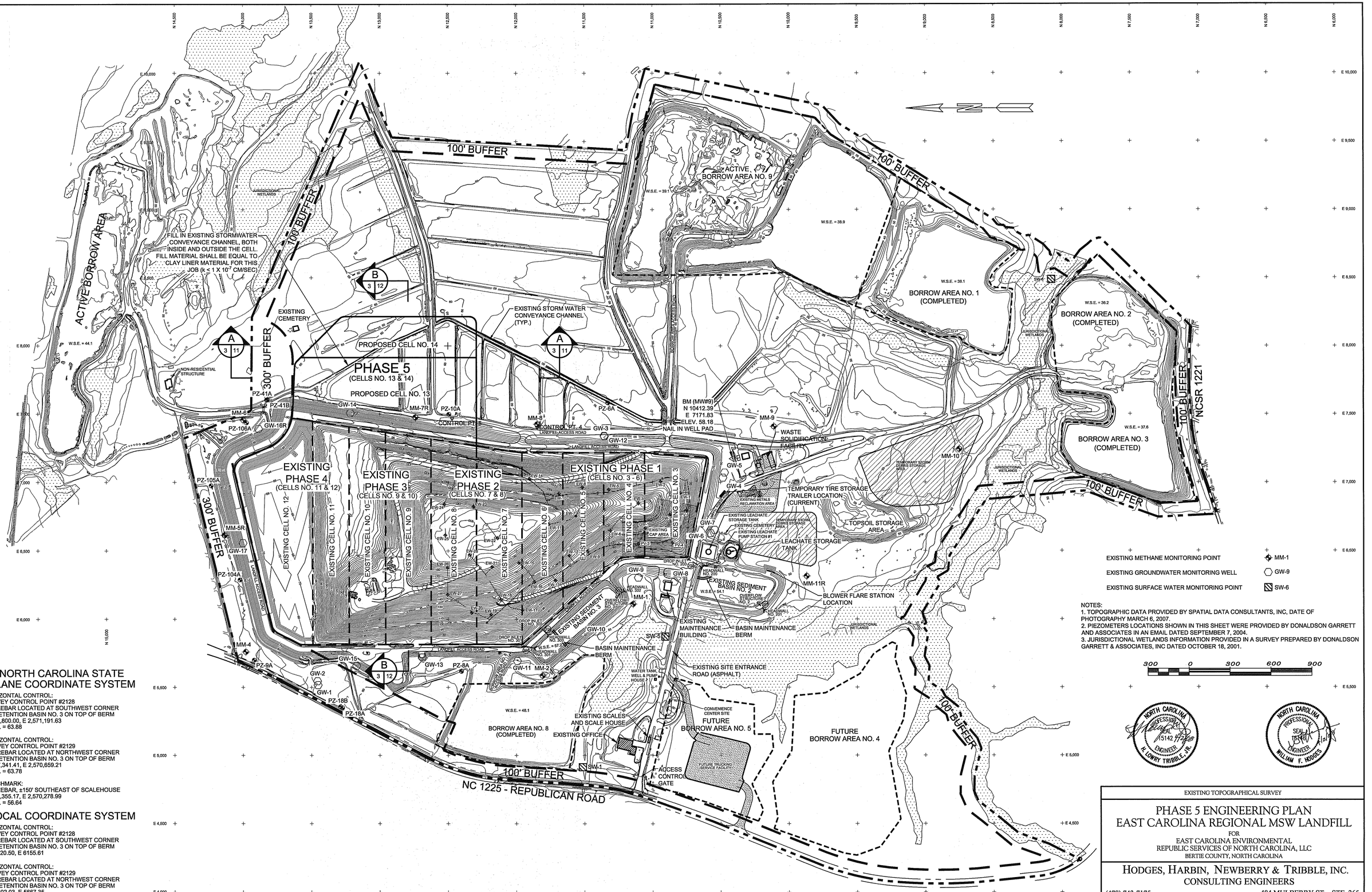
Legend
o ..... denotes monuments found or set as noted on plat.
D.B. ..... Deed Book
Pg. ..... Page

NORTH CAROLINA
BERTIE COUNTY

I, Thomas J. Fields, certify that this plat was prepared from an actual survey done by me in Jan 94-Nov 95 and is in all respects correct to the best of my knowledge and belief. The ratio of precision as calculated by latitudes and departures is 1:20,000+. This plat was prepared in accordance with Board Rule .1600 Witness my original signature and official stamp this the 19th day of February 2001.

Thomas J. Fields
SURVEYOR PLS-2906

SEAL L-2906 NORTH CAROLINA PROFESSIONAL LAND SURVEYOR THOMAS JEFFREY FIELDS



NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 866,800.00, E 2,571,191.63
ELEV. = 63.88

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 867,341.41, E 2,570,659.21
ELEV. = 63.78

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
N 866,355.17, E 2,570,278.99
ELEV. = 56.64

LOCAL COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11220.50, E 6155.61

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11802.03, E 5667.35

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST
OF SCALEHOUSE
ELEV. = 56.64

NOTES:
1. TOPOGRAPHIC DATA PROVIDED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
2. PIEZOMETERS LOCATIONS SHOWN IN THIS SHEET WERE PROVIDED BY DONALDSON GARRETT AND ASSOCIATES IN AN EMAIL DATED SEPTEMBER 7, 2004.
3. JURISDICTIONAL WETLANDS INFORMATION PROVIDED IN A SURVEY PREPARED BY DONALDSON GARRETT & ASSOCIATES, INC DATED OCTOBER 18, 2001.

300 0 300 600 900

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER H. LOWRY TRIBBLE, JR.

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER WILLIAM F. HODGES 12/2/08

EXISTING TOPOGRAPHICAL SURVEY

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG. ECP5-TP	EDIT 4-1-08
SCALE	1" = 300'	SHEET 3 OF 19	
DATE	APRIL, 2008		

DRAINAGE STRUCTURES

PIPE NO.	SIZE (DIA)	LENGTH	SLOPE	MATERIAL
200 (E)	54"	113'	4.14%	RCP
201 (E)	30"	69'	2.97%	RCP
300 (E)	36"	67'	2.30%	CMP
301 (R)	TWIN - 48"	84'	2.56%	RCP
302 (R)	60"	71'	0.51%	RCP
400	TWIN - 42"	104'	1.92%	RCP
401	36"	75'	5.33%	RCP

DROP INLET NO.	TOP ELEV.	THROAT ELEV.	INVERT ELEV.
200 (E)	67.77	66.27	58.35
300 (E)	64.85	63.35	59.45
301 (R)	66.11	64.61	58.81
400	74.00	72.50	64.00

HEADWALL NO.	INVERT ELEV.
200 (E)	53.69
201 (E)	48.95
300 (E)	57.91
301 (R)	56.65
302 (R)	53.60
400	62.00
401	56.00

*(E) - EXISTING STRUCTURE TO REMAIN
*(R) - REPLACEMENT OF EXISTING STRUCTURE

NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

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ELEV. = 56.64

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200 0 200 400 600

TOP OF CLAY LINER GRADING PLAN

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
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REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

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CONSULTING ENGINEERS
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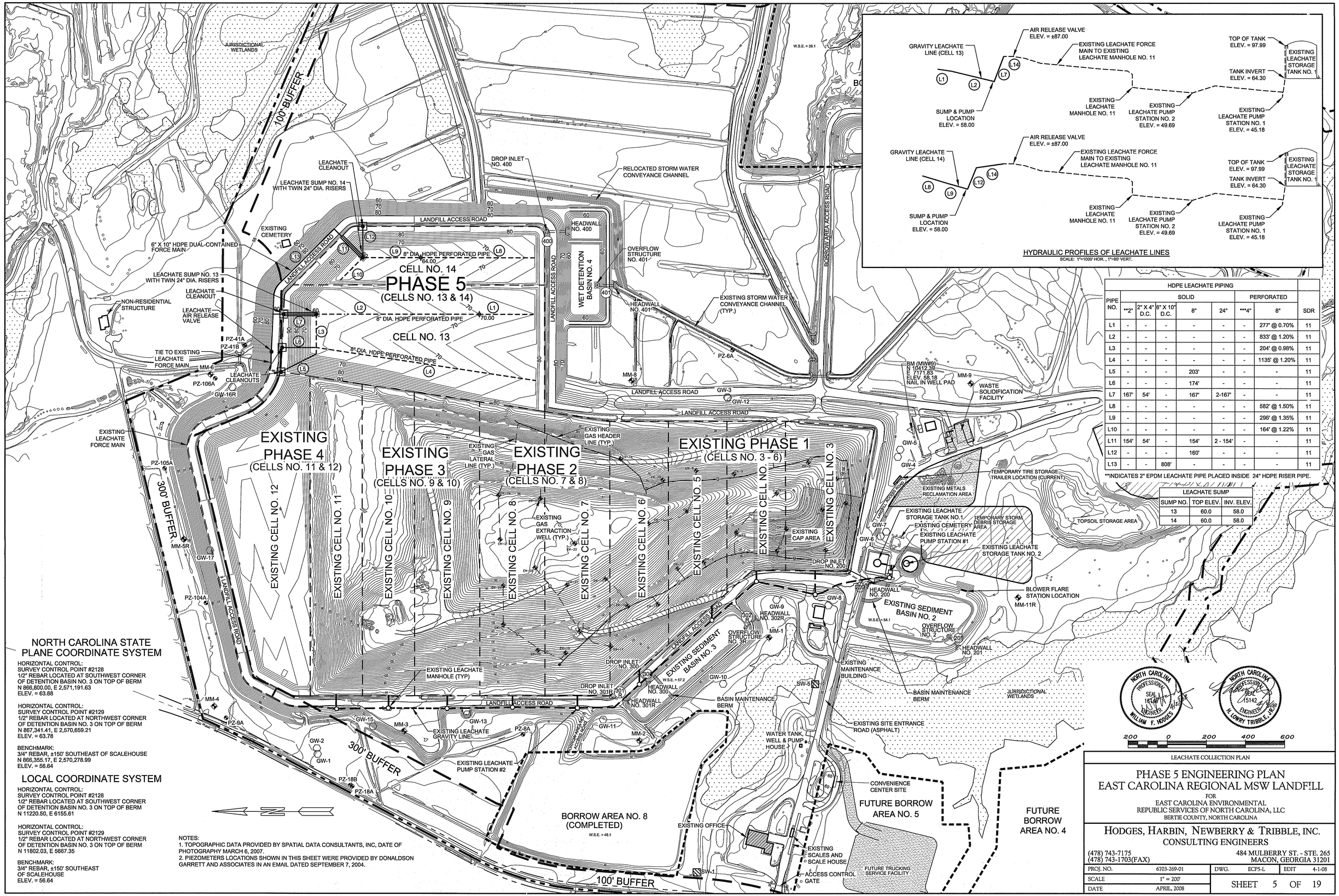
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-IG
SCALE	1" = 200'	EDIT	4-1-08
DATE	APRIL, 2008	SHEET	4 OF 19



HYDRAULIC PROFILES OF LEACHATE LINES

SCALE: 1"=1000' HOR. , 1"=80' VERT.

HDPE LEACHATE PIPING								
PIPE NO.	SOLID					PERFORATED		SDR
	**2"	2" X 4" D.C.	6" X 10" D.C.	8"	24"	***4"	8"	
L1	-	-	-	-	-	-	277' @ 0.70%	11
L2	-	-	-	-	-	-	833' @ 1.20%	11
L3	-	-	-	-	-	-	204' @ 0.98%	11
L4	-	-	-	-	-	-	1135' @ 1.20%	11
L5	-	-	-	203'	-	-	-	11
L6	-	-	-	174'	-	-	-	11
L7	167'	54'	-	167'	2-167'	-	-	11
L8	-	-	-	-	-	-	582' @ 1.50%	11
L9	-	-	-	-	-	-	296' @ 1.35%	11
L10	-	-	-	-	-	-	164' @ 1.22%	11
L11	154'	54'	-	154'	2 - 154'	-	-	11
L12	-	-	-	160'	-	-	-	11
L13	-	-	808'	-	-	-	-	11

**INDICATES 2" EPDM LEACHATE PIPE PLACED INSIDE 24" HDPE RISER PIPE.

LEACHATE SUMP		
SUMP NO.	TOP ELEV.	INV. ELEV.
13	60.0	58.0
14	60.0	58.0

NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

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3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
N 866,355.17, E 2,570,278.99
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1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11220.50, E 6155.61

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N 11802.03, E 5667.35

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ELEV. = 56.64

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NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER H. LOWRY TRIBBLE, JR.

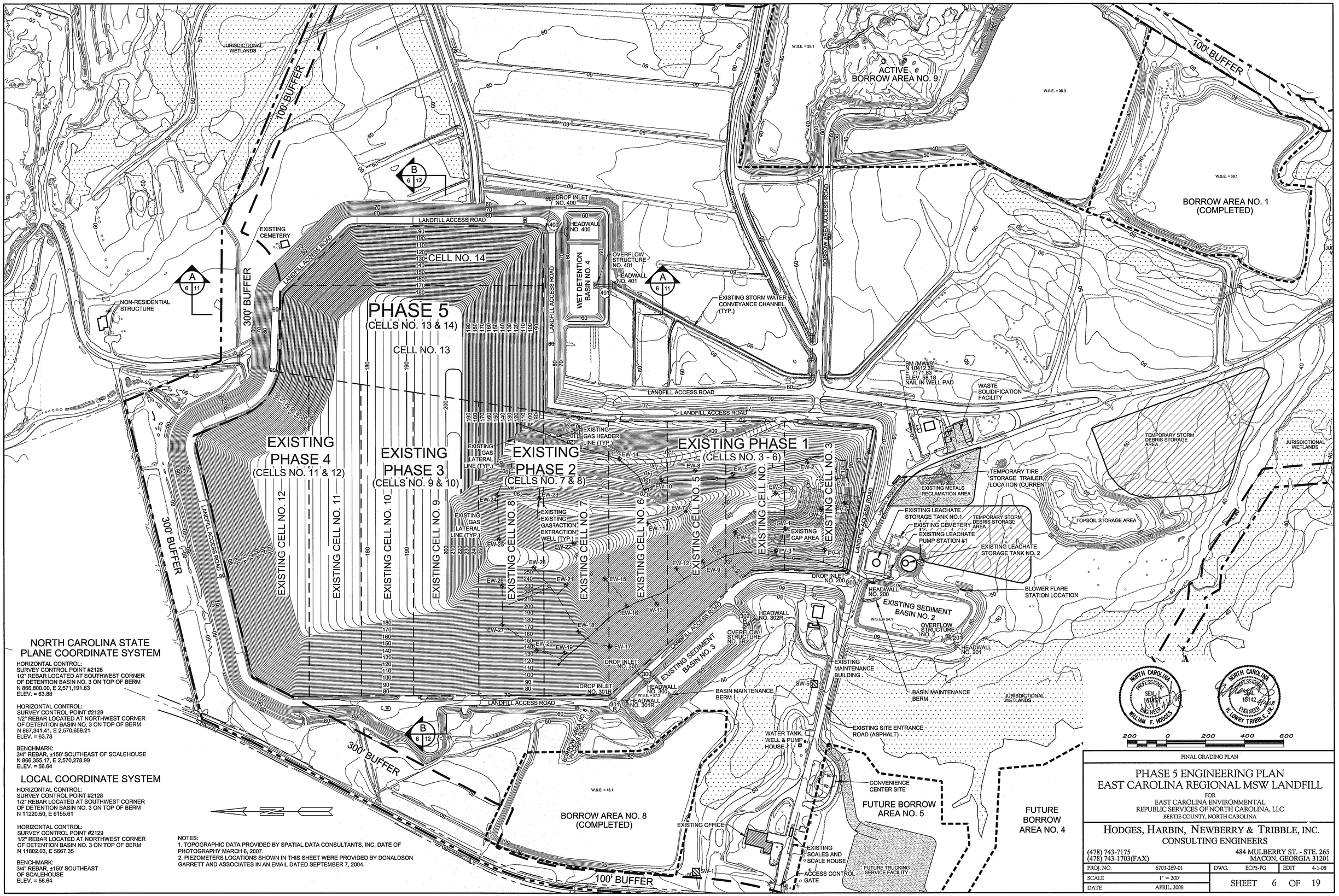
LEACHATE COLLECTION PLAN

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG. ECP5-L	EDIT 4-1-08
SCALE	1" = 200'	SHEET 5 OF 19	
DATE	APRIL, 2008		



NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

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N 11802.03, E 5667.35

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NORTH CAROLINA PROFESSIONAL SEAL 16142 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 18142 ENGINEER H. LOWRY TRIBBLE, JR.

FINAL GRADING PLAN

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
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BERTIE COUNTY, NORTH CAROLINA

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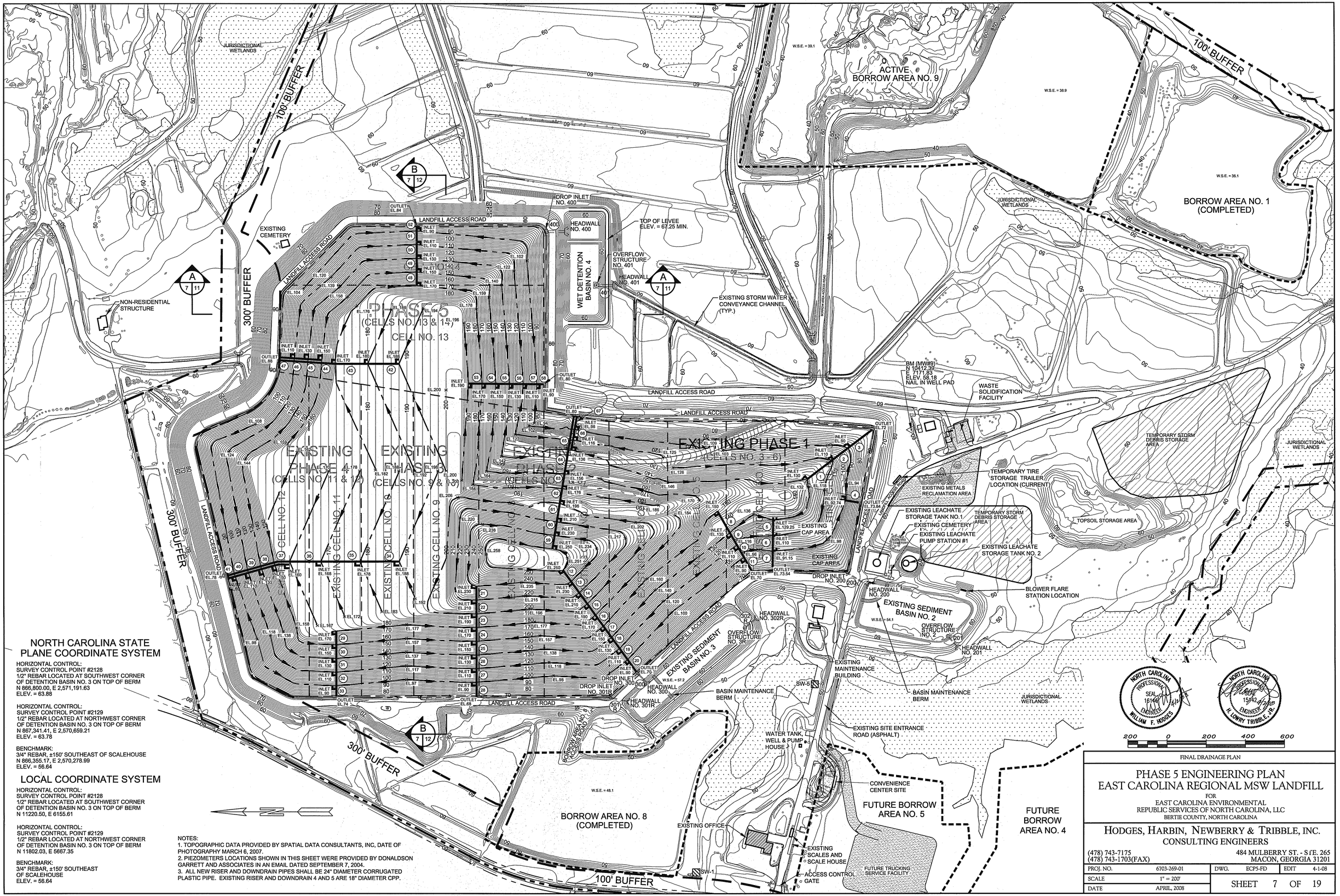
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-FG	EDIT	4-1-08
SCALE	1" = 200'	SHEET	6	OF	19
DATE	APRIL, 2008				



NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

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3. ALL NEW RISER AND DOWNDRAIN PIPES SHALL BE 24" DIAMETER CORRUGATED PLASTIC PIPE. EXISTING RISER AND DOWNDRAIN 4 AND 5 ARE 18" DIAMETER CPP.

NORTH CAROLINA PROFESSIONAL SEAL 16146 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 15942 ENGINEER H. LOWRY TRIBBLE, JR.

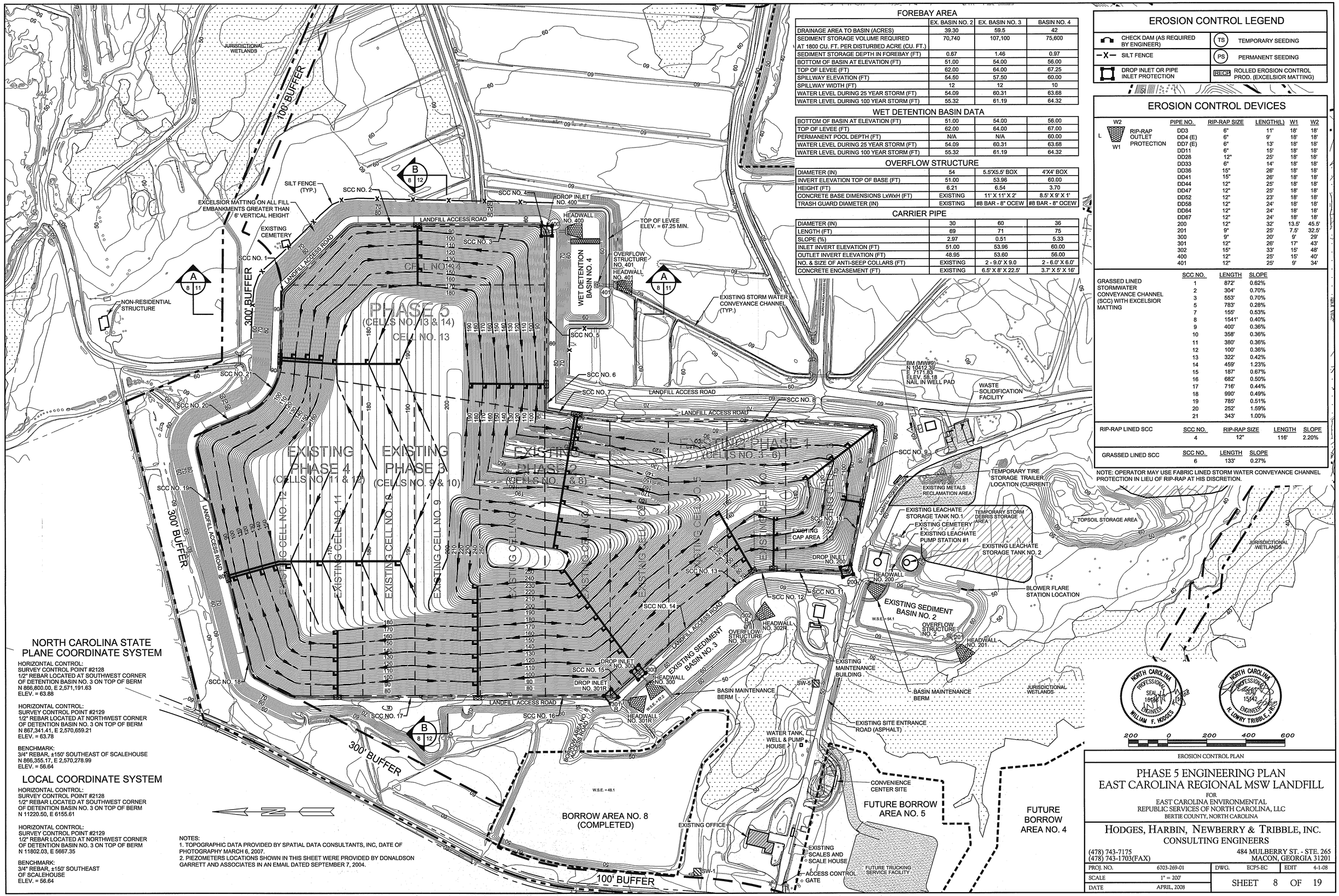
FINAL DRAINAGE PLAN

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG. ECP5-FD	EDIT 4-1-08
SCALE	1" = 200'	SHEET 7 OF 19	
DATE	APRIL, 2008		



FOREBAY AREA

	EX. BASIN NO. 2	EX. BASIN NO. 3	BASIN NO. 4
DRAINAGE AREA TO BASIN (ACRES)	39.30	59.5	42
SEDIMENT STORAGE VOLUME REQUIRED AT 1800 CU. FT. PER DISTURBED ACRE (CU. FT.)	70,740	107,100	75,600
SEDIMENT STORAGE DEPTH IN FOREBAY (FT)	0.67	1.46	0.97
BOTTOM OF BASIN AT ELEVATION (FT)	51.00	54.00	56.00
TOP OF LEVEE (FT)	62.00	64.00	67.25
SPILLWAY ELEVATION (FT)	54.50	57.50	60.00
SPILLWAY WIDTH (FT)	12	12	10
WATER LEVEL DURING 25 YEAR STORM (FT)	54.09	60.31	63.68
WATER LEVEL DURING 100 YEAR STORM (FT)	55.32	61.19	64.32

WET DETENTION BASIN DATA

BOTTOM OF BASIN AT ELEVATION (FT)	51.00	54.00	56.00
TOP OF LEVEE (FT)	62.00	64.00	67.00
PERMANENT POOL DEPTH (FT)	N/A	N/A	60.00
WATER LEVEL DURING 25 YEAR STORM (FT)	54.09	60.31	63.68
WATER LEVEL DURING 100 YEAR STORM (FT)	55.32	61.19	64.32

OVERFLOW STRUCTURE

DIAMETER (IN)	54	5.5'X5.5' BOX	4'X4' BOX
INVERT ELEVATION TOP OF BASE (FT)	51.00	53.96	60.00
HEIGHT (FT)	6.21	6.54	3.70
CONCRETE BASE DIMENSIONS LxWxH (FT)	EXISTING	11' X 11' X 2'	8.5' X 9' X 1'
TRASH GUARD DIAMETER (IN)	EXISTING	#8 BAR - 8" OCEW	#8 BAR - 8" OCEW

CARRIER PIPE

DIAMETER (IN)	30	60	36
LENGTH (FT)	69	71	75
SLOPE (%)	2.97	0.51	5.33
INLET INVERT ELEVATION (FT)	51.00	53.96	60.00
OUTLET INVERT ELEVATION (FT)	48.95	53.60	56.00
NO. & SIZE OF ANTI-SEEP COLLARS (FT)	EXISTING	2 - 9.0' X 9.0	2 - 6.0' X 6.0'
CONCRETE ENCASEMENT (FT)	EXISTING	6.5' X 8' X 22.5'	3.7' X 5' X 16'

EROSION CONTROL LEGEND

CHECK DAM (AS REQUIRED BY ENGINEER)		TS	TEMPORARY SEEDING
SILT FENCE		PS	PERMANENT SEEDING
DROP INLET OR PIPE INLET PROTECTION		RECP	ROLLED EROSION CONTROL PROD. (EXCELSIOR MATTING)

EROSION CONTROL DEVICES

RIP-RAP OUTLET PROTECTION (W2 / L / W1)

PIPE NO.	RIP-RAP SIZE	LENGTH(L)	W1	W2
DD3	6"	11'	18'	18'
DD4 (E)	6"	9'	18'	18'
DD7 (E)	6"	13'	18'	18'
DD11	6"	15'	18'	18'
DD28	12"	25'	18'	18'
DD33	6"	14'	18'	18'
DD36	15"	26'	18'	18'
DD41	15"	26'	18'	18'
DD44	12"	25'	18'	18'
DD47	12"	25'	18'	18'
DD52	12"	23'	18'	18'
DD58	12"	24'	18'	18'
DD64	12"	24'	18'	18'
DD67	12"	24'	18'	18'
200	12"	32'	13.5'	45.5'
201	9"	25'	7.5'	32.5'
300	9"	20'	9'	29'
301	12"	26'	17'	43'
302	15"	33'	15'	48'
400	12"	25'	15'	40'
401	12"	25'	9'	34'

GRASSED LINED STORM/WATER CONVEYANCE CHANNEL (SCC) WITH EXCELSIOR MATTING

SCC NO.	LENGTH	SLOPE
1	872'	0.62%
2	304'	0.70%
3	553'	0.70%
5	783'	0.28%
7	155'	0.53%
8	1541'	0.40%
9	400'	0.36%
10	358'	0.36%
11	380'	0.36%
12	100'	0.36%
13	322'	0.42%
14	459'	1.23%
15	187'	0.67%
16	682'	0.50%
17	716'	0.44%
18	990'	0.49%
19	785'	0.51%
20	252'	1.59%
21	343'	1.00%

RIP-RAP LINED SCC

SCC NO.	RIP-RAP SIZE	LENGTH	SLOPE
4	12"	116'	2.20%

GRASSED LINED SCC

SCC NO.	LENGTH	SLOPE
6	133'	0.27%

NOTE: OPERATOR MAY USE FABRIC LINED STORM WATER CONVEYANCE CHANNEL PROTECTION IN LIEU OF RIP-RAP AT HIS DISCRETION.

NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 866,800.00, E 2,571,191.63
ELEV. = 63.88

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 867,341.41, E 2,570,659.21
ELEV. = 63.78

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
N 866,355.17, E 2,570,278.99
ELEV. = 56.64

LOCAL COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11220.50, E 6155.61

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11802.03, E 5667.35

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
ELEV. = 56.64

NOTES:
1. TOPOGRAPHIC DATA PROVIDED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
2. PIEZOMETERS LOCATIONS SHOWN IN THIS SHEET WERE PROVIDED BY DONALDSON GARRETT AND ASSOCIATES IN AN EMAIL DATED SEPTEMBER 7, 2004.

NORTH CAROLINA PROFESSIONAL SEAL 16144 ENGINEER WILLIAM F. HOBBS

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER H. LOWRY TRIBBLE, JR.

EROSION CONTROL PLAN

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-EC
SCALE	1" = 200'	EDIT	4-1-08
DATE	APRIL, 2008	SHEET	8 OF 19

LEGEND

- APPROXIMATE LOCATION OF EXISTING METHANE MONITORING POINT — MM-3
- APPROXIMATE LOCATION OF EXISTING METHANE MONITORING POINT TO BE ABANDONED — MM-5
- APPROXIMATE LOCATION OF PROPOSED METHANE MONITORING POINT — MM-5R
- APPROXIMATE LOCATION OF EXISTING GROUNDWATER MONITORING WELL — GW-13
- APPROXIMATE LOCATION OF EXISTING GROUNDWATER MONITORING WELL TO BE ABANDONED — GW-11
- APPROXIMATE LOCATION OF PROPOSED GROUNDWATER MONITORING WELL — GW-16
- APPROXIMATE LOCATION OF EXISTING SURFACE WATER MONITORING POINT — SW-1
- APPROXIMATE LOCATION OF EXISTING PIEZOMETER — PZ-106A

NOTE:
LAYER II MONITORING WELLS, GW-3 AND GW-5, AND LAYER IV MONITORING WELLS, GW-1, GW-4, GW-6 AND GW-12 ARE NOT CURRENTLY USED AS PART OF THE ACTIVE WATER QUALITY MONITORING SYSTEM BUT WILL CONTINUE TO BE USED FOR WATER LEVEL MEASUREMENTS ONLY. SW-6 (NOT SHOWN) IS LOCATED SOUTH OF BORROW AREA NO. 1 IN BETWEEN BORROW AREA NO. 1 AND NO. 2.

PHASE 5 CELL CONSTRUCTION	POINTS TO BE INSTALLED	POINTS TO BE ABANDONED
CELL 13	GW-18, GW-21, MM-12	GW-14, MM-7R
CELL 14	GW-19, GW-20, MM-13, MM-14	

PHASE 5
(CELLS NO. 13 & 14)
CELL NO. 14
CELL NO. 13
EXISTING PHASE 1
(CELLS NO. 3 - 6)
EXISTING PHASE 2
(CELLS NO. 7 & 8)
EXISTING PHASE 3
(CELLS NO. 9 & 10)
EXISTING PHASE 4
(CELLS NO. 11 & 12)
EXISTING CELL NO. 3
EXISTING CELL NO. 4
EXISTING CELL NO. 5
EXISTING CELL NO. 6
EXISTING CELL NO. 7
EXISTING CELL NO. 8
EXISTING CELL NO. 9
EXISTING CELL NO. 10
EXISTING CELL NO. 11
EXISTING CELL NO. 12
ACTIVE BORROW AREA NO. 9
BORROW AREA NO. 1 (COMPLETED)
BORROW AREA NO. 8 (COMPLETED)
FUTURE BORROW AREA NO. 5
FUTURE BORROW AREA NO. 4
100' BUFFER
300' BUFFER
LANDFILL ACCESS ROAD
BORROW AREA ACCESS ROAD
EXISTING CEMETERY
NON-RESIDENTIAL STRUCTURE
JURISDICTIONAL WETLANDS
DROP INLET NO. 400
HEADWALL NO. 400
WET DETENTION BASIN NO. 4
OVERFLOW STRUCTURE NO. 4
EXISTING STORM WATER CONVEYANCE CHANNEL (TYP.)
EXISTING GAS HEADER LINE (TYP.)
EXISTING GAS LATERAL LINE (TYP.)
EXISTING GAS EXTRACTION WELL (TYP.)
EXISTING SEDIMENT BASIN NO. 3
OVERFLOW STRUCTURE NO. 3
DROP INLET NO. 300
HEADWALL NO. 300
HEADWALL NO. 301R
DROP INLET NO. 200
HEADWALL NO. 200
EXISTING SEDIMENT BASIN NO. 2
OVERFLOW STRUCTURE NO. 2
HEADWALL NO. 201
HEADWALL NO. 302
EXISTING CAP AREA
EXISTING LEACHATE STORAGE TANK NO.1
EXISTING CEMETARY AREA
EXISTING LEACHATE PUMP STATION #1
EXISTING LEACHATE STORAGE TANK NO. 2
EXISTING METALS RECLAMATION AREA
TEMPORARY STORM DEBRIS STORAGE AREA
TEMPORARY TIRE STORAGE TRAILER LOCATION (CURRENT)
TOPSOIL STORAGE AREA
BLOWER FLARE STATION LOCATION
EXISTING MAINTENANCE BUILDING
BASIN MAINTENANCE BERM
EXISTING SITE ENTRANCE ROAD (ASPHALT)
WATER TANK, WELL & PUMP HOUSE
CONVENIENCE CENTER SITE
EXISTING OFFICE
EXISTING SCALES AND SCALE HOUSE
ACCESS CONTROL GATE
FUTURE TRUCKING SERVICE FACILITY
WASTE SOLIDIFICATION FACILITY
BM (MW#9) N 10412.39 E 7171.83 ELEV. 58.18 NAIL IN WELL PAD
W.S.E. = 39.1
W.S.E. = 38.9
W.S.E. = 36.1
W.S.E. = 54.1
W.S.E. = 57.2
W.S.E. = 48.1
MM-1, MM-2, MM-3, MM-4, MM-5R, MM-6, MM-7R, MM-8, MM-9, MM-10, MM-11R, MM-12, MM-13, MM-14
GW-1, GW-2, GW-3, GW-4, GW-5, GW-6, GW-7, GW-8, GW-9, GW-10, GW-11, GW-12, GW-13, GW-14, GW-15, GW-16R, GW-17, GW-18, GW-19, GW-20, GW-21
PZ-6A, PZ-8A, PZ-9A, PZ-18A, PZ-18B, PZ-41A, PZ-41B, PZ-104A, PZ-105A, PZ-106A
SW-1

NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 866,800.00, E 2,571,191.63
ELEV. = 63.88

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 867,341.41, E 2,570,659.21
ELEV. = 63.78

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
N 866,355.17, E 2,570,278.99
ELEV. = 56.64

LOCAL COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11220.50, E 6155.61

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11802.03, E 5667.35

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
ELEV. = 56.64

NOTES:
1. TOPOGRAPHIC DATA PROVIDED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
2. PIEZOMETERS LOCATIONS SHOWN IN THIS SHEET WERE PROVIDED BY DONALDSON GARRETT AND ASSOCIATES IN AN EMAIL DATED SEPTEMBER 7, 2004.
3. POTENTIOMETRIC CONTOUR DATA TAKEN FROM FIGURE DH-2 YORKTOWN FORMATION OCTOBER 31, 2006 POTENTIOMETRIC SURFACE CONTOUR MAP OF THE DESIGN HYDROGEOLOGIC REPORT--EAST CAROLINA REGIONAL LANDFILL PHASE FIVE, PREPARED BY GOLDER ASSOCIATES, AND DATED JULY 2007, LAST REVISED DECEMBER 5, 2007.

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 1043 GEOLOGIST MARK S. PREDDY 3/31/08

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 16142 WILLIAM F. HODGES 3/31/08

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 15142 H. LOWRY TRIBBLE, JR. 3/31/08

200 100 0 200 400
GRAPHIC SCALE IN FEET

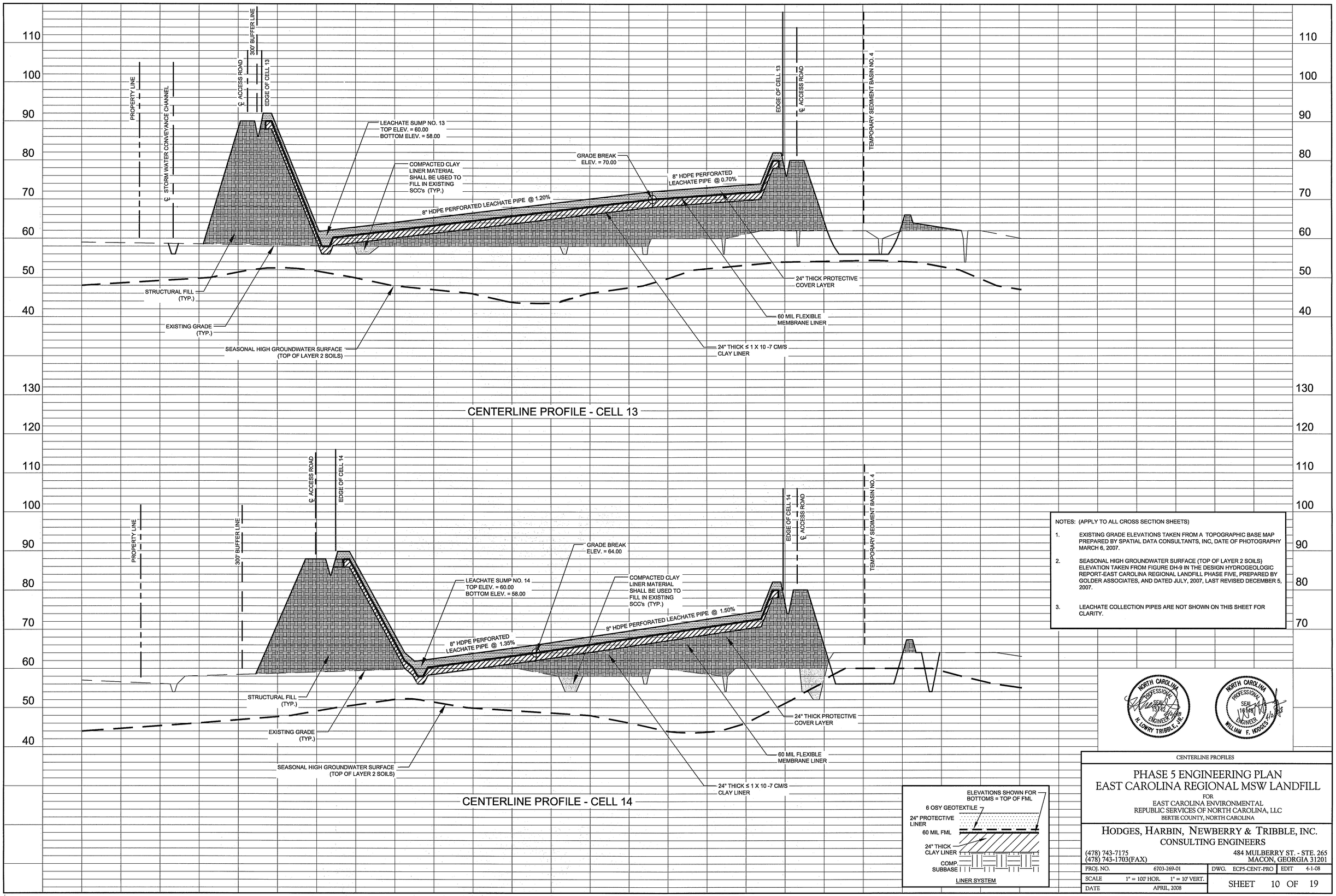
ENVIRONMENTAL MONITORING PLAN

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-EM-BLE
SCALE	1" = 200'	EDIT	3-28-08
DATE	APRIL, 2008	SHEET	9 OF 19



NOTES: (APPLY TO ALL CROSS SECTION SHEETS)

1. EXISTING GRADE ELEVATIONS TAKEN FROM A TOPOGRAPHIC BASE MAP PREPARED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
2. SEASONAL HIGH GROUNDWATER SURFACE (TOP OF LAYER 2 SOILS) ELEVATION TAKEN FROM FIGURE DH-9 IN THE DESIGN HYDROGEOLOGIC REPORT-EAST CAROLINA REGIONAL LANDFILL PHASE FIVE, PREPARED BY GOLDER ASSOCIATES, AND DATED JULY, 2007, LAST REVISED DECEMBER 5, 2007.
3. LEACHATE COLLECTION PIPES ARE NOT SHOWN ON THIS SHEET FOR CLARITY.

LINER SYSTEM

NORTH CAROLINA PROFESSIONAL SEAL 19168 ENGINEER H. LOWRY TRIBBLE, JR.

NORTH CAROLINA PROFESSIONAL SEAL 19168 ENGINEER WILLIAM F. HODGES

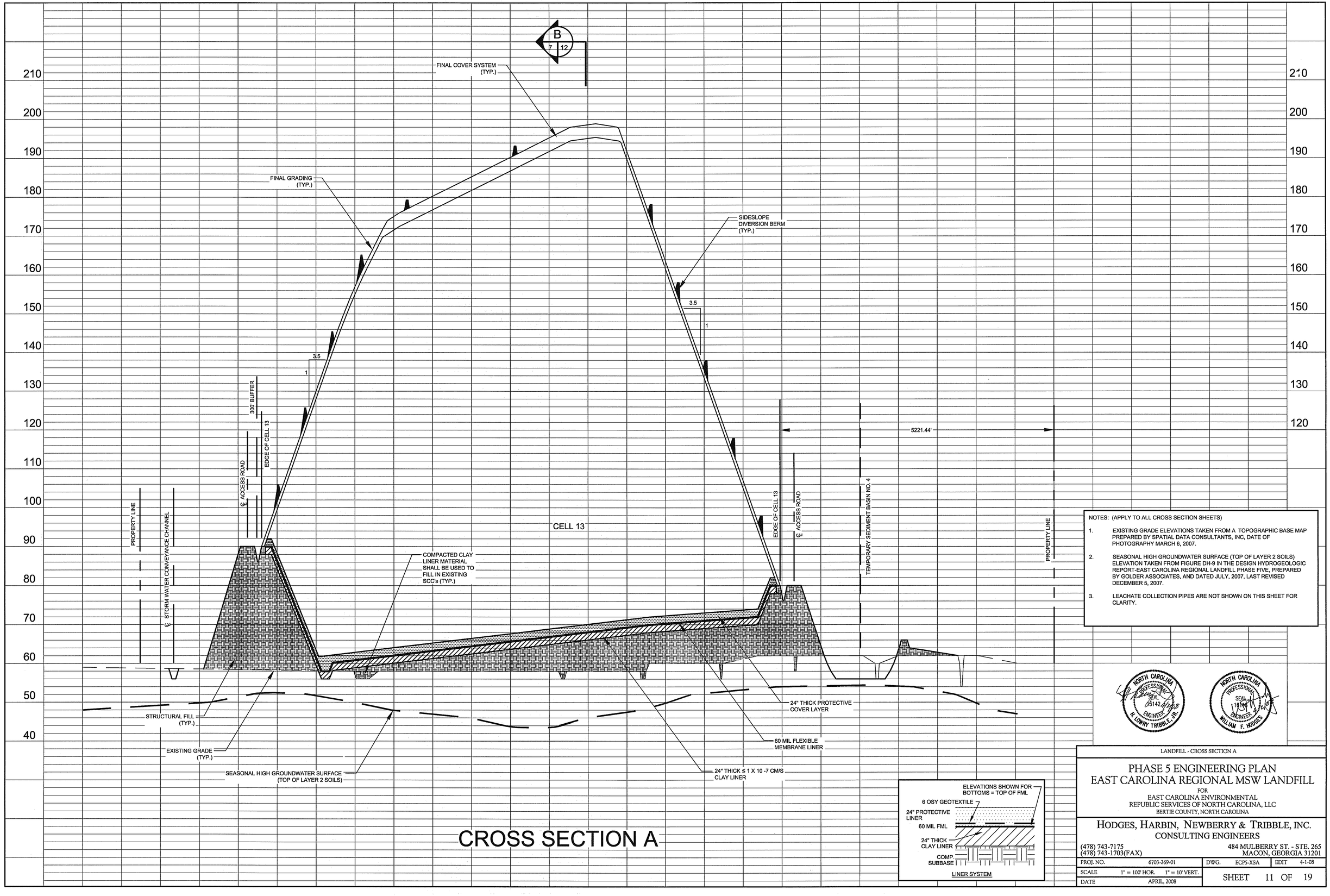
CENTERLINE PROFILES

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG. ECP5-CENT-PRO	EDIT 4-1-08
SCALE	1" = 100' HOR. 1" = 10' VERT.	SHEET 10 OF 19	
DATE	APRIL, 2008		



CROSS SECTION A

LINER SYSTEM

NOTES: (APPLY TO ALL CROSS SECTION SHEETS)

1. EXISTING GRADE ELEVATIONS TAKEN FROM A TOPOGRAPHIC BASE MAP PREPARED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
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3. LEACHATE COLLECTION PIPES ARE NOT SHOWN ON THIS SHEET FOR CLARITY.

NORTH CAROLINA PROFESSIONAL SEAL 25142 ENGINEER H. LOWRY TRIBBLE, JR.

NORTH CAROLINA PROFESSIONAL SEAL 18196 ENGINEER WILLIAM F. HODGES

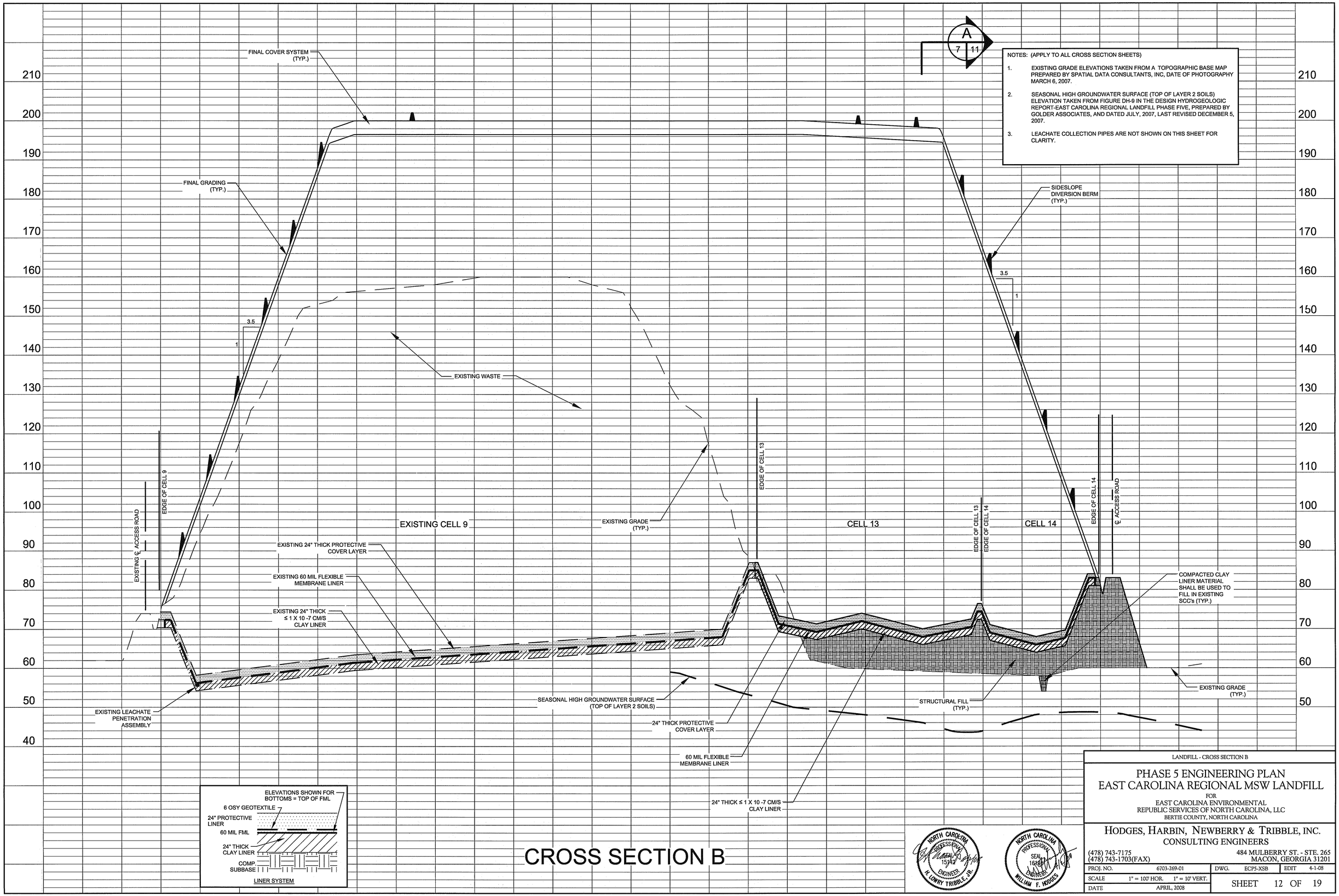
LANDFILL - CROSS SECTION A

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-XSA
SCALE	1" = 100' HOR. 1" = 10' VERT.	EDIT	4-1-08
DATE	APRIL, 2008	SHEET	11 OF 19



NOTES: (APPLY TO ALL CROSS SECTION SHEETS)

1. EXISTING GRADE ELEVATIONS TAKEN FROM A TOPOGRAPHIC BASE MAP PREPARED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
2. SEASONAL HIGH GROUNDWATER SURFACE (TOP OF LAYER 2 SOILS) ELEVATION TAKEN FROM FIGURE DH-9 IN THE DESIGN HYDROGEOLOGIC REPORT-EAST CAROLINA REGIONAL LANDFILL PHASE FIVE, PREPARED BY GOLDER ASSOCIATES, AND DATED JULY, 2007, LAST REVISED DECEMBER 5, 2007.
3. LEACHATE COLLECTION PIPES ARE NOT SHOWN ON THIS SHEET FOR CLARITY.

CROSS SECTION B

LANDFILL - CROSS SECTION B

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

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CONSULTING ENGINEERS
(478) 743-7175
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484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG. ECP5-XSB	EDIT 4-1-08
SCALE	1" = 100' HOR. 1" = 10' VERT.	SHEET 12 OF 19	
DATE	APRIL, 2008		

DRAINAGE STRUCTURES

PIPE NO.	SIZE (DIA)	LENGTH	SLOPE	MATERIAL
301 (R)	TWIN - 48"	84'	2.56%	RCP
302 (R)	60"	71'	.051%	RCP
400	TWIN - 42"	104'	1.92%	RCP
401	36"	75'	5.33%	RCP

DROP INLET NO.	TOP ELEV.	THROAT ELEV.	INVERT ELEV.
301 (R)	66.11	64.61	58.81
400	74.00	72.50	64.00

HEADWALL NO.	INVERT ELEV.
301 (R)	56.65
302 (R)	53.60
400	62.00
401	56.00

*(E) - EXISTING STRUCTURE TO REMAIN
*(R) - REPLACEMENT OF EXISTING STRUCTURE

BORROW AREA NO. 1
(COMPLETED)

JURISDICTIONAL WETLANDS
100' BUFFER
300' BUFFER
EXISTING CEMETERY
NON-RESIDENTIAL STRUCTURE
PROPOSED STORM WATER CONVEYANCE CHANNEL
DROP INLET NO. 400
HEADWALL NO. 400
TOP OF LEVEE ELEV. = 67.25 MIN.
OVERFLOW STRUCTURE NO. 401
HEADWALL NO. 401
WET DETENTION BASIN NO. 4
FILL SCC's WITH COMPACTED CLAY MATERIAL TO PROVIDE POSITIVE DRAINAGE
EXISTING STORM WATER CONVEYANCE CHANNEL (TYP.)
LANDFILL ACCESS ROAD
BORROW AREA ACCESS ROAD
EXISTING ACCESS ROAD
PHASE 5
CELL NO. 13
ACTIVE BORROW AREA NO. 9
W.S.E. = 39.1
W.S.E. = 38.9
BM (MW#9)
N 10412.38
E 7171.85
ELEV. 58.18
NAIL IN WELL PAD
WASTE SOLIDIFICATION FACILITY
TEMPORARY STORM DEBRIS STORAGE AREA
EXISTING METALS RECLAMATION AREA
EXISTING LEACHATE STORAGE TANK NO.1
EXISTING CEMETERY AREA
EXISTING LEACHATE PUMP STATION #1
EXISTING LEACHATE STORAGE TANK NO. 2
TOPSOIL STORAGE AREA
EXISTING CAP AREA
DROP INLET NO. 200
HEADWALL NO. 200
BLOWER FLARE STATION LOCATION
EXISTING SEDIMENT BASIN NO. 2
W.S.E. = 54.1
OVERFLOW STRUCTURE NO. 2
HEADWALL NO. 201
EXISTING PHASE 1
EXISTING PHASE 2
EXISTING PHASE 3
EXISTING PHASE 4
EXISTING CELL NO. 3
EXISTING CELL NO. 4
EXISTING CELL NO. 5
EXISTING CELL NO. 6
EXISTING CELL NO. 7
EXISTING CELL NO. 8
EXISTING CELL NO. 9
EXISTING CELL NO. 10
EXISTING CELL NO. 11
EXISTING CELL NO. 12
DROP INLET NO. 300
HEADWALL NO. 300
W.S.E. = 57.2
EXISTING SEDIMENT BASIN NO. 3
DROP INLET NO. 301R
HEADWALL NO. 301R
HEADWALL NO. 302R
OVERFLOW STRUCTURE NO. 3R
EXISTING MAINTENANCE BUILDING
BASIN MAINTENANCE BERM
EXISTING SITE ENTRANCE ROAD (ASPHALT)
WATER TANK, WELL & PUMP HOUSE
CONVENIENCE CENTER SITE
FUTURE BORROW AREA NO. 5
FUTURE BORROW AREA NO. 4
BORROW AREA NO. 8
(COMPLETED)
W.S.E. = 48.1
EXISTING OFFICE
EXISTING SCALES AND SCALE HOUSE
ACCESS CONTROL GATE
FUTURE TRUCKING SERVICE FACILITY
100' BUFFER

200 0 200 400 600

NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 866,800.00, E 2,571,191.63
ELEV. = 63.88

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 867,341.41, E 2,570,659.21
ELEV. = 63.78

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
N 866,355.17, E 2,570,278.99
ELEV. = 56.64

LOCAL COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11220.50, E 6155.61

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER
OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11802.03, E 5667.35

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST
OF SCALEHOUSE
ELEV. = 56.64

NOTES:
1. TOPOGRAPHIC DATA PROVIDED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
2. PIEZOMETERS LOCATIONS SHOWN IN THIS SHEET WERE PROVIDED BY DONALDSON GARRETT AND ASSOCIATES IN AN EMAIL DATED SEPTEMBER 7, 2004.
3. AS FILL PROGRESSES IN CELL NO. 13, STORM WATER DIVERSION BERMS SHALL BE CONSTRUCTED ON THE EAST SIDE OF CELL NO. 13 TO DIRECT ALL STORM WATER FROM THE LANDFILL AREA TO THE SEDIMENT BASINS.

NORTH CAROLINA PROFESSIONAL SEAL 16146 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER H. LOWRY TRIBBLE, JR.

SEQUENCE OF FILL - CELL NO. 13

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-SQ-13
SCALE	1" = 200'	EDIT	4-1-08
DATE	APRIL, 2008	SHEET	13 OF 19

JURISDICTIONAL WETLANDS

100' BUFFER

300' BUFFER

EXISTING CEMETERY

NON-RESIDENTIAL STRUCTURE

64.00

CELL NO. 14

PHASE 5
(CELLS NO. 13 & 14)

EXISTING CELL NO. 13

STORM WATER CONVEYANCE CHANNEL

DROP INLET NO. 400

HEADWALL NO. 400

WET DETENTION BASIN NO. 4

OVERFLOW STRUCTURE NO. 401

HEADWALL NO. 401

LANDFILL ACCESS ROAD

EXISTING STORM WATER CONVEYANCE CHANNEL (TYP.)

BORROW AREA ACCESS ROAD

EXISTING ACCESS ROAD

W.S.E. = 39.1

ACTIVE BORROW AREA NO. 9

W.S.E. = 38.9

100' BUFFER

W.S.E. = 38.1

BORROW AREA NO. 1
(COMPLETED)

JURISDICTIONAL WETLANDS

BM (MW#9)
N 10412.39
E 7171.85
ELEV. 58.18
NAIL IN WELL PAD

WASTE SOLIDIFICATION FACILITY

TEMPORARY STORM DEBRIS STORAGE AREA

JURISDICTIONAL WETLANDS

EXISTING PHASE 4
(CELLS NO. 11 & 12)

EXISTING PHASE 3
(CELLS NO. 9 & 10)

EXISTING PHASE 2
(CELLS NO. 7 & 8)

EXISTING PHASE 1
(CELLS NO. 3 - 6)

EXISTING CELL NO. 12

EXISTING CELL NO. 11

EXISTING CELL NO. 10

EXISTING CELL NO. 9

EXISTING CELL NO. 8

EXISTING CELL NO. 7

EXISTING CELL NO. 6

EXISTING CELL NO. 5

EXISTING CELL NO. 4

EXISTING CELL NO. 3

EXISTING METALS RECLAMATION AREA

EXISTING LEACHATE STORAGE TANK NO.1

TEMPORARY STORM DEBRIS STORAGE

EXISTING CEMETERY AREA

EXISTING LEACHATE PUMP STATION #1

EXISTING LEACHATE STORAGE TANK NO. 2

TOPSOIL STORAGE AREA

EXISTING CAP AREA

DROP INLET NO. 200

HEADWALL NO. 200

BLOWER FLARE STATION LOCATION

EXISTING SEDIMENT BASIN NO. 2

W.S.E. = 54.1

OVERFLOW STRUCTURE NO. 2

HEADWALL NO. 201

HEADWALL NO. 302R

OVERFLOW STRUCTURE NO. 3R

EXISTING SEDIMENT BASIN NO. 3

W.S.E. = 57.2

DROP INLET NO. 300

HEADWALL NO. 300

DROP INLET NO. 301R

HEADWALL NO. 301R

EXISTING ACCESS ROAD

EXISTING MAINTENANCE BUILDING

BASIN MAINTENANCE BERM

BASIN MAINTENANCE BERM

JURISDICTIONAL WETLANDS

EXISTING SITE ENTRANCE ROAD (ASPHALT)

WATER TANK, WELL & PUMP HOUSE

CONVENIENCE CENTER SITE

FUTURE BORROW AREA NO. 5

FUTURE BORROW AREA NO. 4

FUTURE TRUCKING SERVICE FACILITY

EXISTING SCALES AND SCALE HOUSE

ACCESS CONTROL GATE

EXISTING OFFICE

BORROW AREA NO. 8
(COMPLETED)

W.S.E. = 48.1

60' BORROW AREA ACCESS ROAD

300' BUFFER

100' BUFFER

200 0 200 400 600

NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 866,800.00, E 2,571,191.63
ELEV. = 63.88

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 867,341.41, E 2,570,659.21
ELEV. = 63.78

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
N 866,355.17, E 2,570,278.99
ELEV. = 56.64

LOCAL COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11220.50, E 6155.61

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11802.03, E 5667.35

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
ELEV. = 56.64

NOTES:
1. TOPOGRAPHIC DATA PROVIDED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
2. PIEZOMETERS LOCATIONS SHOWN IN THIS SHEET WERE PROVIDED BY DONALDSON GARRETT AND ASSOCIATES IN AN EMAIL DATED SEPTEMBER 7, 2004.
3. AS FILL PROGRESSES IN CELL NO. 13, STORM WATER DIVERSION BERMS SHALL BE CONSTRUCTED ON THE EAST SIDE OF CELL NO. 13 TO DIRECT ALL STORM WATER FROM THE LANDFILL AREA TO THE SEDIMENT BASINS.

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER H. LOWRY TRIBBLE, JR.

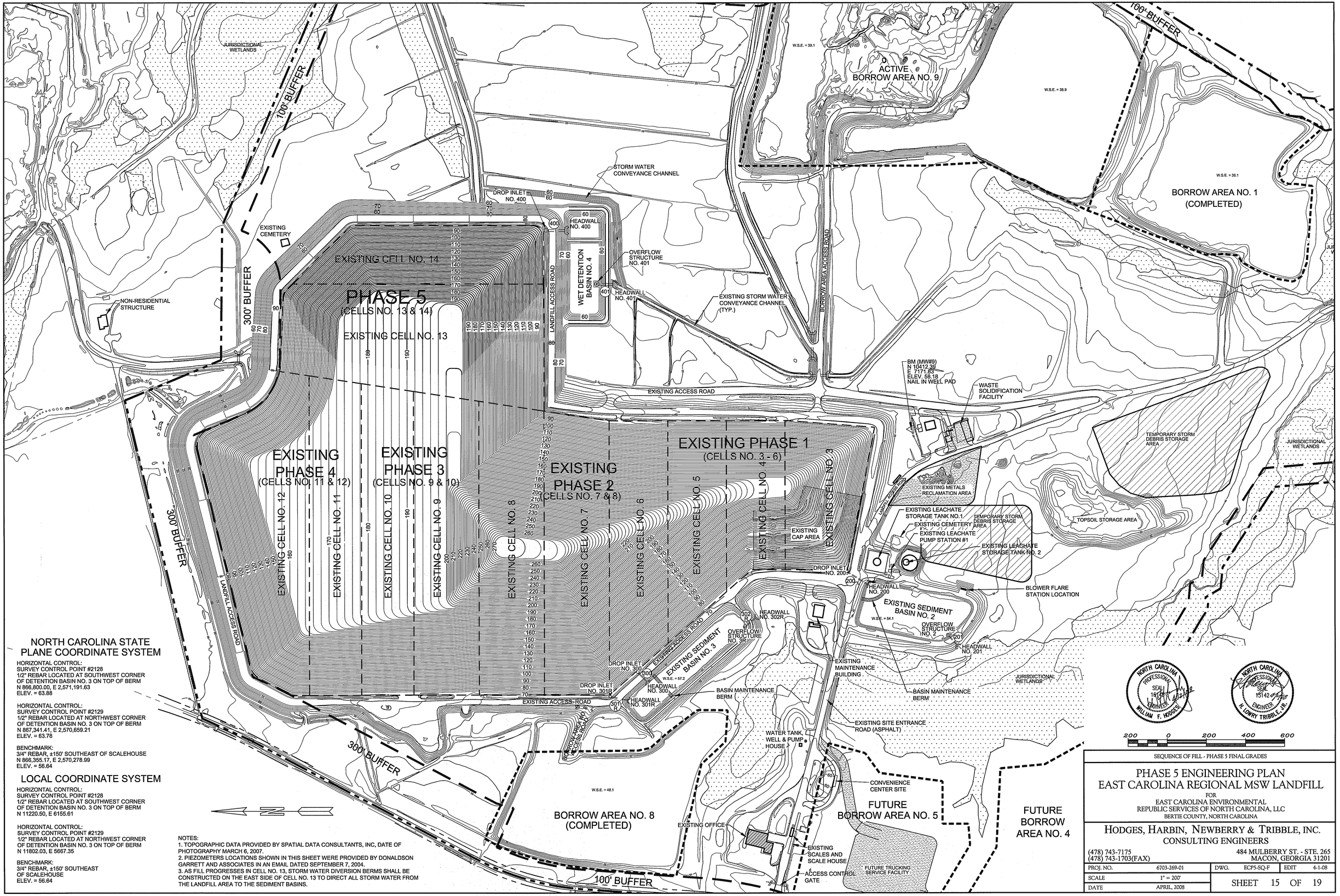
SEQUENCE OF FILL - CELL NO. 14

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-SQ-14
SCALE	1" = 200'	EDIT	4-1-08
DATE	APRIL, 2008	SHEET	14 OF 19



NORTH CAROLINA STATE PLANE COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 866,800.00, E 2,571,191.63
ELEV. = 63.88

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 867,341.41, E 2,570,659.21
ELEV. = 63.78

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
N 866,355.17, E 2,570,278.99
ELEV. = 56.64

LOCAL COORDINATE SYSTEM

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2128
1/2" REBAR LOCATED AT SOUTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11220.50, E 6155.61

HORIZONTAL CONTROL:
SURVEY CONTROL POINT #2129
1/2" REBAR LOCATED AT NORTHWEST CORNER OF DETENTION BASIN NO. 3 ON TOP OF BERM
N 11802.03, E 5667.35

BENCHMARK:
3/4" REBAR, ±150' SOUTHEAST OF SCALEHOUSE
ELEV. = 56.64

NOTES:
1. TOPOGRAPHIC DATA PROVIDED BY SPATIAL DATA CONSULTANTS, INC, DATE OF PHOTOGRAPHY MARCH 6, 2007.
2. PIEZOMETERS LOCATIONS SHOWN IN THIS SHEET WERE PROVIDED BY DONALDSON GARRETT AND ASSOCIATES IN AN EMAIL DATED SEPTEMBER 7, 2004.
3. AS FILL PROGRESSES IN CELL NO. 13, STORM WATER DIVERSION BERMS SHALL BE CONSTRUCTED ON THE EAST SIDE OF CELL NO. 13 TO DIRECT ALL STORM WATER FROM THE LANDFILL AREA TO THE SEDIMENT BASINS.

NORTH CAROLINA PROFESSIONAL SEAL 16139 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER H. LOWRY TRIBBLE, JR.

SEQUENCE OF FILL - PHASE 5 FINAL GRADES

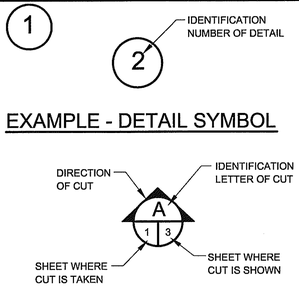
PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-SQ-F	EDIT	4-1-08
SCALE	1" = 200'	SHEET	15	OF	19
DATE	APRIL, 2008				

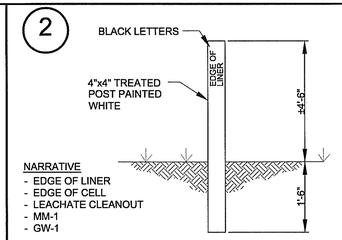
1



EXAMPLE - DETAIL SYMBOL

EXAMPLE - SECTION SYMBOL

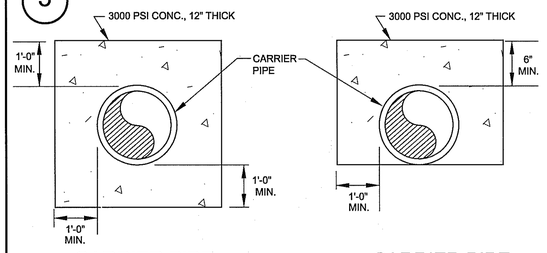
2



NOTE: OTHER STYLE MARKERS MAY BE USED AT THE DISCRETION OF THE OPERATOR.

MARKER POSTS

3



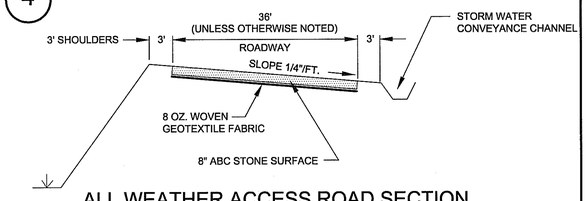
CARRIER PIPE ANTI-SEEPAGE COLLAR

WET DETENTION BASIN NO. 4

CARRIER PIPE CONCRETE ENCASEMENT

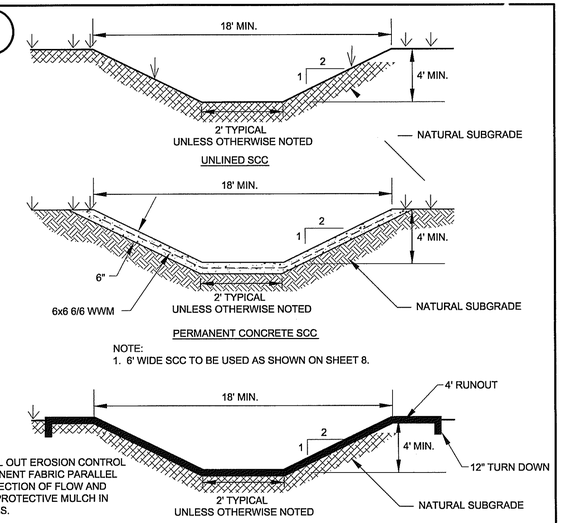
WET DETENTION BASIN NO. 4

4



ALL WEATHER ACCESS ROAD SECTION

5



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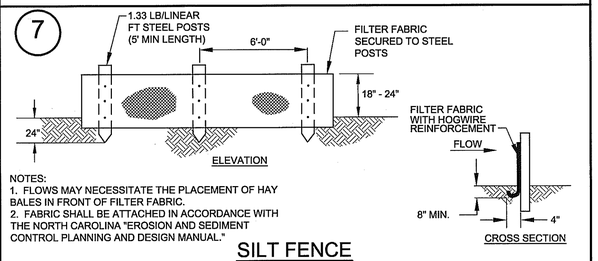
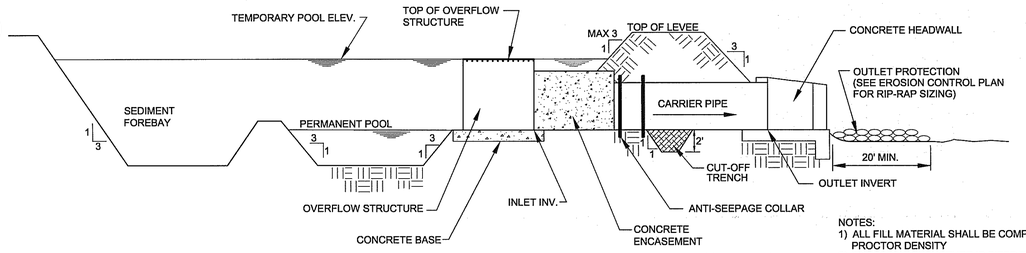


NOTES:
1. FLOWS MAY NECESSITATE THE PLACEMENT OF HAY BALES IN FRONT OF FILTER FABRIC.
2. FABRIC SHALL BE ATTACHED IN ACCORDANCE WITH THE NORTH CAROLINA "EROSION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL."

SILT FENCE

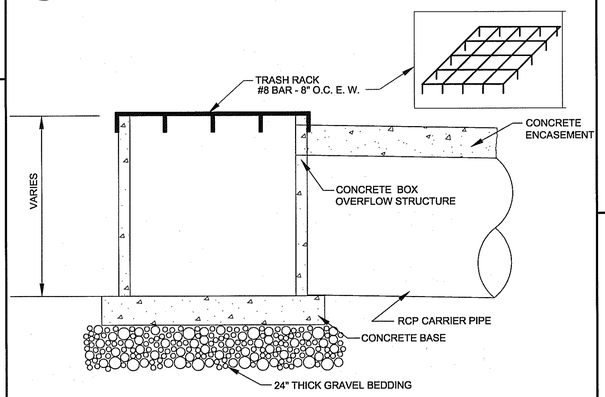
6



NOTES:
1) ALL FILL MATERIAL SHALL BE COMPACTED TO 95% STD. PROCTOR DENSITY
2) OVERFLOW STRUCTURE IS SIZED TO CARRY BOTH NORMAL FLOW AND EMERGENCY FLOW.

WET DETENTION BASIN NO. 4

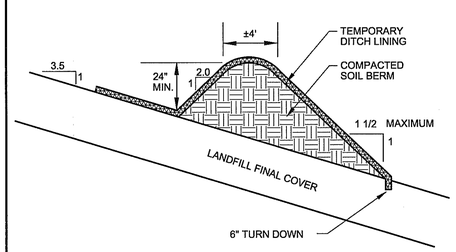
10



BASIN NO.	DEWATERING DEVICE	NO. OF HOLES PER ROW	NO. OF ROWS	RISER SIZE	RISER HEIGHT	CARRIER PIPE DIAMETER	CONCRETE BASE	CONCRETE ENCASEMENT
3	115 - 1" DIA. HOLES	23	5	5.5' x 5.5'	6.54'	60"	11' x 11' x 2.0'	6.5' x 8.0' x 22.5'
4	1 - 6" X 7" HOLE 1 - 6" X 10" HOLE	1	2	4' x 4'	3.70'	36"	8.5' x 9.0' x 1.0'	3.7' x 5.0' x 16'

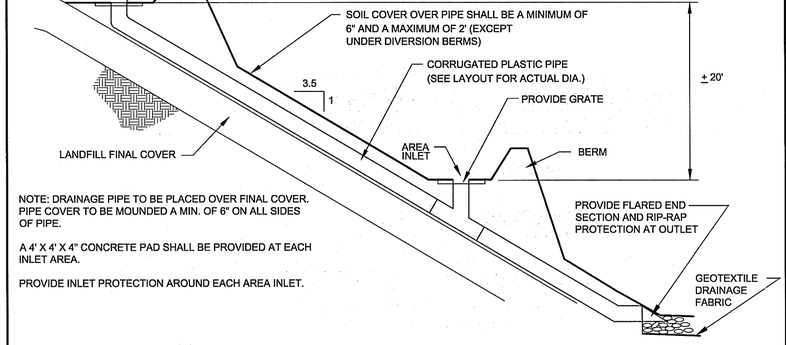
OVERFLOW STRUCTURE

8



LANDFILL SIDE SLOPE BERM

9



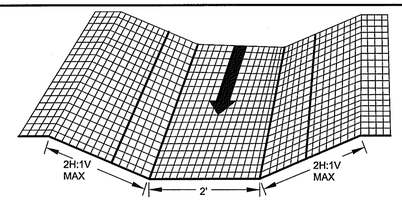
NOTE: DRAINAGE PIPE TO BE PLACED OVER FINAL COVER. PIPE COVER TO BE MOUNDED A MIN. OF 6" ON ALL SIDES OF PIPE.

A 4' X 4' X 4" CONCRETE PAD SHALL BE PROVIDED AT EACH INLET AREA.

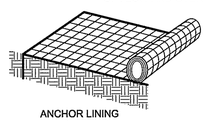
PROVIDE INLET PROTECTION AROUND EACH AREA INLET.

AREA INLET DOWNDRAIN

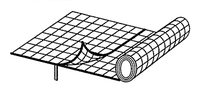
11



ROLL OUT EXCELSIOR MATTING PARALLEL TO DIRECTION OF FLOW AND OVER PROTECTIVE MULCH IN DITCHES.



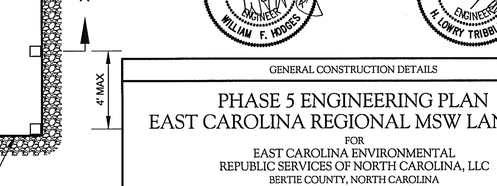
ANCHOR LINING IN A 6" TRENCH.



JOIN STRIPS BY ANCHORING WITH UNTREATED WOODEN STAKES AND OVERLAPPING 18" OR APPROVED WIRE STAPLES

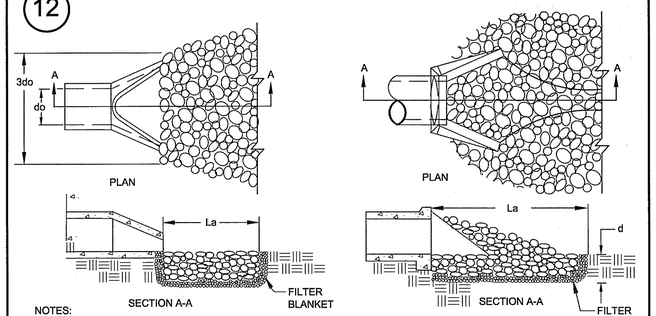
TEMPORARY EXCELSIOR LINING
STORM WATER CONVEYANCE CHANNEL

STORM WATER CONVEYANCE CHANNEL SECTIONS



RIP-RAP SCC

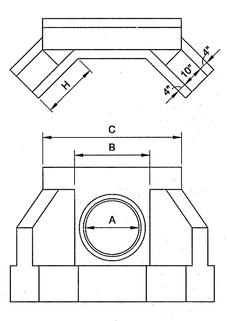
12



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

OUTLET PROTECTION

13

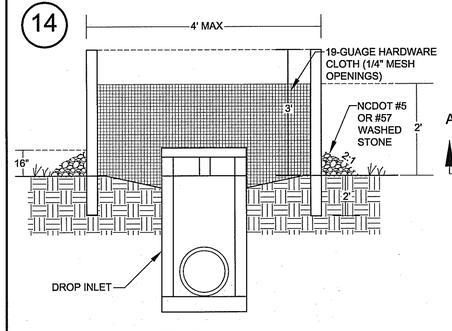


"A"	"B"	"C"	"D"	"E"	"F"	"G"	"H"
12"	1'-8"	4'-0"	2'-6"	1'-8"	1'-2"	1'-3"	1'-7"
15"	2'-0"	4'-4"	2'-10"	2'-0"	1'-3"	1'-3"	1'-7"
18"	2'-4"	4'-8"	3'-2"	2'-4"	1'-4"	1'-3"	1'-7"
24"	2'-10"	5'-2"	3'-8"	2'-10"	1'-5"	1'-4"	2'-1"
30"	3'-6"	5'-10"	4'-4"	3'-6"	1'-9"	1'-6"	2'-5"
36"	4'-0"	6'-4"	4'-10"	4'-0"	2'-0"	1'-8"	2'-11"
42"	4'-6"	6'-10"	5'-4"	4'-6"	2'-3"	2'-0"	3'-6"
48"	5'-2"	7'-6"	6'-0"	5'-2"	2'-6"	2'-0"	4'-0"
54"	5'-9"	8'-1"	6'-7"	5'-9"	2'-9"	2'-0"	4'-6"
60"	6'-4"	8'-8"	7'-2"	6'-4"	3'-0"	2'-2"	5'-0"

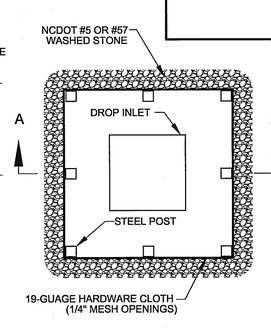
NOTES:
1. PRECAST CONSTRUCTION SHALL MEET THE REQUIREMENTS OF THE NC. D.O.T. AND ASTM C-478.
2. REINFORCING STEEL SHALL BE A MINIMUM OF #4 @ 6" O.C.E.W.
3. FOR TWIN PIPES, DOUBLE DIMENSIONS "B" AND "C."

CONCRETE HEADWALL

14



SECTION A-A



PLAN

NOTES:
1. CONTRACTOR SHALL UNIFORMLY GRADE A SHALLOW DEPRESSION APPROACHING THE INLET.
2. WIRE MESH SHALL BE SECURED AT TOP, MIDDLE AND BOTTOM OF STEEL POSTS.

DROP INLET PROTECTION

NORTH CAROLINA PROFESSIONAL SEAL 16148 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 15170 ENGINEER H. LOWRY TRIBBLE, JR.

GENERAL CONSTRUCTION DETAILS

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR

EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
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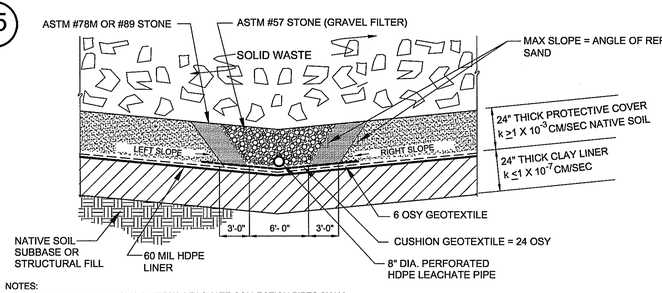
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-D1
SCALE	NOT TO SCALE	EDIT	4-1-08
DATE	APRIL, 2008		

15

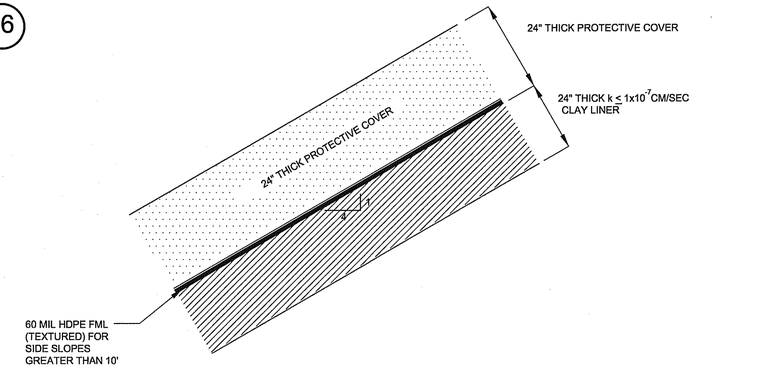


NOTES:
1.) PERFORATED 4" DIA. SUPPLEMENTAL LEACHATE COLLECTION PIPES SHALL BE INSTALLED IN THE PLANE WITH THE GEOTEXTILE GEOCOMPOSITE ON 90' CENTERS PERPENDICULAR TO THE 8" PERFORATED LEACHATE COLLECTION PIPE IN THE CENTERLINE OF THE CELL.
2.) 60 MIL HDPE LINER COMPONENT SHALL BE COVERED WITH A MIN 6 OZ. PER SQ. YARD GEOTEXTILE FABRIC (EXCEPT ON SIDE SLOPES).

MINIMUM SLOPE		
CELL NO.	LEFT	RIGHT
13E	2.00%	2.60%
13W	2.60%	2.00%
14	2.00%	2.60%

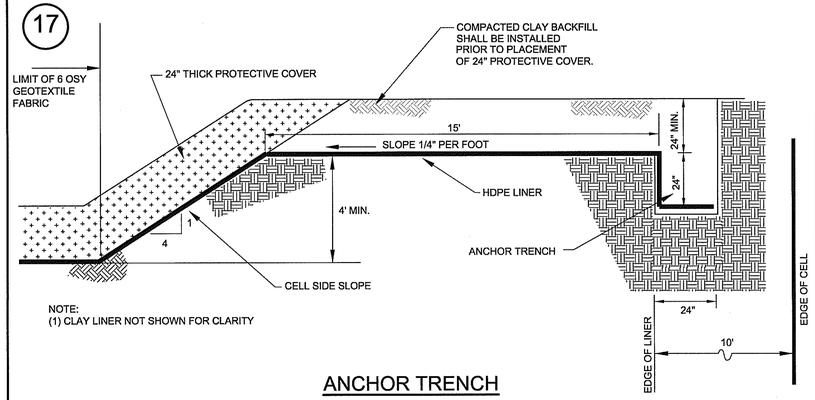
BOTTOM LINER SYSTEM "A"

16



SIDE SLOPE LINER SYSTEM "A" OR "B"

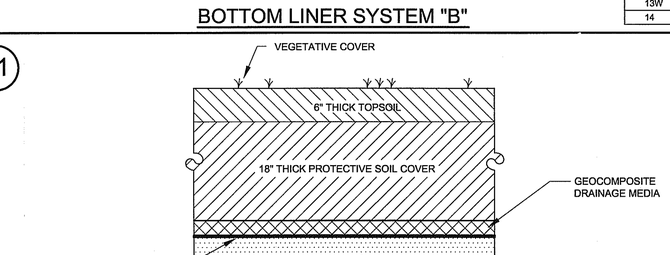
17



NOTE:
(1) CLAY LINER NOT SHOWN FOR CLARITY

ANCHOR TRENCH

18

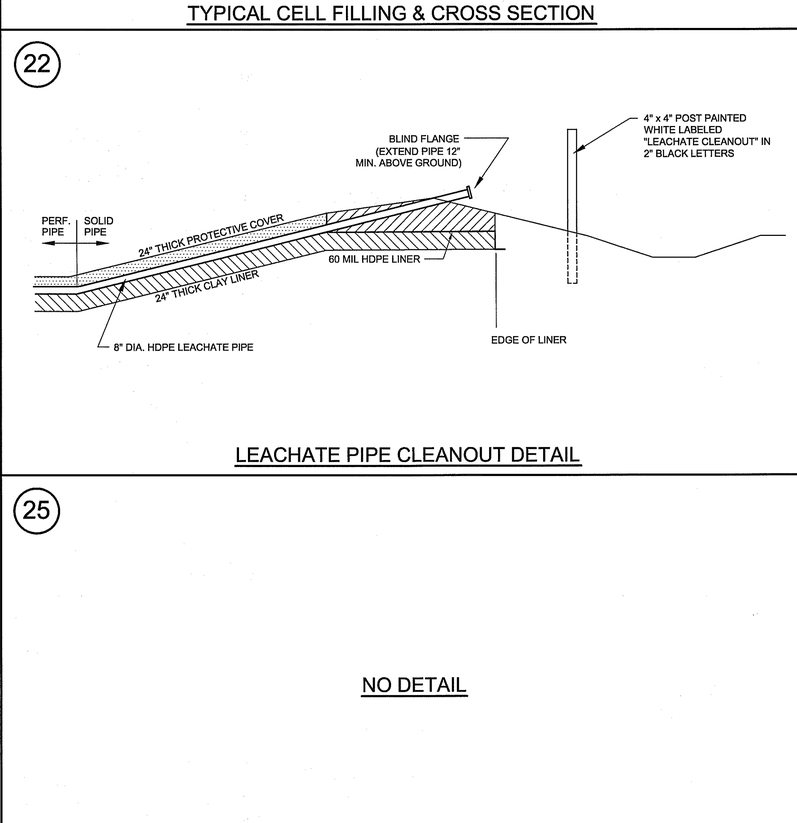


NOTES:
1.) PERFORATED 4" DIA. SUPPLEMENTAL LEACHATE COLLECTION PIPES ARE NOT REQUIRED WITH k ≥ 1 X 10-2 CM/SEC PROTECTIVE COVER MATERIAL.
2.) 60 MIL HDPE LINER COMPONENT SHALL BE COVERED WITH A MIN 6 OZ. PER SQ. YARD GEOTEXTILE FABRIC, EXCEPT ON SIDE SLOPES.

MINIMUM SLOPE		
CELL NO.	LEFT	RIGHT
13E	2.00%	2.60%
13W	2.60%	2.00%
14	2.00%	2.60%

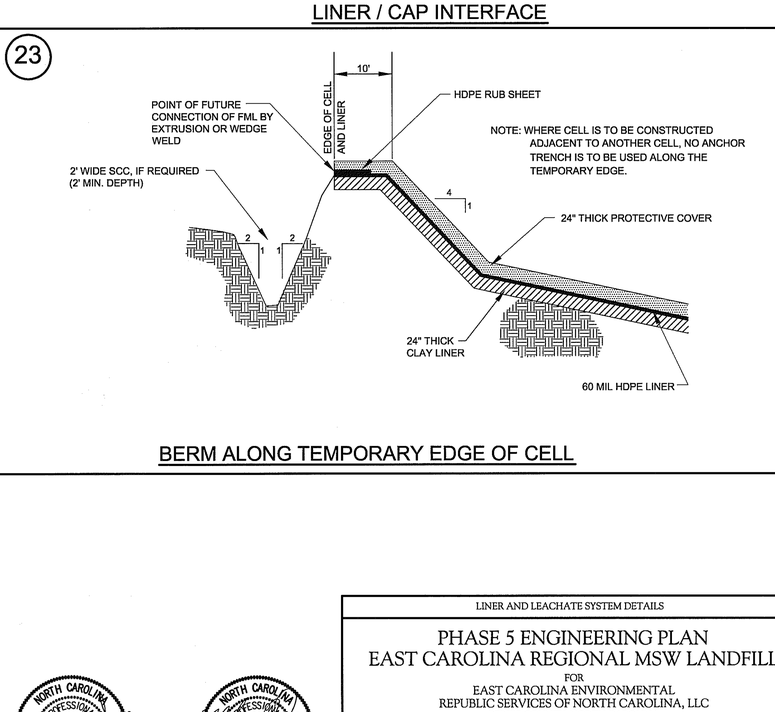
BOTTOM LINER SYSTEM "B"

19



TYPICAL CELL FILLING & CROSS SECTION

20



NOTE:
60 MIL HDPE LINER COMPONENT SHALL BE COVERED WITH A MIN 6 OZ. PER SQ. YARD GEOTEXTILE FABRIC, EXCEPT ON SIDE SLOPES.

LINER / CAP INTERFACE

21

NOTE: 18" OF K ≤1 X 10-5 CM/ SEC SOIL LINER MAY BE ELIMINATED ON SLOPES GREATER THAN 10%.

FINAL COVER SYSTEM

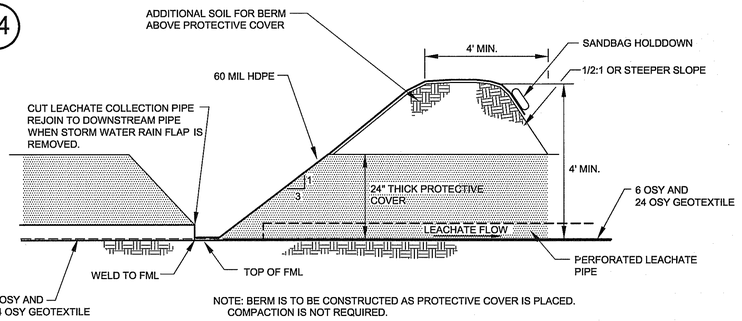
22

LEACHATE PIPE CLEANOUT DETAIL

23

BERM ALONG TEMPORARY EDGE OF CELL

24



NOTE: BERM IS TO BE CONSTRUCTED AS PROTECTIVE COVER AS PLACED. COMPACTION IS NOT REQUIRED.

STORM WATER RAIN FLAP

25

NO DETAIL

NORTH CAROLINA PROFESSIONAL SEAL 16842 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 13142 ENGINEER H. LOWRY TRIBBLE, JR.

LINER AND LEACHATE SYSTEM DETAILS

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

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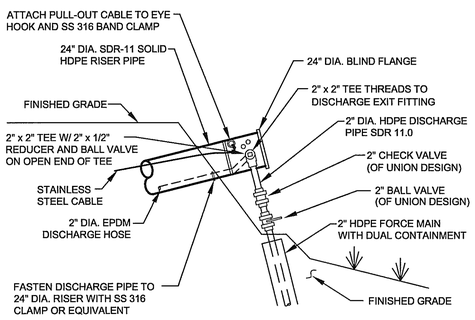
DATE	APRIL, 2008		

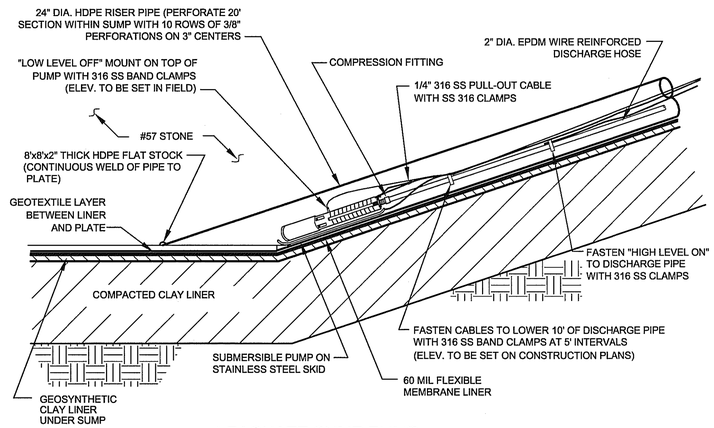
26



NOTE:
1. WRAP DISCHARGE PIPE AND FITTINGS WITH INSULATION AND HEAT TAPE.
2. THE ENDS OF ALL PIPES SHALL BE SEALED.

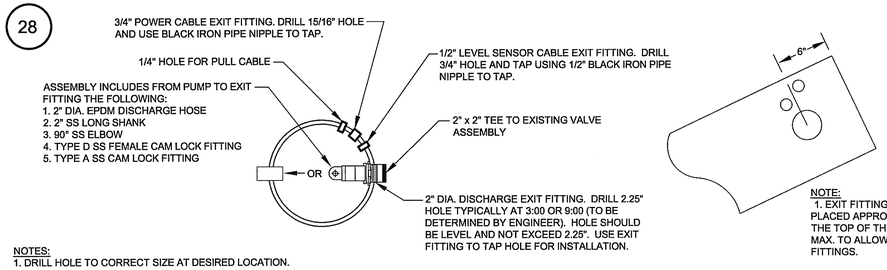
FORCE MAIN FITTINGS W/ FREEZE PROTECTION

27



LEACHATE SUMP PUMP

28



NOTES:
1. DRILL HOLE TO CORRECT SIZE AT DESIRED LOCATION.
2. THREAD EXIT NIPPLE INTO DRILLED HOLE. HOLD AT NON-THREADED BOSS AREA OR ATTACH END CAP TO TURN. EXTEND INTO RISER APPROXIMATELY 2.5".
3. ATTACH MALE CAM AND GROOVE FITTING-USE THREAD PASTE.
4. BACK UP NIPPLE UNTIL SHOULDER OF CAM AND GROOVE FITTING IS AGAINST INSIDE OF RISER PIPE WALL.
5. POSITION CABLE EXIT FITTINGS AS REQUIRED-TYPICALLY ABOVE THE DISCHARGE EXIT FITTING.
6. THE 24" DIA. RISER PIPE SHALL BE CLEANED OF ALL HDPE PIPE SHAVINGS ONCE DRILLING IS COMPLETE. ALL SHAVINGS SHALL BE REMOVED FROM INSIDE THE PIPE PRIOR TO PLACING THE SYSTEM INTO OPERATION.

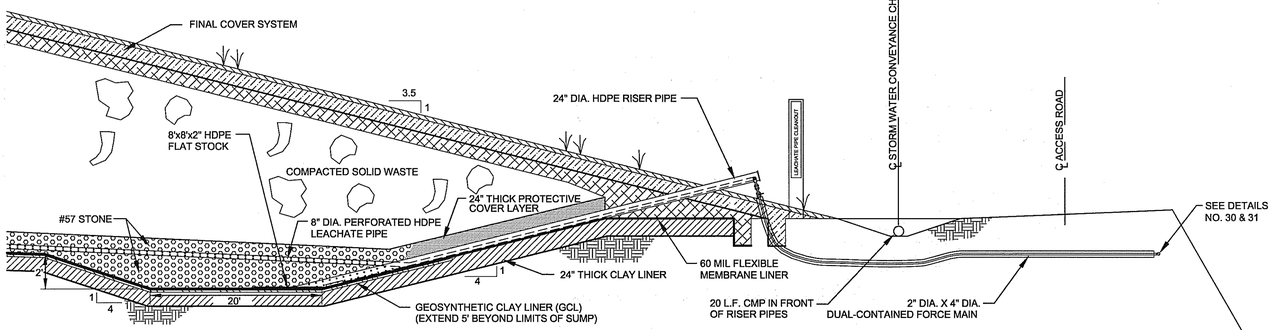
INTO 24" RISER VIEW

NOTE:
1. EXIT FITTINGS SHOULD BE PLACED APPROXIMATELY 6" BELOW THE TOP OF THE RISER AND 10" MAX. TO ALLOW REACH TO FITTINGS.

SIDE VIEW

24" DIAMETER RISER SIDE EXIT

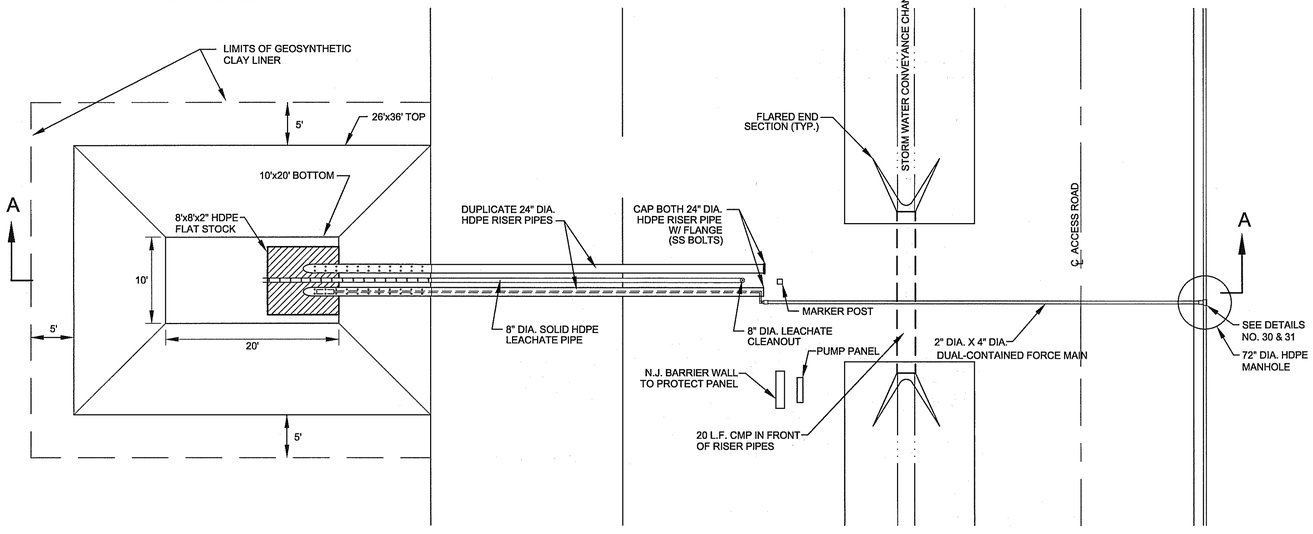
29



NOTE:
1. 2" DIA. DISCHARGE PIPE AND 4" DIA. FORCE MAIN SHALL HAVE A MINIMUM 42" COVER AND SHALL BE DUAL-CONTAINED.
2. LEACHATE CLEANOUT NOT SHOWN FOR CLARITY.

SECTION A

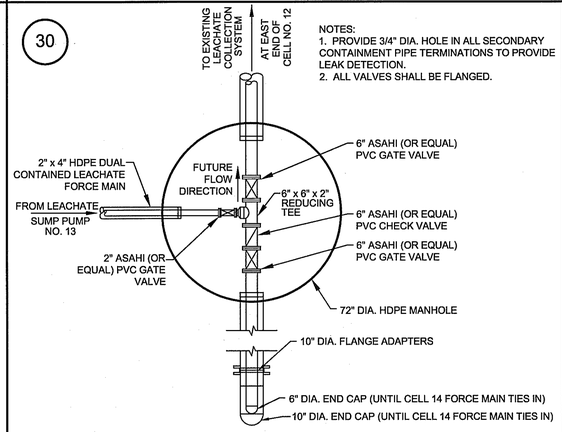
NOTE:
ENTIRE SUMP SHALL BE FILLED WITH ASTM #57 GRAVEL.



NOTE: ELECTRIC CONDUIT SHALL BE PLACED IN SAME TRENCH WITH FORCE MAIN.

PLAN VIEW
LEACHATE SUMP ASSEMBLY

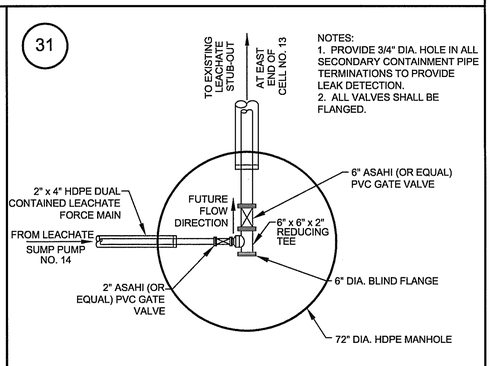
30



NOTES:
1. PROVIDE 3/4" DIA. HOLE IN ALL SECONDARY CONTAINMENT PIPE TERMINATIONS TO PROVIDE LEAK DETECTION.
2. ALL VALVES SHALL BE FLANGED.

PROPOSED LEACHATE TIE-IN
AT LEACHATE SUMP 13

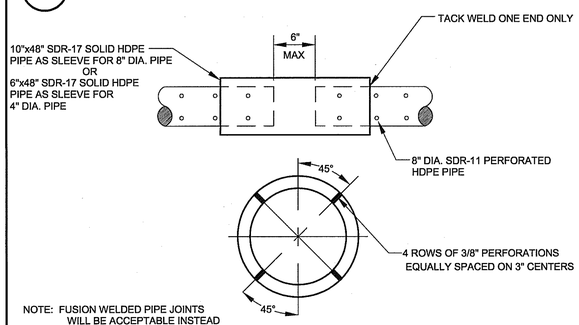
31



NOTES:
1. PROVIDE 3/4" DIA. HOLE IN ALL SECONDARY CONTAINMENT PIPE TERMINATIONS TO PROVIDE LEAK DETECTION.
2. ALL VALVES SHALL BE FLANGED.

PROPOSED LEACHATE TIE-IN
AT LEACHATE SUMP 14

32



NOTE: FUSION WELDED PIPE JOINTS WILL BE ACCEPTABLE INSTEAD OF SLEEVED JOINTS.

4" DIA. AND 8" DIA. PERFORATED SDR-11 HDPE PIPE

NORTH CAROLINA PROFESSIONAL SEAL 16146 ENGINEER WILLIAM F. HODGES

NORTH CAROLINA PROFESSIONAL SEAL 15142 ENGINEER H. LOWRY TRIBBLE, JR.

LINER AND LEACHATE SYSTEM DETAILS

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

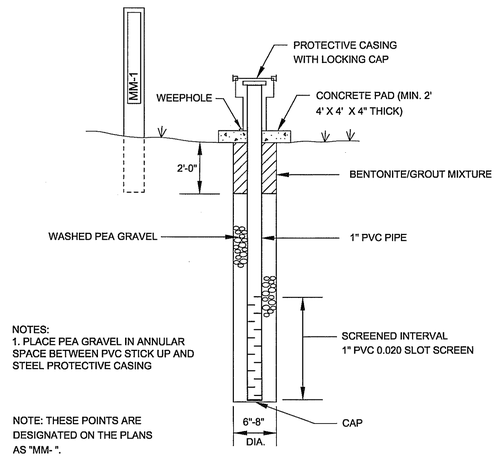
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG.	ECP5-D3
SCALE	NOT TO SCALE	EDIT	4-1-08
DATE	APRIL, 2008	SHEET	18 OF 19

33

NO DETAIL

34

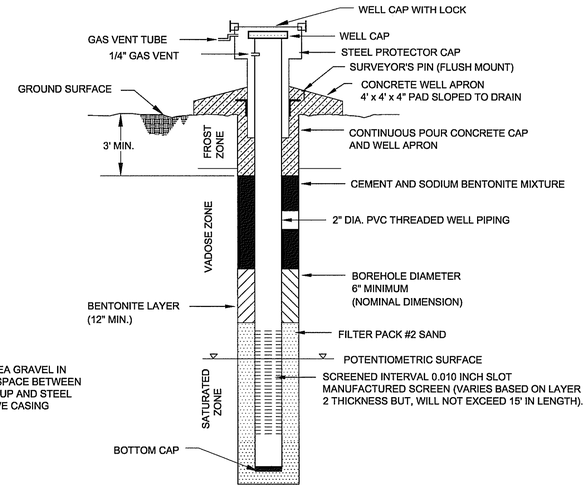


NOTES:
1. PLACE PEA GRAVEL IN ANNULAR SPACE BETWEEN PVC STICK UP AND STEEL PROTECTIVE CASING

NOTE: THESE POINTS ARE DESIGNATED ON THE PLANS AS "MM- ".

METHANE GAS MONITORING PROBE

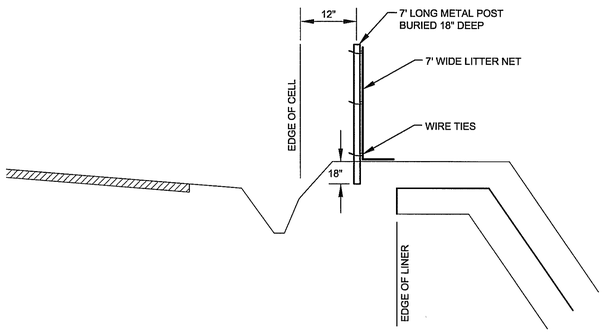
35



NOTES:
1. PLACE PEA GRAVEL IN ANNULAR SPACE BETWEEN PVC STICK UP AND STEEL PROTECTIVE CASING

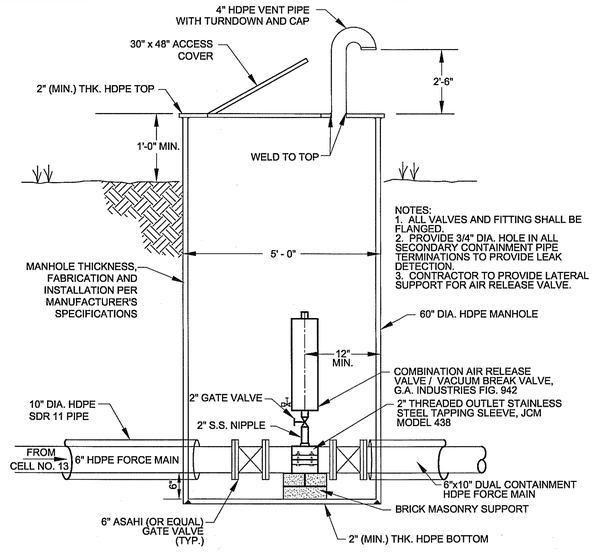
GROUND WATER MONITORING WELL (TYP.)

36



LITTER FENCE AT SOUTH END OF CELL

37



NOTES:
1. ALL VALVES AND FITTING SHALL BE FLANGED.
2. PROVIDE 3/4" DIA. HOLE IN ALL SECONDARY CONTAINMENT PIPE TERMINATIONS TO PROVIDE LEAK DETECTION.
3. CONTRACTOR TO PROVIDE LATERAL SUPPORT FOR AIR RELEASE VALVE.

LEACHATE AIR RELEASE VALVE

38

NO DETAIL

39

NO DETAIL

40

NO DETAIL

MISCELLANEOUS DETAILS

PHASE 5 ENGINEERING PLAN
EAST CAROLINA REGIONAL MSW LANDFILL

FOR
EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC
BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
(478) 743-7175
(478) 743-1703(FAX)
484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-269-01	DWG. ECP5-D4	EDIT 4-1-08
SCALE	NOT TO SCALE	SHEET 19 OF 19	
DATE	APRIL, 2008		

X. CORRESPONDENCE

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
484 MULBERRY STREET • SUITE 265 • MACON, GEORGIA 31201
P. O. BOX 974 • MACON, GEORGIA 31202-0974

H. LOWRY TRIBBLE, JR., PE
WILLIAM F. HODGES, PE
HAROLD L. NEWBERRY, PE
W. MICHAEL STUBBS, PE

CLINT L. COURSON
DANIEL E. CHEEK , PE
K. MATTHEW CHEEK, PE

TELEPHONE (478) 743-7175
FAX (478) 743-1703

WEBSITE WWW.HHNT.COM

November 19, 2007

Mr. Edward F. Mussler, III, P.E.
NCDENR
1646 Mail Service Center
Raleigh, NC 27699-1646

Re: East Carolina Regional Landfill
Permit No. 08-03
Bertie County
HHNT Project No. 6703-260-07

Dear Mr. Mussler:

On behalf of East Carolina Regional Landfill, we are requesting permanent approval for the use of petroleum contaminated soil (PCS) as alternate daily cover (ADC). Please note, the use of PCS as ADC was previously approved by DENR as a demonstration project.

Should you have any questions, please call.

Sincerely,

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.

William F. Hodges, P.E.
Professional Engineer

WFH/rh/bk

Enclosure

cc: Bill Cooksey
Ray Hoffman, P.E.
Matt Cheek, P.E.

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
484 MULBERRY STREET • SUITE 265 • MACON, GEORGIA 31201
P. O. BOX 974 • MACON, GEORGIA 31202-0974

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WILLIAM F. HODGES, PE
HAROLD L. NEWBERRY, PE
W. MICHAEL STUBBS, PE

CLINT L. COURSON
DANIEL E. CHEEK, PE
K. MATTHEW CHEEK, PE

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WEBSITE www.HHNT.COM

November 8, 2007

Mr. Edward F. Mussler, III, P.E.
NCDENR
1646 Mail Service Center
Raleigh, NC 27699-1646

Re: East Carolina Regional MSW Landfill
Permit No. 08-03
Bertie County, North Carolina
HHNT Project No. 6703-260-01

Dear Mr. Mussler:

This letter follows up our discussion concerning soil borings in future cell development areas on the subject project. Over the past 14 years this site has been thoroughly investigated with soil boring density exceeding one per acre over all developed areas. Much information has been obtained during these past soils/hydrogeological efforts.

The principal purpose of this letter is to request a variance from Rule T 15A.13B.0538 concerning the density of one boring per acre. We request that for the remainder of the site, the boring density be changed to one boring per four acres. Justification for approving this request includes:

A. 205 soil borings have been advanced on this property during the past 14 years. Ample data exists for this site.

B. Due to the Coastal Plain geology and the lack of topographical relief, there is minimal variability across this site.

C. Should the Section feel additional data is required during the review process, additional borings can be requested.

Since soil explorations are ongoing at this facility, we request a response at your earliest convenience.

Should you have any questions, please call.

Sincerely,

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.

William F. Hodges, P.E.
Professional Engineer

WFH/rm

cc: Ray Hoffman, P.E.
Bill Cooksey
Matt Cheek, P.E.

E. Cell 12

6703-273-01

NCDENR

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Dexter R. Matthews, Director | Division of Waste Management | Michael F. Easley, Governor | William G. Ross Jr., Secretary

November 5, 2007

Mr. Ray Hoffman
Republic Services of North Carolina, LLC
P O Box 2943
Hickory NC 28603

Re: Redesign of base grade elevations and leachate system for Cell 12
East Carolina Regional Landfill
Bertie County, Doc ID No. RCO 3336

Dear Mr. Hoffman:

The Solid Waste Section has reviewed the above referenced submittal and has no objections to the redesign of the base grade elevations and leachate collection system details for Cell 12.

If you have any questions or comments, or should you wish to discuss this further, please contact me at (919) 508-8510, or by email at donna.wilson@ncmail.net.

Sincerely,

Donna J. Wilson

Donna J. Wilson
Environmental Engineer
Solid Waste Section

cc: Bill Cooksey, Republic services
Bill Hodges, Hodges, Harbin, Newberry & Tribble
Chuck Boyette

1646 Mail Service Center, Raleigh, North Carolina 27699-1646
Telephone 919-508-8400 \ *Fax* 919-733-4810 \ *Internet* http://wastenotnc.org
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W. MICHAEL STUBBS, PE

CLINT L. COURSON
DANIEL E. CHEEK, PE
K. MATTHEW CHEEK, PE

TELEPHONE (478) 743-7175
FAX (478) 743-1703

WEBSITE WWW.HHNT.COM

October 11, 2007

Mr. Edward F. Mussler, III, P.E.
NCDENR
1646 Mail Service Center
Raleigh, NC 27699-1646

Re: East Carolina Regional Landfill
Construction of Cell No. 12
Bertie County
Permit No. 08-03
HHNT Project No. 6703-273-01

Dear Mr. Mussler:

We have enclosed two sets of plans and bid documents for the construction of Cell No. 12 for your review and approval. Construction on this cell is expected to begin in about 45 days.

Should you have any questions, please call.

Sincerely,

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.

William F. Hodges, P.E.
Professional Engineer

WFH/rm

Enclosures

cc: Ray Hoffman, P.E., w/o encl.
Steve Nichting, w/o encl.
Bill Cooksey, w/o encl.
Matt Cheek, P.E., w/o encl.

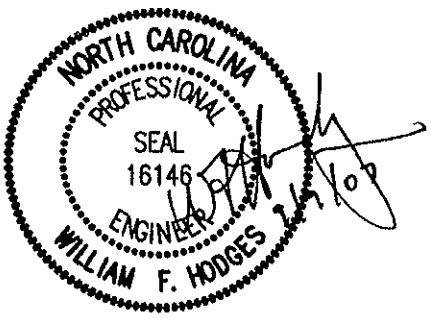
SPECIFICATIONS AND CONTRACT DOCUMENTS

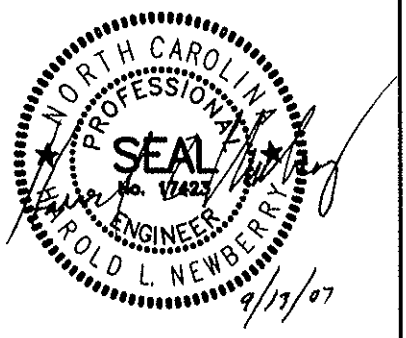
FOR

CONSTRUCTION OF CELL NO. 12
EAST CAROLINA REGIONAL MSW LANDFILL

BERTIE COUNTY, NORTH CAROLINA
REPUBLIC SERVICES OF NORTH CAROLINA, LLC

SEPTEMBER 2007





HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
484 MULBERRY STREET
SUITE 265
MACON, GEORGIA 31201

TEL: (478) 743-7175 **FAX: (478) 743-1703**

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
484 MULBERRY STREET • SUITE 265 • MACON, GEORGIA 31201
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DANIEL E. CHEEK , PE
K. MATTHEW CHEEK, PE

TELEPHONE (478) 743-7175
FAX (478) 743-1703

WEBSITE www.HHNT.COM

July 26, 2007

Mr. Edward F. Mussler, III, P.E.
NCDENR
1646 Mail Service Center
Raleigh, NC 27699-1646

Re: East Carolina Regional MSW Landfill
New Leachate Storage Tank
HHNT Project No. 6703-268-01

Dear Mr. Mussler:

Enclosed are two (2) copies of the proposed leachate storage tank piping plan at the above referred facility for your use. We plan to begin construction within the next several weeks. A new Operations Plan will be submitted with Phase 5 Construction Permit Application which will include the new operating procedures for the tanks.

Should you have any questions, please call.

Sincerely,

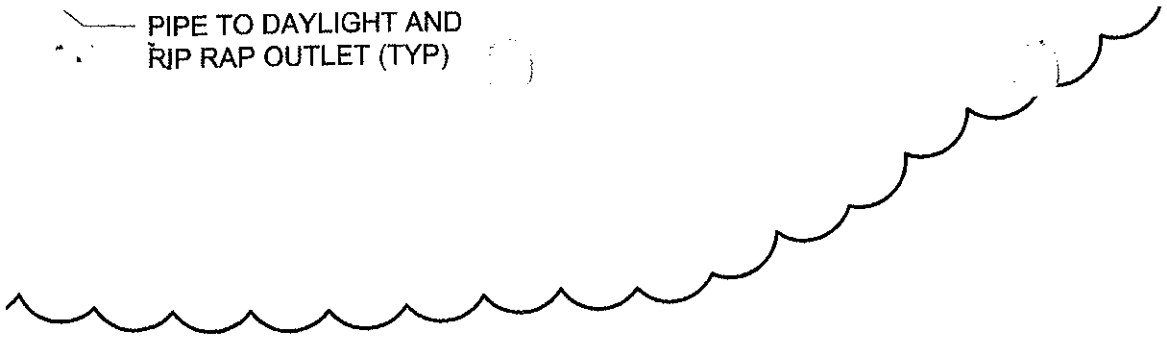
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.

William F. Hodges, P.E.
Professional Engineer

WFH/rm

Enclosure

cc: Bill Cooksey, w/encl.
Ray Hoffman, P.E., w/encl.
Hal Newberry, P.E., w/o encl.
Matt Cheek, P.E., w/o encl.



NOTES:

1.) ALL STAINLESS STEEL PIPE AND FITTINGS SHALL BE SCHEDULE 10, 304 STAINLESS STEEL UNLESS OTHERWISE SHOWN.

2.) ~~ALL 4" X 8" DUAL CONTAINED PIPING SHALL CONSIST OF HDPE SDR 11~~ CARRIER PIPE AND HDPE SDR 21 CONTAINMENT PIPE.

3.) PROVIDE HEAT TRACING, INSULATION, AND ALUMINUM JACKETING FOR ALL EXPOSED STAINLESS STEEL PIPING.

4.) PROVIDE FLOAT SWITCHES IN BOTH TANKS TO LOCK-OUT TRANSFER PUMP AT TANK OVERFLOW LEVEL OR TANK LOW LEVEL. LOCATE FLOAT SWITCHES NEAR TANK LADDER.

5.) THE BASE FOUNDATION FOR THE PROPOSED TANK SHALL BE SET EQUAL TO THE BASE FOUNDATION FOR THE EXISTING TANK, PER THE OWNER'S REQUEST.

LEACHATE STORAGE TANK PIPING PLAN

NEW LEACHATE STORAGE TANK

EAST CAROLINA REGIONAL MSW LANDFILL

EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC

BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS

(478) 743-7175
(478) 743-1703(FAX)

484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-268-01	DWG.	EC-LT-SP	EDIT	6-07-07
SCALE	1" - 10'	SHEET	1	OF	1
DATE	APRIL, 2007				

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS
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P. O. BOX 974 • MACON, GEORGIA 31202-0974

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W. MICHAEL STUBBS, PE

CLINT L. COURSON
DANIEL E. CHEEK , PE
K. MATTHEW CHEEK, PE

TELEPHONE (478) 743-7175
FAX (478) 743-1703

WEBSITE WWW.HHNT.COM

July 12, 2007

Mr. Edward F. Mussler, III, P.E.
NCDENR
1646 Mail Service Center
Raleigh, NC 27699-1646

Re: East Carolina Regional Landfill
Permit No. 08-03
Bertie County
HHNT Project No. 6703-260-01

Dear Mr. Mussler:

We have enclosed five (5) copies of an "Existing Topographical Survey-Facility Plan Information" for the subject facility which shows the second leachate storage tank, the relocated flare, the pond forebays and other facility components. This plan is being provided for your information.

Should you have any questions, please call.

Sincerely,

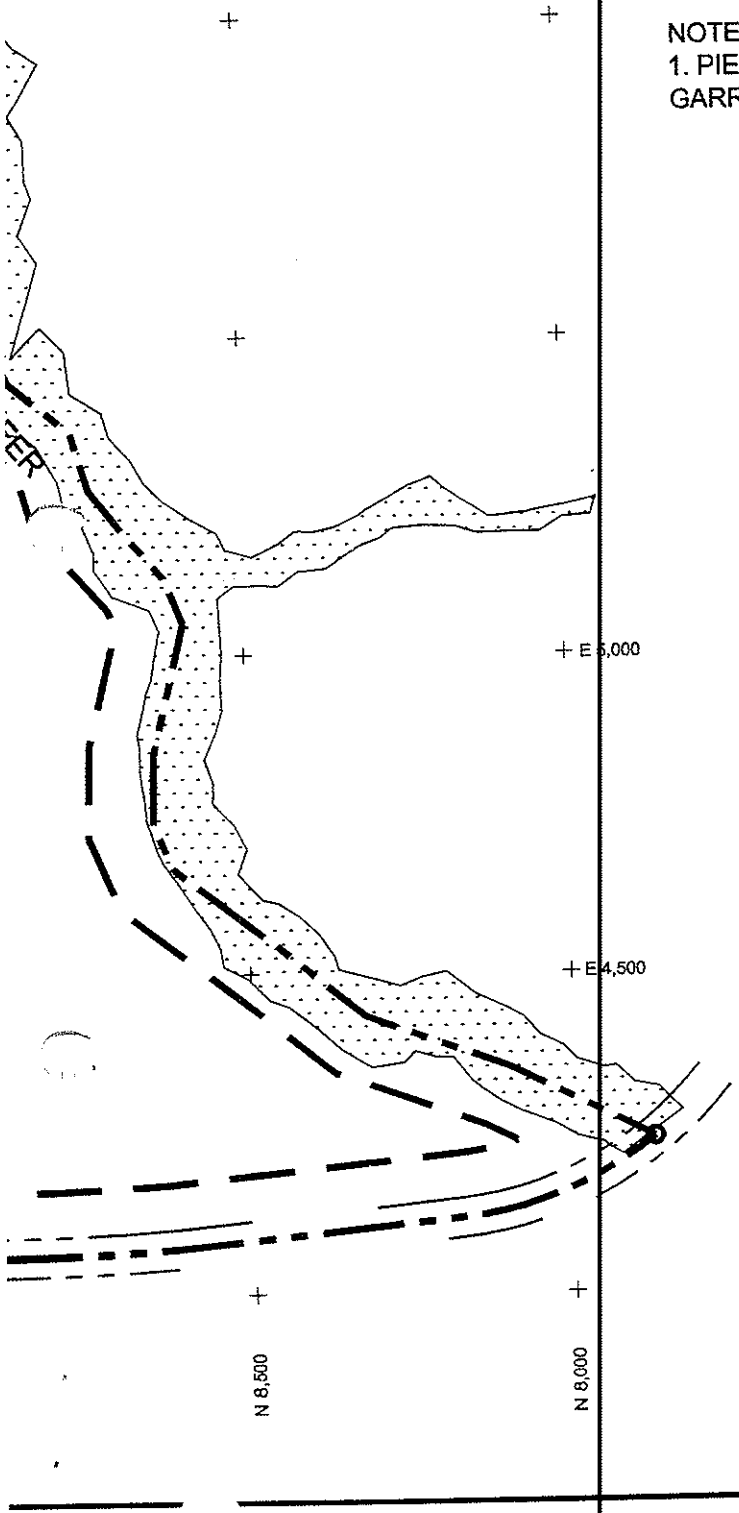
HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.

William F. Hodges, P.E.
Professional Engineer

WFH/rm

Enclosure

cc: Bill Cooksey, w/encl.
Ray Hoffman, P.E., w/encl.
Matt Cheek, P.E., w/o encl.



NOTES:
1. PIEZOMETERS LOCATIONS SHOWN IN THIS SHEET WERE PROVIDED BY DONALDSON GARRETT AND ASSOCIATES IN AN EMAIL DATED SEPTEMBER 7, 2004.

300 0 300 600 900

NORTH CAROLINA PROFESSIONAL SEAL 16116 ENGINEER WILLIAM F. HODGES 7/12/07

NORTH CAROLINA PROFESSIONAL SEAL 32248 ENGINEER K. MATTHEW CHEEK 7-12-07

EXISTING TOPOGRAPHICAL SURVEY - FACILITY PLAN INFORMATION

FACILITY PLAN LAYOUT

EAST CAROLINA REGIONAL MSW LANDFILL

EAST CAROLINA ENVIRONMENTAL
REPUBLIC SERVICES OF NORTH CAROLINA, LLC

BERTIE COUNTY, NORTH CAROLINA

HODGES, HARBIN, NEWBERRY & TRIBBLE, INC.
CONSULTING ENGINEERS

(478) 743-7175
(478) 743-1703(FAX)

484 MULBERRY ST. - STE. 265
MACON, GEORGIA 31201

PROJ. NO.	6703-260-01	DWG. ECP4-TPR	EDIT 7-12-07
SCALE	1" = 300'	SHEET 1 OF 1	
DATE	JULY, 2007		

NCDENR

North Carolina Department of Environment and Natural Resources

Dexter R. Matthews, Director | **Division of Waste Management** | Michael F. Easley, Governor
William G. Ross Jr., Secretary

Ms. Joyce Dishmon
Republic Services of North Carolina, LLC.
1379 Tellowee Road
Eden, NC 27288

Re: Use of Contaminated Soils as Alternate Daily Cover at East Carolina Regional Landfill.

Dear Mrs. Dishmon,

This letter is in response to your letter of April 22, 2005. That letter was concerning the proposed use of alternate daily cover at the East Carolina Environmental Landfill, facility permit no. 08-03. The Section is as at a small loss as to the nature and reason for the request. As you are aware we do not perfom waste determinations. Rather each faciltiy, through it's waste screening plan, is responsilbe to ensure that they do not take wastes that are hazardous or that they are not permitted to receive.

With respect to using solid waste as alternate daily cover, Republic and the Section have had a long history of such . On May 9, 2001 the section provided Republic Services of North Carolina, LLC with a letter regarding alterante daily cover soils and waste reporting for the North Carolina Annual Report (copy attached). The letter addressed the use of ADC and how they should be categorized for record keeping purposes, or for application to the landfill's daily, permitted, tonnage cap. Additionally your facilites have modified their operations plans to cover the use of solid waste, primaily contamintated soils, as ADC.

Given this previous guidance, there in not a need for the Section to comment on or approve each individual waste soil that your facilities desire to use as ADC. You should determine that it is a solid waste, nonhazardous, meets the requirements of Rule .1626(2)(b), and that it is applied in accordance with the terms and conditons of the May 9, 2001 letter and your approved facility operations plan. .

If you have any further questions please do not hesitate to contact me

Sincerely

Ed Mussler
Environmental Engineer
Solid Waste Sedtion

Cc: Bill Hodges, HHNT
Mark Poindexter DWM
John Crowder, DWM
Jim Barber, SWM
Brent Rockett, DWM
Ray Hoffman, Republic Services of NC, LLC

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Dexter R. Matthews, Director Division of Waste Management Michael F. Easley, Governor
William G. Ross Jr., Secretary

July 30, 2004

Mr. Tom Flanagan
East Carolina Regional Landfill
1922 Republican Road
Aulander, NC 27805

RE: Petroleum Contaminated Soil (PCS) As Alternate Daily Cover (ADC), East Carolina Regional MSW Landfill, Permit No. 08-03, Continued Use Approval.

Dear Mr. Flanagan;

The Division of Waste Management, Solid Waste Section, hereby issues an extension of the demonstration project of using petroleum contaminated soil as alternate daily cover until August 1, 2005, or until the project becomes part of the permanent operating procedures of the facility. East Carolina Regional Landfill shall continue to maintain the records of the project, at the facility, per the approved operation plan, "Operation Plan, East Carolina Regional MSW Landfill, Bertie County, North Carolina, March 2002". At the present time no further reports are required to be submitted to the Section, but we reserve the right to ask for a future report of the facility activities.

Currently the Solid Waste Section is reviewing its policies and procedures for the handling and use of petroleum contaminated soils as alternate daily cover. It is the intent of the Section to issue guidelines and permit condition for the general use, operations, data collection and reporting of the activity, that will be applicable to all municipal solid waste landfill facilities in North Carolina. When this occurs, your facility will be given the opportunity to review and accept the conditions, so as to continue using PCS as ADC.

The future statewide blanket approval for use of PTC as ADC will likely include a provision that any MSW facility which chooses to implement the program, will be required to obtain new local government approval, in the form of a new resolution or revised franchise, approving the revised facility operating plan. If there are any questions concerning this extension of the approval to operate a pilot demonstration project for the use of PTC as ADC, please contact us.

Sincerely,

James C Coffey

James C. Coffey, Chief
Solid Waste Section

cc: Ed Mussler, DWM
Jim Barber DWM
Chuck Boyette, DWM Bill Hodges, HHNT

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North Carolina
Department of Environment and Natural Resources

Division of Waste Management

Michael F. Easley, Governor
William G. Ross Jr., Secretary
Dexter R. Matthews, Director

NCDENR

January 21, 2003

RECEIVED
JAN 30 2003

Mr. William F. Hodges, P.E.
Hodges, Harbin, Newberry and Tribble
484 Mulberry Street Suite 265
Macon, Ga 31201

RE: Permit Modification, Alternate Protective Cover, East Carolina Regional LF, Permit Number 08-03.

Dear Mr. Hodges:

The Division of Waste Management, the Solid Waste Section (Section) is in receipt of your letter of 6 November 2002. This letter provided information and rational for changing the hydraulic conductivity specification of the protective cover over the FML liner on this facility. The proposed alternative cover is native sandy soil with a permeability of at least 5 x 10^{-4} cm/sec, and the addition of leachate collection lines.

The Section has reviewed the proposed modification to the approved plan. Pursuant to Permit to Construct, Number 08-03, permit condition 10, the Section has reviewed the changes and hereby accepts them. The plan will be included in list of approved documents of the permit to operate for Cell 10.

Field changes or other deviations from the approved plan, should be included on the as-built drawings and properly identified in the final CQA report as required by the plan. If you have any questions or need additional assistance, please contact the Section.

Sincerely,

James C Coffey

James C. Coffey, Chief
Solid Waste Section

cc Chuck Boyett, DWM
Jim Barber, DWM
Mark Fry, DWM