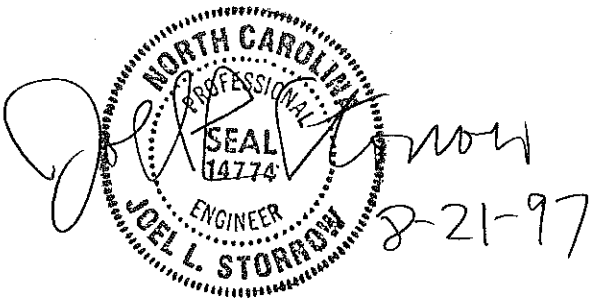
ENGINEERING PLAN

Macon County MSW Landfill
Phase II - Cell 1
June 1997
Revised August 19, 1997

JOEL L. STORROW

McGill ASSOCIATES

Engineering • Planning • Finance
Asheville, North Carolina



JUNE, 1997

96117.00

ENGINEERING PLAN
Macon County MSW Landfill
Phase II - Cell 1

The Engineering Plan incorporates the plans and specifications relative to detailed design and performance of the Phase II Cell 1. This plan has been prepared as required under Rule .1617 and in accordance with Section .1620 of the Solid Waste management Rules (15 NCAC 13B). Sections .1624 (Construction Requirements For MSWLF Facilities), .1627 (Closure and Post-Closure Requirements for MSWLF Facilities), and .1680 (Leachate Storage Requirements) were also closely referenced during the development of this plan. This Engineering Plan covers the engineering and design of Phase II - Cell 1.

1.0 ANALYSIS OF FACILITY DESIGN

1.1 Composite Liner and Leachate Collection System

The Phase II - Cell 1 expansion has the following liner and Leachate Collection System (LCS) design characteristics (from bottom to top):

- a minimum four (4) foot vertical buffer from projected high water table to bottom of composite liner,
- a two (2) foot thick compacted clay liner with maximum permeability of 1×10^{-7} cm/sec.,
- a sixty (60) mil high density polyethylene (HDPE) geomembrane liner, smooth on the floor and textured on the slopes,
- a sixteen (16)-once geotextile cushion on the floor and slopes,
- a two (2) foot thick drainage layer with minimum permeability of $1x10^{-2}$ cm/sec, including leachate collection and transfer piping

The stability calculations, settlement calculations, and anchor trench design are included in a separate report titled "Geotechnical Exploration and Design Recommendations" prepared by Terra Consultants, Inc.

1.2 Cap System

The Phase II - Cell 1 Expansion has the following cap system design characteristics (from bottom to top):

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

Revisions by McGill Associates, dated August 19, 1997

The stability calculations for the final cap design are included in a separate report titled "Geotechnical Exploration and Design Recommendations" prepared by Terra Consultants, Inc.

1.3 Leachate Collection and Storage Facilities

The leachate collection line is made up of one (1), eight (8)-inch perforated HDPE main collector line which runs in the north/south direction down the center of the landfill. The lateral collectors are a series of six (6)-inch perforated HDPE pipes that run in the east/west direction in the cell. The lateral collectors are spaced a maximum of 200 feet apart and maintain a minimum grade of 3.0%. See Sheet 4 of the design drawings for the layout of the leachate collection lines. Refer to Attachment B of the Facility Plan for the HELP model analysis (input and output data).

The Phase II - Cell 1 Expansion has two (2) sump areas within the cell. One sump is located at the northern tip of the cell, which is the lowest point of the cell. The other sump is located on the western side of the cell, about midway of the cell. The sump areas are four (4)-foot square recessed areas, which are double lined with HDPE geomembrane.

The sump areas have an eighteen (18)-inch perforated HDPE riser pipe which rests on the 16-ounce geotextile cushion along the slope and lies between the sump and the top of the perimeter berm. A submersible pump will be placed inside each of the 18-inch risers. The pump station controls will be located on top of the perimeter berm at the end of the pump riser. Controls will include automatic pump controls and auto-dialer capability. Refer to Attachment C of the Facility Plan for leachate pump sizing and perforation calculations.

The pumps will discharge into a three (3)-inch dual contained force main which runs along the western edge of the cell to the existing surface impoundment at the Franklin Wastewater Treatment Plant. The force main will be located along the western edge of the perimeter access road. The line will be dual-contained HDPE pipe, with a nominal inside pipe diameter of three (3) inches. Refer to Attachment C of the Facility Plan for force main calculations.

The maximum average monthly flow of leachate was calculated to be 362,077 gallons through the HELP model analysis. The amount of leachate actually produced will be recorded on a daily basis from the flow meters on the leachate pumps.

The leachate holding pond is located on the northern side of the Town of Franklin's Wastewater Treatment Plant. The pond was constructed during the Phase I construction of the landfill built in 1992. The pond base consist of 18-inches of low permeability compacted clay, below a 60 mil. HDPE liner, below a eight (8) ounce geotextile, , below a three (3) inch Fabriform Unimat. The capacity of the pond, allowing for a two (2) foot freeboard, is approximately 770,000 gallons. The existing Phase I waste area is averaging between 12,000 and 13,000 gallons per day of leachate, with the peak

generation of approximately 15,000 gallons per day. Using the average flow of 13,000 gallons per day, the average flow from Phase I would be approximately 390,00 gallons. The total projected monthly flow for both phases would be approximately 752,077 gallons. The existing surface impoundment will be sufficient to store the average monthly flow of leachate.

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

2.0 FACILITY DESIGN SUMMARY

2.1 Analytical Methods Used for Design Evaluation

2.1.1 Liner Components.

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

2.1.2 Leachate collection system

Designed to handle leachate production flows as determined by the HELP Model. Pipe spacing, pipe size, and pond size based upon flow volume from HELP Model and Manning's Equation.

2.1.3 Leachate Production - HELP Model

Volumes - HELP Model
Storage Facilities - HELP Model

2.1.4 Gas Collection System

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

2.2 Definition of Critical Conditions and Assumptions Made

Critical components

- Phase II - Cell 1 Expansion will piggyback onto existing cell.

- Separation of a minimum four (4) feet above projected high water table
- Maximize use of existing property
- If on-site soils are used they will most likely require amendment to achieve a maximum permeability of $1x10^{-7}$ cm/sec.
- Use of a gravel wrap around leachate collection pipes to minimize chance of clogging
- Liner system and cap system per current regulations

2.3 Technical References Used

- EPA 530-R-93-017 "Solid waste disposal facility criteria, technical manual"
- NC Regulations (15A NCAC 13B)
- Federal Regulations
- HELP Model, Version 3.04A
- Geomembrane liner manufacturer literature
- "Subtitle D technical training manual"
- EPA/625/R-94/008 Seminar publication "Design, operation, and closure of municipal soil waste landfill"
- EPA/600/R-94/168a "Hydraulic evaluation of landfill performance (HELP) Model user's guide for version 3"

2.4 Location Restrictions

The Phase II - Cell 1 expansion complies with all location restrictions given in Section .1622 of the Solid Waste Management Rules (15A NCAC 13B).

2.4.1 Airport Safety

Rule .1622(1) specifies that a new MSWLF unit not be located closer than 5000 feet from any airport runway used only by piston powered aircraft and no closer than 10,000 feet from any runway used by turbine powered aircraft. There are no airport runways within 10,000 feet of the Franklin MSW Landfill.

The Macon County Airport is located approximately 11,500 feet to the northwest of the landfill. The airport is operated by Mountain Air, Inc. and is used by piston-powered aircraft. Rule .1622(1) requires landfill owners of a site within 5 miles of a airport runway to contact the affected airport and the Federal Aviation Administration (FAA). The letters to the Macon County airport and the FAA are included in the Site Study. Thus, the landfill location satisfies the location restriction of Rule .1622(2).

2.4.2 Floodplains

Rule .1622(2) states that a new MSWLF unit, existing MSWLF units, and lateral expansions shall not be located in the 100 year floodplains unless the owner demonstrates that the landfill will not restrict the 100-year flood, reduce the temporary storage capacity, or result of a washout of solid waste.

The outline of the proposed landfill activity and the extent of the 100-year floodplain at the site is shown on Sheet 4. The floodplain delineation is based on the Tennessee Valley Authority flood data of October 1964. The proposed landfill activity does not encroach in the 100-year floodplain. Thus, the landfill activity has no impact on the 100-year floodplain and satisfies the location restriction of Rule .1622(2).

2.4.3 Wetlands

Rule .1622(3) states that new MSWLF units and lateral expansions shall not be located in wetlands unless demonstrations of lack of alternatives, lack of impact, and possible mitigation if a MSW landfill was located in wetlands.

Sheet 2 shows wetland locations on the landfill property as delineated by Mr. David Baker, Corps of Engineers on February 5, 1997. The wetlands is generally confined to the banks of the Little Tennessee River and low areas in the middle of the site. As shown on Sheet 3, the proposed landfill activity will not encroach into the delineated wetlands. A copy of the Wetlands Map has been included as Appendix D. Thus, the landfill location satisfies the location restriction of Rule .1622(3).

2.4.4 Fault Areas

Rule .1622(4) states that new MSWLF units and lateral expansions shall not be located within 200 feet of a fault that has had displacement in Holocene time, unless the owner or operator demonstrates that a alternative setback distance of less than 200 feet will prevent damage structural damage to the MSW landfill and will be protective of human health and environment.

From the original site suitability study by Westinghouse Environmental and Geotechnical Services, Inc., no faulting has been documented in the immediate vicinity of the landfill property. The landfill location satisfies the location restrictions of Rule .1622(4).

2.4.5 Seismic Impact Zones

Rule .1622(5) states that new MSWLF and lateral expansions shall not be located in seismic impact zones, unless the owner demonstrates that all containment structures, including liners, leachate collection systems, and surface water control systems are designed to resist the maximum horizontal acceleration in lithified earth materials for the site.

The Site Study includes a copy of the U.S. Geological Survey Map (Algermissen and others, 1990), which depicts via contouring, the area of the United States where the horizontal acceleration has a 90% probability of not being exceeded in 250 years (or a 10 percent probability of being exceeded). The Franklin Landfill site is located between the 0.20g contour and the 0.22g spot location. There is a 10 percent probability that horizontal acceleration at the site will reach about 0.21g in 250 years, thus the 0.10g criteria is exceeded at the landfill site.

The landfill containment structures, including liners, leachate collection systems, and surface water control systems will be designed to resist the potential maximum horizontal acceleration in lithified earth materials on the site.

2.4.6 Unstable Areas

Rule .1622(6) states that owners of new MSWLF units, existing MSWLF, and lateral expansions located in unstable areas shall demonstrate that engineering measures have been incorporated into the MSW landfill design to ensure that the integrity of the structural components of the landfill will not be disrupted.

From the original site suitability study by Westinghouse Environmental and Geotechnical Services, Inc., the generalized subsurface profiles and compaction testing results in and around Cell No. 1 did not indicate that areas of potential mass movement exist. Additional geologic and structural analysis of the proposed landfill has been completed and furnished in a separate report titled "Geotechnical Exploration and Design Recommendations" by Terra Consultants, Inc. The site does not exhibit karst terrain characteristics and is not subject to sinkhole activity or caves. Based on the above considerations, the landfill site is stable and satisfies the location restrictions of Rule .1622(6).

2.4.7 Cultural Resources

Rule .1622(7) states that new MSWLF units or lateral expansions shall not damage or destroy an archaeological or historical property.

A archeological study was completed on a portion of the property in 1990. The study covered approximately 60 acres on the western portion of the property in the areas cells 1 and 2. A copy of this study is included in Site Study. The study did not include the remaining acreage on the east side of the large pond in the middle of the property. This portion of the property, which include portions of Phase II and cells 3 & 4 has recently been completed. The findings of the recent survey included a old cemetery and two sites which no historical significance. The additional survey was completed by Appalachian State University's Department of Anthropology. A summary of their findings is included in the site study.

2.4.8 State Nature and Historic Preserve

Rule .1622(8) states that new MSWLF units or lateral expansions shall not have an adverse impact on any lands included in the State Nature and Historic Preserve.

There are no state parks, recreation or scenic areas, or any other lands included in the State Nature and Historic Preserve located in the immediate vicinity of the landfill.

2.4.9 Water Supply Watersheds

Rule .1622(9) states that new MSWLF units or lateral expansions shall not be located in the critical area of a water supply watershed or in the watershed for a stream segment classified as WS-1.

The Franklin Landfill is not located in the critical area of a water supply watershed or in the watershed for a stream segment classified as WS-1. Based on available information, there are no water intakes off the Little Tennessee River for consumable water.

2.4.10 Endangered and Threatened Species

Rule .1622(10) states that new MSWLF units and lateral expansions shall not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973.

An Endangered Species Study was performed by the State of North Carolina Department of Natural Resources and Community Development relative to the presence of any endangered or threatened species of plant, fish, or wildlife. A copy the letter with the study results is included in the site study. Based on their study, a population of Olive Darter occurs in Lake Emory. However, the species of Olive Darter is located within the wetland and floodplain areas which are outside the proposed area for development. Therefore; the proposed landfill development should not have an impact on any endangered or threatened species and satisfies the location restriction of Rule .1622(10).

3.0 MATERIALS AND CONSTRUCTION PRACTICES

All materials and methods used for constructing the Phase II - Cell 1 Expansion should meet the requirements set forth in Section .1624 of the Solid Waste Management Rules (15A NCAC 13B).

3.1 Subgrade

The landfill subgrade will be adequately free of organic materials and will consist of on-site soils or select fill material previously approved by the Division. The subgrade will be graded according to plans approved by the Division. The landfill operator may be

required to notify the Division's hydrogeologist for inspection of the subgrade once excavation is complete. This notification would be indicated in the permit to construct.

Before construction of the liner system, the project engineer will visually inspect the subgrade. The project engineer will evaluate the integrity of the surface and document proper preparation and elevations according to plans approved by the Division. The subgrade will be proof-rolled using procedures specified by the design or project engineer. The subgrade will be tested for moisture and density requirements at the minimum frequency given in the Division approved plans.

3.2 Clay Liner

The materials used to construct the compacted clay liner will consist of on-site or off-site materials and may require the addition of a bentonite admixture. The material will be mixed and stockpiled according to methods given in the Division approved plans. The material will also be free of particles greater than three (3) inches in any dimension.

Construction methods used for placement of the compacted clay liner will vary according to quality of material used. These construction methods will be verified by constructing a test pad. The area, equipment, liner thickness, and subgrade slope and conditions will all be representative of field conditions during test pad construction. The following tasks will be performed for each lift of the test pad:

- three (3) locations will be tested for moisture content, density, and sample taken for recompacted lab permeability tests.
- at least one (1) Shelby tube sample will be taken for lab permeability testing.

The clay material will maintain the properties of the moisture-density-permeability relationship curves throughout construction of the compacted clay liner. A single lift of clay will never have a compacted thickness greater than six (6) inches. Lifts greater than six (6) inches thick will be stripped to six (6) inches and recompacted. At a minimum, each lift of the compacted clay liner will be tested for moisture content, density, and permeability.

3.3 Geomembrane Liner

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

The installation of the geomembrane will conform to manufacturer's recommendations and conform to methods given in the Division approved plans, including the following:

- The clay liner surface that the geomembrane will be placed on should be reasonably free of stone, organic material, protrusions, loose soil, and any abrupt changes in grade.
- Field seaming preparation and methods, general panel orientation, and restrictive weather conditions.
- Anchor trench dimensions and liner termination.
- Protection from material installed directly above the geomembrane.
- Destructive and non-destructive testing as described in CQA Plan.

3.4 Leachate Collection Pipes

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

The leachate collection pipes will be installed according to the layout and details given in the Division approved plans. All piping will be equipped with cleanouts for periodic cleaning and maintenance. The bedding material for the collection lines will be 5/8-inch washed aggregate with no more than five (5) percent by weight passing the #200 sieve. This aggregate will be chemically compatible with leachate generated in the cell.

3.5 Drainage Layer

The drainage layer/protective cover is specified as a granular material not to exceed 5/8 inches with a minimum permeability of $1x10^{-2}$ cm/sec and less than 1% calcium carbonate content. The aggregate used as the drainage layer in the cell will not be adversely affected by leachate produced in the cell and will promote lateral drainage of leachate.

The drainage layer will be placed by methods given in the Division approved plans, and in a manner which prevents equipment from working directly on the geomembrane. The drainage layer material will be stable on the 3:1 side slopes of the cell. Please refer to the separate report titled "Geotechnical Exploration and Design Recommendations" by Terra Consultants, Inc. for a detailed description of the stability of the drainage layer on the side slopes.

3.6 Filter Layers

The filter material around the leachate collection pipes is a 5/8" washed stone with less than 5% material passing the no. 200 sieve. The filter material is then wrapped with a 6 oz./sy non-woven geotextile. The filter layers in the leachate collection system will prevent migration of fine soil particles from entering the leachate collection pipes, while allowing leachate to enter the leachate collection pipes without clogging. Geosynthetic filters will demonstrate adequate permeability and soil particle retention, while having chemical and physical resistance from waste placement, leachate, and any overlying material.

All filter layers will be installed according to the Division approved plans, specifications, and CQA plan. Geosynthetic filters will not be wrapped directly around leachate collection piping.

3.7 Erosion Control

The erosion control structures are designed and will be maintained to manage the run-off generated by the 24-hour, 25-year storm event and will conform to the requirements of the Sedimentation Pollution Control Law (15A NCAC 4). Refer to Attachment C for a copy of the Erosion Control Plan which will be submitted to the North Carolina Land Quality Section.

4.0 DESIGN HYDROGEOLOGIC REPORT

The Design Hydrogeologic Report was prepared by Pin-Point Environmental Services, Inc. A copy of this report is included with this design package submitted to the Solid Waste Division.

5.0 ENGINEERING DRAWINGS

5.1 Existing Conditions

Sheet 2 of the design drawings shows existing site topography, existing roads, existing buildings, existing borrow and stockpile areas, limits of existing Phase I cell no. 1, and proposed location of the Phase II - Cell 1 Expansion.

5.2 Grading Plans

The grading plans identify the proposed limits of excavation, subgrade elevations, boring locations, clay liner elevations, and drainage layer elevations. Sheet 3 of the construction drawings shows subgrade elevations and the locations of the borings. Sheet 4 shows the top elevations of the clay liner. Sheet 5 shows the top elevations of the LCS drainage layer.

5.3 Base liner System

The grades for the top of the composite liner are shown on Sheet 4. As shown on the drawings, the minimum floor slope within the cell is two (2) percent. The interior 3.1 side slopes and exterior fill slopes of 2:1 are also shown on Sheet 4. There will be no liner penetrations of the base liner system. The anchor configuration and details of the base liner system are shown on Sheet numbers 19 through 21.

5.4 Leachate Collection System

Since the drainage layer for the LCS is placed directly on the geotextile cushion and geomembrane, and the geomembrane is placed directly on the clay liner, then the top of the clay liner grades given on Sheet 4, also serves as the base elevations for the drainage layer. The top of the drainage layer is shown on Sheet 5 of the drawings. The layout of the main collector lines and lateral collector lines is shown on Sheet 4. The cleanout and sump locations are also identified on this drawing. Details for the LCS, including sump details, cleanout details, and piping details are shown on Sheet numbers 19 through 21.

5.5 Stormwater Segregation System

Stormwater will be diverted from inactive areas of the cell by use of intermediate berms within the cell covered by a temporary synthetic cover. Water that accumulates in the northern half of cell 1 will be pumped over the perimeter berm to an outside diversion ditch. Temporary berms will be constructed during operation of the landfill to separate the cell into smaller subcells in order to keep stormwater from entering the leachate collection system. These temporary berms will be placed a minimum of twenty-five (25) feet away from an active working face to ensure that stormwater is not contaminated by landfilling activities. Sheet 5 of the design drawings shows the proposed locations of the permanent subdividing berm and the division of subcells. Details of the stormwater segregation system are shown on Sheet numbers 19 through 21.

5.6 Cap System

Sheet 12 of the construction drawings shows final grades of the proposed Phase II - Cell 1 Expansion. The cap includes a one (1) foot compacted intermediate cover, an eighteen (18)-inch clay layer, a forty (40) mil textured HDPE geomembrane, a double-sided eight (8)-ounce geocomposite, and an eighteen (18)-inch thick vegetative\erosion layer. The gas collection system is an active system which includes approximately 26 extraction wells, a main gas header around the perimeter of the cell, two knockout sumps, and will tie to the proposed gas system for the existing Phase I. Details of the system are shown on Sheets 19-21 of the design drawings. The Permanent Erosion Control Plan (Sheet no. 13) shows the diversion ditches, permanent ditches, stormdrains, silt fencing and sediment ponds necessary for run-off control of the capped cell. The final grades (top of

protective and vegetative cover) are shown on Sheet 12. The final access road to the top of the cell, is also shown on Sheet 12. Details of the cap system are shown on Sheet numbers 19 through 21 of the design drawings.

5.7 Erosion Control

The permanent erosion control plan is shown on Sheet 13 of the design drawings. The erosion control plans will consist of all necessary diversion ditches, sediment ponds, permanent ditches, stormdrains, and silt fence necessary to control sedimentation on the site. The temporary erosion control plan, which will be followed during the construction of phase II is shown on sheet 7.

5.8 Vertical Separation Requirements

Cross sections of the cut and fill within Phase II - Cell 1 Expansion are shown on Sheet numbers 16 through 18 of the design drawings. These drawings illustrate the base liner thickness, the depth of waste, the cap system thickness, and the existing ground elevation. Cross sections of the subsurface conditions, created from boring data at the site, are shown on Sheets 5 through 9 of the Design Hydrogeologic Report. The projected high water contour map is shown on Figure 3 of the report, and the bedrock contours of the site are shown on Figure 2. A copy of the Design Hydrogeologic Report was included as part of the design package submitted to the NCDEHNR, Solid Waste Division. The smallest separation between the base grades and the water table is 6.05 feet at boring PZ-12 located in the southern tip of the cell. The settlement potential in this area is approximately ten (10) inches as shown on the post settlement map included in the separate report titled "Geotechnical Exploration and Design Recommendations" by Terra Consultants, Inc.

ATTACHMENT A

Geometry of Landfill to
Contain 24 Hour/ 25 Year Storm

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JOB 7611.00
SHEET NO. 1 OF 1
CALCULATED BY JRB DATE
DESCRIPTION MACON Co. MSW LF.
SCALE PROJECT NO.

DEMONSTRATION OF LANDFILL GEOMETRY TO CONTROL AND CONTAIN 24 HOUR, 25 YEAR STORM.

FOR THE DEMONSTRATION USE THE WORST CASE SCENARIO WHICH WOULD BE WHEN THE LARGEST SUBCELL IS OPEN WITH A SMALL AMOUNT OF WASTE. THE LARGEST SUBCELL IS SUBCELL 1 WHICH IS 3.8 ACRES.

ASSUMPTIONS: $C = 1.0$
$i_{25} = 7.3$ in/hr
$A = 3.8$ acres

$Q = CiA$ RATIONAL FORMULA

$= 1.0(7.3)(3.8) = \underline{27.74}$ CFS

MAXIMUM STORM DURATION = 10 MINUTES = 600 seconds

REQUIRED STORAGE VOLUME = (27.74)(600 seconds) = 16,644 C.F.

AVAILABLE STORAGE FOR SUBCELL 1:
There is a 6-foot berm at bottom of subcell 1. If we allow a 1' freeboard the lowest point on the berm would be at elevation 2054.0.

AVAILABLE STORAGE AT ELEV 2054:
$VOL = \frac{0 + 8800}{2} \times 5$ feet = 22,000 C.F.

22,000 C.F. > 16,644 C.F.
∴ AVAIL STOR. > REQ. STORAGE O.K.

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JOB MACON Co. MSW LANDFILL
SHEET NO. 2 OF 2
CALCULATED BY JRB DATE 8/7/97
DESCRIPTION
SCALE PROJECT NO. 96117.00

TIME TO DRAIN 24 hr 25 YEAR STORM

VOLUME OF STORM: V= 16,664 c.f. = 124,646 gals

PUMP CAPACITY (one PUMP) Q= 42.3 gpm

PUMP OUT TIME = $\frac{124,646}{42.3}$ = 2947 mins = 49.1 hours

ATTACHMENT B

Leachate Collection Pipe Stability

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JOB 1611 7100
SHEET NO. 1 OF 3
CALCULATED BY JRB DATE 6/23/97
DESCRIPTION MACON CO. MSW LANDFILL
SCALE PROJECT NO.

LEACHATE PIPE STABILITY

EVALUATION OF SDR 17 LEACHATE COLLECTION PIPES

MAX WASTE ELEVATION = 2142
BASE GRADE ELEVATION = 2060
MAX DEPTH 82'

LAYERS OF OVERBURDEN:

2' OF DRAINAGE LAYER	@ 130 pcf	= 260 psf	= 1.8 psi
77' OF WASTE	@ 60 pcf	= 4620 psf	
3' OF COMPACTED SOIL	@ 110 pcf	330 psf	
		5210 psf	

$$\frac{5210\ psf}{144\ in^2/ft^2} = 36.2\ psi.$$

Weight of Equipment:

229 EXCAVATOR approximate weight = 70,000 lbs
PAD AREA = 7300 in²

70,000 lb / 7300 in² = 9.58 psi EQUIPMENT
1.8 psi DRAINAGE LAYER
11.4 psi

PIPE STABILITY: *FROM DRISCOPIPE MANUAL
WALL CRUSHING. $S_A = \frac{(SDR-1)P_T}{2}$ SDR = 17
P_T = 36.2 psi

$= \frac{(17-1)36.2}{2}$

$= 289.6\ psi$

⇒ COMPRESSIVE STRENGTH OF HDPE PIPE IS APPROX. 1500 psi

SAFETY FACTOR = 1500/289.6 = 5.17 O.K.

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JOB
SHEET NO. 2 OF 3
CALCULATED BY DATE
DESCRIPTION
SCALE PROJECT NO.

WALL BUCKLING:

$$P_{CB} = 0.8\sqrt{E' \times P_C}$$

$P_T = 36.2$ psi

$$P_C = \frac{2.32\ E}{(SDR)^3}$$

→ P_{CB} must be greater than P_T to resist against wall buckling

→ Assume $E' = \underline{3000}$ psi → crushed stone (moderate compaction)

→ From pg 37 of Driscopipe Design Manual CHT. 25

Time dependant modulus of Elasticity @ 150 psi tensile stress $E = \underline{30,000}$ psi

$$P_C = \frac{2.32\ (30000)}{17^3} = 14.17 \text{ psi}$$

$$P_{CB} = 0.8\sqrt{3000 \times 14.17}$$

$= 164.9$ psi ALLOWABLE SOIL PRESSURE

⇒ 36.2psi < 164.9 psi O.K.

FACTOR OF SAFETY $= \frac{164.9}{36.2} = 4.6$ O.K.

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JOB
SHEET NO. 3 OF 3
CALCULATED BY DATE
DESCRIPTION
SCALE PROJECT NO.

RING DEFLECTION:

FOR 6" SDR 17 $D = 6.625$ in $t = 0.39$ inch

ALLOW RING DEFLECT = $\frac{\Delta Y}{D} = 0.25 \varepsilon (SDR)$

ΔY = vertical deflect, inches
D = PIPE O.D. IN.
ε = TANGENTIAL STRAIN IN THE SURFACE OF THE PIPE RING DUE TO DEFLECTION ($\varepsilon = 0.01$ PJ 39 Dr500)
SDR - STANDARD DIM. RATIO D/t
t = pipe thickness, in

$\frac{\Delta Y}{6.625} = 0.25(0.01)(17)$

$\Delta Y = 0.0425 (6.625)$

$\Delta Y = 0.28$ inches

$\frac{\Delta Y}{D} = \frac{0.28}{6.625} = 0.0423 = 4.23\%$

Vertical Strain = $\varepsilon = \frac{P_T}{E'}$

E' = Soil modulus, psi
ε = vertical soil strain
P_T = Total vert. soil pressure

$\varepsilon = \frac{36.2}{3000} = 0.0121$

ALLOW RING DEFLECT > VERT SOIL STRAIN

$\frac{\Delta Y}{D} = 0.0423 > \varepsilon = 0.0121$

FACTOR OF SAFETY = $\frac{0.0423}{0.0121} = 3.50$ ∴ O.K.

ATTACHMENT C

Erosion Control Plan

Erosion Control Plan

This project includes grading for temporary access roads to service the existing landfill cell during construction, permanent access roads, perimeter berms, and cell floor of the Phase 2, Cell 1 Expansion. The project is located on Lakeside Drive, northeast of Franklin at the existing Macon County Landfill property. Approximately 28.4 acres will be disturbed during construction of this project. Construction of this project will take place in two (2) stages. The first stage will be constructed between August 1997 and December 1997 and it is anticipated that the second stage will begin construction in December 1997 and should be completed by August of 1998.

Due to the long operating period of the landfill prior to closure, this Erosion Control Plan has been designed to consider two stages of development of the disturbed area. The first stage of development considered was the construction and operation of the landfill. This is the stage in which the majority of the land disturbing activities will take place, and is represented by the drawing titled "Temporary Erosion Control Plan - Construction and Operation". As the landfill is filled over the estimated 11.7 year life of the cell, final grades will be reached and the landfill will be capped. The second stage of development considered was the landfill after reaching final grades and being capped. The second stage is represented by the drawing titled "Permanent Erosion Control Plan". The Erosion Control Plan has been designed to accommodate changes in flow as the landfill is filled.

This Erosion Control Plan was designed in accordance with the North Carolina Department of Environment, Health, and Natural Resources, Land Quality Section and Solid Waste Section regulations. The plan is designed for

the 25-year storm event as required by the N.C.D.E.H.N.R, Solid Waste Section regulations. The plan includes all erosion control measures necessary to control siltation of the construction site including but not limited to silt fencing, Riprap ditches, grass-lined diversion ditches, Riprap inlet/outlet protection, construction of five sediment basins, temporary slope drains, catch basins with inlet protection, and temporary and permanent stormdrain piping.

SECTION 02821 SEEDING, FERTILIZING AND MULCHING

02821.1 SCOPE

This section covers the furnishing of all labor, equipment and materials necessary for the landscaping of all areas of the site disturbed by construction operations and all earth surfaces of embankments including rough and fine grading, topsoil if required, fertilizer, lime, seeding and mulching. The Contractor shall adapt his operations to variations in weather or soil conditions as necessary for the successful establishment and growth of the grasses or legumes.

02821.2 GRADING

Rough grading shall be done as soon as all excavation required in the area has been backfilled. The necessary earthwork shall be accomplished to bring the existing ground to the desired finish elevations as shown on the Contract Drawings or otherwise directed.

Fine grading shall consist of shaping the final contours for drainage and removing all large rock, clumps of earth, roots and waste construction materials. It shall also include thorough loosening of the soil to a depth of 6-inches by plowing, discing, harrowing or other approved methods until the area is acceptable as suitable for subsequent landscaping operations. The work of landscaping shall be performed on a section by section basis immediately upon completion of earthwork.

Upon failure or neglect on the part of the Contractor to coordinate his grading with seeding and mulching operations and diligently pursue the control of erosion and siltation, the Engineer may suspend the Contractor's grading operations until such time as the work is coordinated in a manner acceptable to the Engineer.

02821.3 MATERIALS

A. *Fertilizer:*

The quality of fertilizer and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Fertilizer Law and regulations adopted by the North Carolina Board of Agriculture.

Fertilizer shall be 10-10-10 grade. Upon written approval of the Engineer a different grade of fertilizer may be used, provided the rate of application is adjusted to provide the same amounts of plant food.

During handling and storing, the fertilizer shall be cared for in such a manner that it will be protected against hardening, caking, or loss of plant food values. Any hardened or caked fertilizer shall be pulverized to its original conditions before being used.

B. *Lime:*

The quality of lime and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Lime Law and regulations adopted by the North Carolina Board of Agriculture.

During the handling and storing, the lime shall be cared for in such a manner that it will be protected against hardening and caking. Any hardened or caked lime shall be pulverized to its original condition before being used.

Lime shall be agriculture grade ground dolomitic limestone. It shall contain not less than 85% of the calcium and magnesium carbonates and shall be of such fineness that at least 90% will pass a No. 10 sieve and at least 50% will pass a No. 100 sieve.

C. *Seed:*

The quality of seed and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Seed Law and regulations adopted by the North Carolina Board of Agriculture.

Seed shall have been approved by the North Carolina Department of Agriculture or any agency approved by the Engineer before being sown, and no seed will be accepted with a date of test more than nine (9) months prior to the date of sowing. Such testing however, will not relieve the Contractor from responsibility for furnishing and sowing seed that meets these specifications at the time of sowing. When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the Contractor may elect, subject to the approval of the Engineer, to increase the rate of seeding sufficiently to obtain the minimum pure live seed contents specified, provided that such an increase in seeding does not cause the quantity of noxious weed seed per

square yard to exceed the quantity that would be allowable at the regular rate of seed.

During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents, or other causes.

Seed shall be entirely free from bulblets or seed of Johnson Grass, Nutgrass, Sandbur, Wild Onion, Wild Garlic, and Bermuda Grass. The specifications for restricted noxious weed seed refers to the number per pound, singly or collectively, of Blessed Thistle, Wild Radish, Canada Thistle, Corncockle, Field Bindwee, Quackgrass, Dodders, Dock, Horsenettle, Bracted Plantain, Buckhorn or Wild Mustard; but in no case shall the number of Blessed Thistle or Wild Radish exceed 27 seeds of each per pound. No tolerance on weed seed will be allowed.

D. *Mulch:*

Straw mulch shall be threshed straw of oats, rye or wheat free from matured seed of obnoxious weeds or other species which would grow and be detrimental to the specified grass.

02821.4 SEEDBED PREPARATION

The Contractor shall cut and satisfactorily dispose of weeds or other unacceptable growth on the areas to be seeded. Uneven and rough areas outside of the graded section, such as crop rows, farm contours, ditches and ditch spoil banks, fence line and hedgerow soil accumulations, and other minor irregularities which cannot be obliterated by normal seedbed preparation operations, shall be shaped and smoothed as directed by the Engineer to provide for more effective seeding and for ease of subsequent mowing operations.

The soil shall then be scarified or otherwise loosened to a depth of not less than six (6) inches except as otherwise provided below or otherwise directed by the Engineer. Clods shall be broken and the top 2 to 3 inches of soil shall be worked into an acceptable seedbed by the use of soil pulverizers, drags, or harrows; or by other methods approved by the Engineer.

On 2:1 slopes a seedbed preparation will be required that is the same depth as that required on flatter areas, although the degree of smoothness may be reduced from that required on the flatter areas if so permitted by the Engineer.

On cut slopes that are steeper than 2:1, both the depth of preparation and the degree of smoothness of the seedbed may be reduced as permitted by the Engineer, but in all cases the slope surface shall be scarified, grooved, trenched, or punctured so as to provide pockets, ridges, or trenches in which the seeding materials can lodge.

On cut slopes that are either 2:1 or steeper, the Engineer may permit the preparation of a partial or complete seedbed during the grading of the slope. If at the time of seeding and mulching operations such preparation is still in a condition acceptable to the Engineer, additional seedbed preparation may be reduced or eliminated.

The preparation of seedbeds shall not be done when the soil is frozen, extremely wet, or when the Engineer determines that it is in an otherwise unfavorable working condition.

02821.5 APPLICATION

Seed shall be applied by means of a hydro-seeder or other approved methods. The rates of application of seed, fertilizer and limestone shall be as shown on the contract drawings.

Equipment to be used for the application, covering or compaction of limestone, fertilizer, and seed shall have been approved by the Engineer before being used on the project. Approval may be revoked at any time if equipment is not maintained in satisfactory working condition, or if the equipment operation damages the seed. Limestone, fertilizer, and seed shall be applied within 24 hours after completion of seedbed preparation unless otherwise permitted by the Engineer, but no limestone or fertilizer shall be distributed and no seed shall be sown when the Engineer determines that weather and soil conditions are unfavorable for such operations.

Limestone may be applied as a part of the seedbed preparation, provided it is immediately worked into the soil. If not so applied, limestone and fertilizer shall be distributed uniformly over the prepared seedbed at the specific rate of application and then harrowed, raked, or otherwise thoroughly worked or mixed into the seedbed.

Seed shall be distributed uniformly over the seedbed at the required rate of application, and immediately harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil. The depth of covering shall be as directed by the Engineer. If two kinds of seed are to be used which require different depths of covering, they shall be sown separately.

When a combination seed and fertilizer drill is used, fertilizer may be drilled in with the seed after limestone has been applied and worked into the soil. If two kinds of seed are being used which require different depths of covering, the seed requiring the lighter covering may be sown broadcast or with a special attachment to the drill, or drilled lightly following the initial drilling operation.

When a hydraulic seeder is used for application of seed and fertilizer, the seed shall not remain in water containing fertilizer for more than 30 minutes prior to application unless otherwise permitted by the Engineer.

Immediately after seed has been properly covered the seedbed shall be compacted in the manner and degree approved by the Engineer.

When adverse seeding conditions are encountered due to steepness of slope, height of slope, or soil conditions, the Engineer may direct or permit that modifications be made in the above requirements which pertain to incorporating limestone into the seedbed; covering limestone, seed, and fertilizer; and compaction of the seedbed.

Such modifications may include but not be limited to the following:

1. The incorporation of limestone into the seedbed may be omitted on (a) cut slopes steeper than 2:1; (b) on 2:1 cut slopes when a seedbed has been prepared during the excavation of the cut and is still in an acceptable condition; or (c) on areas of slopes where the surface of the area is too rocky to permit the incorporation of the limestone.

2. The rates of application of limestone, fertilizer, and seed on slopes 2:1 or steeper or on rocky surfaces may be reduced or eliminated.

3. Compaction after seeding may be reduced or eliminated on slopes 2:1 or steeper, on rocky surfaces, or on other areas where soil conditions would make compaction undesirable.

02821.6 MULCHING

All seeded areas shall be mulched unless otherwise indicated in the special provisions or directed by the Engineer.

It shall be spread uniformly at a rate of two tons per acre in a continuous blanket over the areas specified.

Before mulch is applied on cut or fill slopes which are 3:1 or flatter, and ditch slopes, the Contractor shall remove and dispose of all exposed stones in excess of 3 inches in diameter and all roots or other debris which will prevent proper contact of the mulch with the soil.

Mulch shall be applied within 24 hours after the completion of the seeding unless otherwise permitted by the Engineer. Care shall be exercised to prevent displacement of soil or seed or other damage to the seeded area during the mulching operations.

Mulch shall be uniformly spread by hand or by approved mechanical spreaders or blowers which will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.

Mulch shall be held in place by applying a sufficient amount of asphalt or other approved binding material to assure that the mulch is properly held in place. The rate and method of application of binding material shall meet the approval of the Engineer. Where the binding material is not applied directly with the mulch it shall be applied immediately following the mulch operation.

The Contractor shall take sufficient precautions to prevent mulch from entering drainage structures through displacement by wind, water, or other causes and shall promptly remove any blockage to drainage facilities which may occur.

02821.7 MAINTENANCE

The Contractor shall keep all seeded areas in good condition, reseeding and mowing if and when necessary as directed by the Engineer, until a good lawn is established over the entire area seeded and shall maintain these areas in an approved condition until final acceptance of the Contract.

Grassed areas will be accepted when a 95 percent cover by permanent grasses is obtained and weeds are not dominant. On slopes, the Contractor shall provide against washouts by an approved method. Any washouts which occur shall be regraded and reseeded until a good sod is established.

Areas of damage or failure due to any cause shall be corrected by being repaired or by being completely redone as may be directed by the Engineer. Areas of damage or failure resulting either from negligence on the part of the Contractor in performing subsequent construction operations

or from not taking adequate precautions to control erosion and siltation as required throughout the various sections of the specifications, shall be repaired by the Contractor as directed by the Engineer at no cost to the Owner.

02821.8 **METHOD OF MEASUREMENT**

See Section 01700 Measurement and Payment.

NOTE: ALL CALC. BASED ON 25 YR. STORM FOR PIPE SIZING

EROSION CALC - BASE GRADING PLAN

- EXIST. SED. POND (A)

DRAINAGE AREA (DISTURBED) TO BASIN = 2.9 AC.

REQ'D VOLUME @ 1800 CF/AC = 2.9 x 1800 = 5,220 CF

APPROX SIZE EXIST POND = 4,000 SF x 2'D = 8,000 CF

EXIST. POND IS O.K. FOR DISTURBED AREAS SEDIMENT STORAGE — RIPRAP DITCH WILL BE CONSTRUCTED FROM (A) TO (B) TO CONTROL ANY OVERFLOW OF RUN-OFF AND/OR SEDIMENT.

• PROPOSED SEDIMENT POND (B)

DISTURBED AREA TO POND = 3.2 AC

SEDIMENT VOLUME REQUIRED @ 1800 CF/AC = 3.2 × 1800 = 5760 CF

VOLUME PROVIDED BY POND = 7,300 SF × 3' D = 21,900 CF

POND (B) IS TO BE EXCAVATED IN NATURAL GROUND TO GIVE A 3' MIN DEPTH, USING A RIPRAP/WASHED STONE FILTER IN A "LEVEL SPREADER" CONFIGURATION AS AN OUTLET. BY BEING OVERSIZED BY OVER 3 TIMES THE REQUIRED, ADDITIONAL CAPACITY TO DELAY CLEANING AND PROTECT ADJOINING WETLANDS WILL BE USEFUL.

PROPOSED SEDIMENT BASIN (C)

DISTURBED AREA TO BASIN = 2.0 Ac.

REQUIRED VOLUME @ 1800 CF/Ac = 2.0 × 1800 = 3,600 CF

VOLUME PROVIDED BY POND = 7,200 SF × 2'D = 14,400 CF

POND (C) WILL BE GRADED WITH 2' MIN DEPTH, USING A RIPRAP/WASHED STONE FILTER AS A "LEVEL SPREADER" OUTLET. STORAGE VOLUME TO BE PROVIDED IS 4 TIMES THE REQUIRED VOLUME, WITH ADD'T VOLUME USED TO DELAY MAINTENANCE AND SILT REMOVAL, AND FOR SAFETY FACTOR

PROPOSED SEDIMENT BASIN (D)

DISTURBED AREA TO POND = 3.6 AC.

VOLUME REQ'D @ 1800 CF/AC. 3.6 x 1800 = 6,480 CF

VOLUME PROVIDED BY POND =

50 : 6800 > 5200 x 2 = 10,400 CF
48 : 3600 > 2500 x 2 = 5,000 CF
46 : 1400 > 700 x 2 = 1400 CF
44 : 0

16,800 CF

POND (D) WILL BE AT NATURAL GRADE, APPROX 7' DEEP, USING A PERFORATED RISER BUILT ON AN EXIST. PIPE FOR AN OUTLET. THE POND WILL HAVE OVER 2.5 TIMES THE REQUIRED VOLUME, AND THE NEARBY ROAD WILL ALLOW FOR EASY MAINTENANCE.

PROPOSED SEDIMENT BASIN (E)

DISTURBED AREA TO BASIN = 1.3 Ac

REQ'D VOLUME @ 1800 CF/AC = 1.3 x 1800 = 2,340 CF

VOLUME PROVIDED BY BASIN = 2400 SF x 3' D = 7200 CF

POND (E) WILL BE GRADED WITH 3' MIN DEPTH, USING A WASHED STONE/RIPRAP FILTER OUTLET DISCHARGING TO THE FORMER WASTE LAGOON. THIS POND (E) IS OVER 3 TIMES THE REQUIRED SIZE; HOWEVER, THIS ADDITIONAL CAPACITY WILL BE UTILIZED WHEN THE SUMP PUMP/FLEXIBLE PIPE IS IN USE TO DRAIN THE LANDFILL BASE'S SUMP AREA. ALSO, THE WASTE LAGOON, DUE TO ITS FORMER USE, CAN ALSO RECEIVE RUNOFF AND SEDIMENT IF NECESSARY.

- RUNOFF COMPUTATIONS – 25 YR. STORM

- RATIONAL FORMULA $Q_{25} = a \cdot C \cdot i$

  Q_{25} = RUNOFF FLOW, IN CFS
  a = AREA, IN AC.
  C = RUNOFF COEFFICIENT (See attached Table 8.03a)
  i = RAINFALL INTENSITY, IN IN./HR

- i IS BASED ON t_c: TIME OF CONCENTRATION.

$$t_c = \frac{\left[\frac{L^3}{H}\right]^{0.385}}{128}$$ (See attached I-3)

MAX L = 950' ; MAX H = 86' ; t_c = 3.87
USE t_c = 5 min.

ON FIG. 8.03f (attached), MIN t_c = 5 MIN AND RETURN PERIOD OF 25 YEARS, i_{25} = 7.3"/HR

- C = 0.5 AVG FOR SITE & PROJECT LIFE

- a = MEASURED BY PLANIMETER FOR EACH BASIN.

SURFACE RUNOFF FOR PERM. ROAD PIPES

STRUCTURE No.	SURFACE AREA	C	i_{25}	Q_{25}
1	1.2	0.5	7.3	4.4
3	1.0			3.6
5	1.7			6.2
7	2.3			8.4
9	0.8			2.9 ✓
11	0.5			1.8
12	2.6			9.5
13	1.8			6.6
15	6.7			24.5

SURFACE RUNOFF CALCULATIONS FOR PIPES

STRUCTURE NO.	SURFACE AREA	C	i_{25}	Q_{25}
S1	0.5	0.5	7.3	1.8
S2	1.1			4.0
S4	0.3			1.1
S5	1.5			5.5
S7	0.8			2.9
S9	0.9			3.3
S11	0.3			1.1
S12	1.5			5.5
S14	0.4			1.5
S15	0.8			2.9
S17	1.2			4.4

PIPE SIZING ("LET-DOWN" CORR. PLASTIC PIPES)

PIPE SECTION	Q_{25} SURFACE	Q_{25} UPSTREAM PIPE	Q_{25} TOTAL	"n"	SLOPE	CALC DIAM	PIPE SIZE
S1-S2	1.8	ϕ	1.8	0.024	22%	6.5"	12"
S2-S3	4.0	1.8	5.8		26%	9.8"	12"
S4-S5	1.1	ϕ	1.1		22%	5.4"	12"
S5-S6	5.5	1.1	6.6		25%	10.4"	12"
S7-S8	2.9	ϕ	2.9		13%	8.6"	12"
9-S10	3.3	ϕ	3.3		18%	8.5"	12"
S11-S12	1.1	ϕ	1.1		22%	5.4"	12"
S12-S13	5.5	1.1	6.6		10%	12.4"	18"
S14-S15	1.5	ϕ	1.5		22%	6.1"	12"
S15-S16	2.9	1.5	4.4		1%	16.4"	18"
S17-S18	4.4	ϕ	4.4		7%	11.3"	12"

PIPE SIZING (ROADWAY PIPES – ALL C.M.P.)

PIPE SECTION	Q_{25} SURFACE	Q_{25} UPSTREAM PIPE	Q_{25} TOTAL	"n"	SLOPE	CALC DIAM	PIPE SIZE
1-2	4.4	5.8	10.2	0.024	34%	11.6"	18"
3-4	3.6	6.6	10.2	0.024	33%	11.6"	18"
5-6	6.2	2.9	9.1	0.024	23%	11.9"	18"
7-8	8.4	3.3	11.7	0.024	7%	16.4"	18"
1-10	2.9	6.6+15.7	25.2	0.024	2%	27.6"	30"
12-9	9.5	6.2	15.7	0.024	4%	20.3"	24"
11-12	1.8	4.4	6.2	0.024	2%	16.3"	18"
13-14	6.6	4.4	11.0	0.024	2%	20.2"	24"
15-16	24.5	6.6+4.4	35.5	0.024	8%	24.2"	24"
16-17	∅	35.5	35.5	0.024	9%	23.7"	24"
17-18	∅	35.5	35.5	0.024	1.5%	33.2"	36"

Elements of the Model

The Rational Equation is given as:

$$Q = CIA \qquad \text{(I-1)}$$

in which:

Q = The estimated design discharge (cfs).

C = The composite runoff coefficient (dimensionless) for the watershed.

I = Rainfall intensity (in/hr) for the designated return period and the time of concentration.

A = Watershed area (ac).

Observe the units carefully. The left and right sides of the equation are essentially equal, because one acre-inch per hour is very nearly one cubic foot per second.

The limit of application of the Rational Method is much in debate. Various writers will recommend as an upper limit of applicability anywhere from zero to two square miles of watershed area. Your author has had acceptable results up to two square miles when compared to statistical analysis of gaged floods.

Following the steps given above:

1. Delineate the Watershed: Normally this is done on a topographic map. Determine the area of the watershed by using a digitizer, a planimeter, an overlaid grid or other suitable device. Remember to put the watershed area in acres. Question the applicability of the Rational Method if the watershed area exceeds 1300 acres.

2. Determine the Time of Concentration: The time of concentration is interpreted as the longest time of flow from points on the watershed ridge to the outlet of the watershed.

There are several recognized ways to estimate time of concentration. One way is to use the Kirpich Equation, which is widely recognized (Bureau of Reclamation, 1974, p 71):

$$t_c = \frac{\left[\frac{L^3}{H}\right]^{0.385}}{128} \qquad \text{(I-2)}$$

in which:

t_c = Time of concentration (min).

L = Hydraulic length of the watershed (ft). Hydraulic length is the length of the longest flow path from the most remote point on the watershed ridge to the outlet.

H = The height (ft) of the most remote point on the watershed ridge above the watershed outlet. It is the elevation difference, or fall, along the hydraulic length.

Another efficient method is that given by the Soil Conservation Service (SCS, 1986). the expressions given there are suitable for spreadsheet analysis.

TR55 – just Source

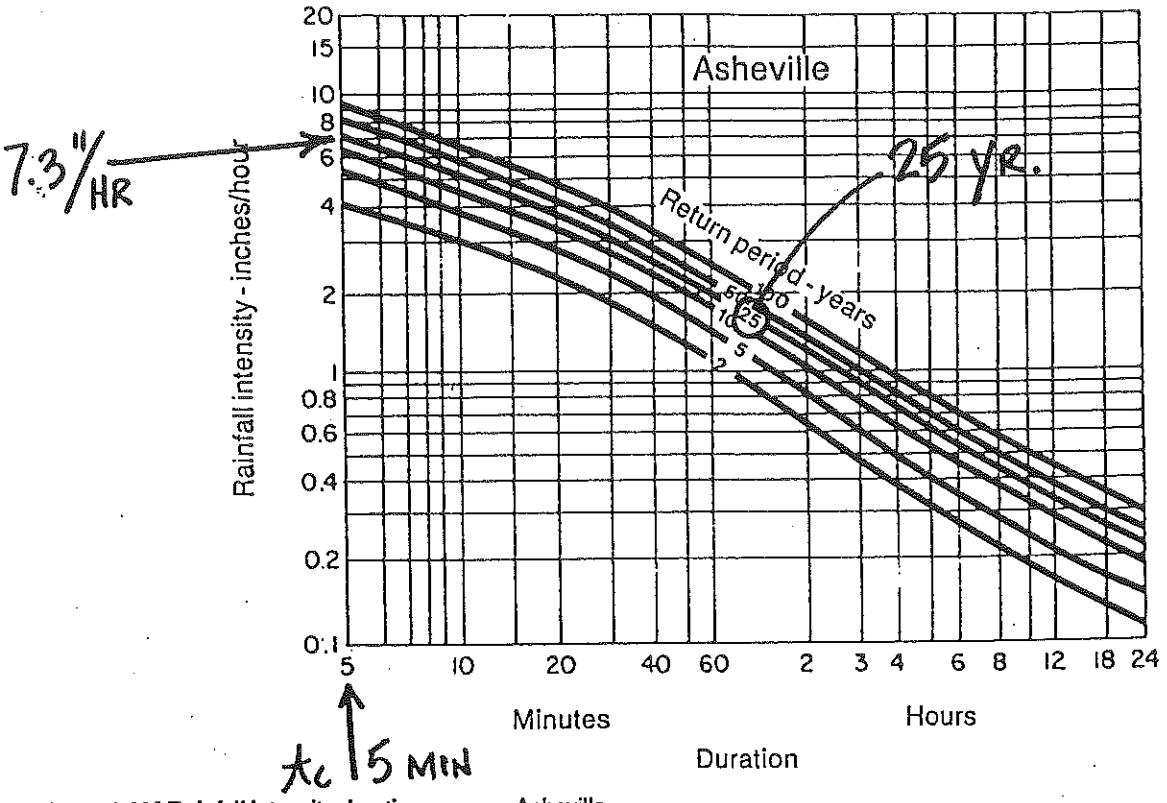


Figure 8.03f Rainfall intensity duration curves—Asheville.

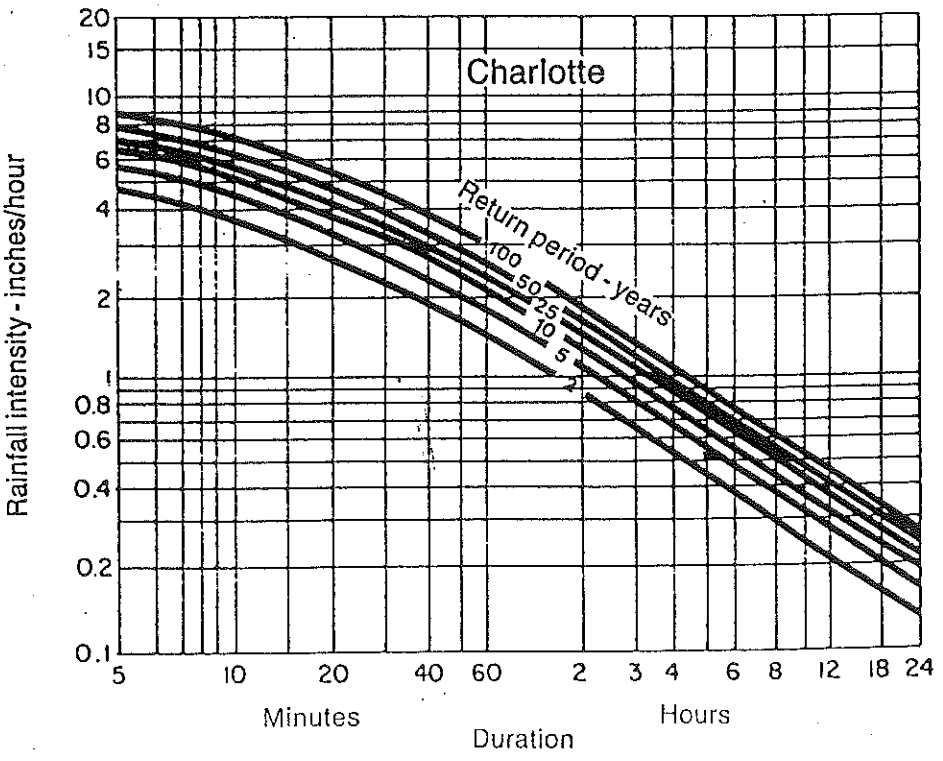


Figure 8.03g Rainfall intensity duration curves—Charlotte.

Table 8.03a
Value of Runoff Coefficient (C) for Rational Formula

Land Use	C	Land Use	C
Business:		Lawns:	
Downtown areas	0.70-0.95	Sandy soil, flat, 2%	0.05-0.10
Neighborhood areas	0.50-0.70	Sandy soil, ave., 2-7%	0.10-0.15
		Sandy soil, steep, 7%	0.15-0.20
Residential:		Heavy soil, flat, 2%	0.13-0.17
Single-family areas	0.30-0.50	Heavy soil, ave., 2-7%	0.18-0.22
Multi units, detached	0.40-0.60	Heavy soil, steep, 7%	0.25-0.35
Multi units, attached	0.60-0.75		
Suburban	0.25-0.40	Agricultural land:	
		Bare packed soil	
Industrial:		Smooth	0.30-0.60
Light areas	0.50-0.80	Rough	0.20-0.50
Heavy areas	0.60-0.90	Cultivated rows	
		Heavy soil no crop	0.30-0.60
Parks, cemeteries	0.10-0.25	Heavy soil with crop	0.20-0.50
		Sandy soil no crop	0.20-0.40
Playgrounds	0.20-0.35	Sandy soil with crop	0.10-0.25
		Pasture	
Railroad yard areas	0.20-0.40	Heavy soil	0.15-0.45
		Sandy soil	0.05-0.25
Unimproved areas	0.10-0.30	Woodlands	0.05-0.25
Streets:			
Asphalt	0.70-0.95		
Concrete	0.80-0.95		
Brick	0.70-0.85		
Drives and walks	0.75-0.85		
Roofs	0.75-0.85		

NOTE: The designer must use judgment to select the appropriate C value within the range for the appropriate land use. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest C values. Smaller areas with slowly permeable soils, steep slopes, and sparse vegetation should be assigned highest C values.

Source: American Society of Civil Engineers

0.5

0.3

DURING LIFE OF LANDFILL, SURFACE WILL VARY FROM BARE SOIL (ROUGH AND SMOOTH) TO GRASSED (PASTURE).

FOR CONSERVATIVE DESIGN, C = 0.5 WILL BE USED.

The overland flow portion of flow time may be determined from Figure 8.03a. The flow time (in minutes) in the channel can be estimated by calculating the average velocity in feet per minute and dividing the length (in feet) by the average velocity.

Step 4. Determine the rainfall intensity, frequency, and duration (Figures 8.03b through 8.03g—source: North Carolina State Highway Commission; Jan. 1973). Select the chart for the locality closest to your location. Enter the "duration" axis of the chart with the calculated time of concentration, Tc. Move vertically until you intersect the curve of the appropriate design storm, then move horizontally to read the rainfall intensity factor, i, in inches per hour.

Step 5. Determine peak discharge, Q (ft^3/sec), by multiplying the previously determined factors using the rational formula (Sample Problem 8.03a).

STORM DRAINAGE PIPE SCHEDULE

PIPE SECTION	MATERIAL	LENGTH	SIZE	SLOPE
S1 - S2	C.P.P.	145'	12"	22%
S2 - S3	C.P.P.	80'	12"	26%
1 - 2	C.M.P.	200'	18"	34%
S4 - S5	C.P.P.	145'	12"	22%
S5 - S6	C.P.P.	130'	12"	25%
3 - 4	C.M.P.	200'	18"	33%
S7 - S8	C.P.P.	170'	12"	13%
5 - 6	C.M.P	120'	18"	23%
S9 - S10	C.P.P.	180'	12"	18%
7 - 8	C.M.P.	100'	18"	7%

STORM DRAINAGE PIPE SCHEDULE

PIPE SECTION	MATERIAL	LENGTH	SIZE	SLOPE
S11 - S12	C.P.P.	145	12"	22%
S12 - S13	C.P.P.	80	18"	10%
9 - 10	C.M.P.	190	30"	2%
S14 - S15	C.P.P.	145	12"	22%
S15 - S16	C.P.P.	130	18"	1%
12 - 9	C.M.P.	250	24"	4%
11 - 12	C.M.P.	90	18"	2%
S17 - S18	C.P.P.	30	12"	7%
13 - 14	C.M.P.	110	24"	2%
15 - 16	C.M.P	110	24"	8%
16 - 17	C.M.P.	210	24"	9%
17 - 18	C.M.P.	135	36"	1.5%

STORM DRAINAGE STRUCTURE SCHEDULE

DRAINAGE STRUCTURE	TYPE	TOP ELEV	INV ELEV
S1	OPEN THROAT C.B.	2141	2138
S2	OPEN THROAT C.B.	2109	2106
S3	FLARED END	—	2085
1	OPEN THROAT C.B.	2087	2084
2	FLARED END	—	2016
S4	OPEN THROAT C.B.	2141	2138
S5	OPEN THROAT C.B.	2109	2106
S6	FLARED END	—	2074
3	OPEN THROAT C.B.	2079	2076
4	FLARED END	—	2010
S7	OPEN THROAT C.B.	2109	2106
S8	FLARED END	—	2084
5	OPEN THROAT C.B.	2073	2070
6	FLARED END	—	2042

STORM DRAINAGE STRUCTURE SCHEDULE

DRAINAGE STRUCTURE	TYPE	TOP ELEV	INV ELEV
S9	OPEN THROAT CB	2109	2106
S10	FLARED END	—	2074
7	OPEN THROAT CB	2072	2069
8	FLARED END	—	2062
S11	OPEN THROAT CB	2141	2138
S12	OPEN THROAT CB	2109	2106
S13	FLARED END	—	2098
9	OPEN THROAT CB	2090	2087
10	FLARED END	—	2085
S14	OPEN THROAT CB	2141	2138
S15	OPEN THROAT CB	2109	2106
S16	FLARED END	—	2105
11	OPEN THROAT CB	2101	2098
12	OPEN THROAT CB	2101	2096

STORM DRAINAGE STRUCTURE SCHEDULE

DRAINAGE STRUCTURE	TYPE	Top ELEV	INV ELEV
S17	OPEN THROAT CB	2109	2106
S18	FLARED END	—	2104
13	OPEN THROAT CB	2191	2188
14	FLARED END	—	2186
15	RISER	2050	2044
16	J.B.	2039	2035
17	J.B.	2021	2017
18	FLARED END	—	2015

Exhibit 7

Minimum slopes for pipe selection.

Minimum slope required to maintain stated minimum velocity at full flow.

Material Application	Concrete Storm	Concrete Sanitary	Corr Mtl Storm	Corr Mtl Sanitary
Manning n	0.013	0.013	0.024	0.024
Min V (ft/sec)	3	2	3	2
Pipe Diameter (in)	Minimum Slope			
15	0.00325	0.00144	0.01107	0.00492
18	0.00255	0.00113	0.00868	0.00386
21 *	0.00207	0.00092	0.00707	0.00314
24	0.00174	0.00077	0.00592	0.00263
27 *	0.00148	0.00066	0.00506	0.00225
30	0.00129	0.00057	0.00439	0.00195
33 *	0.00114	0.00050	0.00387	0.00172
36	0.00101	0.00045	0.00345	0.00153
42	0.00082	0.00037	0.00281	0.00125
48	0.00069	0.00031	0.00235	0.00104
54	0.00059	0.00026	0.00201	0.00089
60	0.00051	0.00023	0.00174	0.00077
66	0.00045	0.00020	0.00154	0.00068
72	0.00040	0.00018	0.00137	0.00061

* Non-standard in some markets.

Exhibit 8

Abbreviated Table of Values of Manning Roughness Coefficients.

Description of Lining	n	
Reinforced concrete pipe	0.013	
Corrugated metal pipe	0.024	(Corr. Plastic) → ←
Concrete, trowelled finish	0.013	
Concrete, float finish	0.015	
Street gutter or paved channel	0.015	
Earth, straight and uniform	0.022	
Grass-lined swales	0.030	— GRASS
Unmaintained brushy channel	0.080	
Stone-lined channel (4-inch)	0.028	
Stone-lined channel (6-in)	0.030	
Stone-lined channel (9-in)	0.032	— 9" RIPRAP
Stone-lined channel (12-in)	0.034	
Stone-lined channel (15-in)	0.035	
Stone-lined channel (18-in)	0.036	— 18" RIPRAP

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.

DITCH SIZING - BASE GRADING PLAN

• DIVERSION DITCH (D1)

MAX. DRAINAGE AREA = 0.4 ac.

$C = 0.5$

$i_{25} = 7.3$

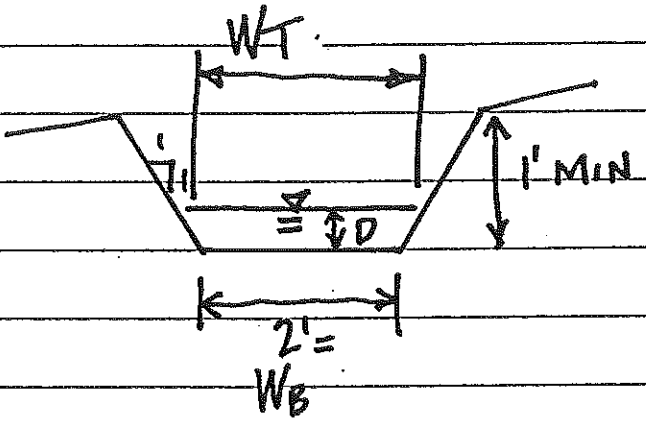
$Q = aCi = 0.4 \times 0.5 \times 7.3 = 1.4$ CFS

AVG SLOPE = 15%

$n = 0.030$ (GRASS)

$z = 1:1$

$W_B = 2'$



COMPUTED: VEL = 4.81 FPS

$D = 0.14'$

$W_T = 2.28'$

$T = yds = 62.4 \times 0.14 \times 0.15 = 1.31$ vs 1.45

GRASS CHANNEL IS OK DUE TO $V < 5$ FPS; USE STRAW W/ NET UNTIL GRASS IS ESTABLISHED.

• DIVERSION DITCH (D2)

MAX DRAINAGE AREA = 1.2 AC

$C = 0.5$

$i = 7.3$

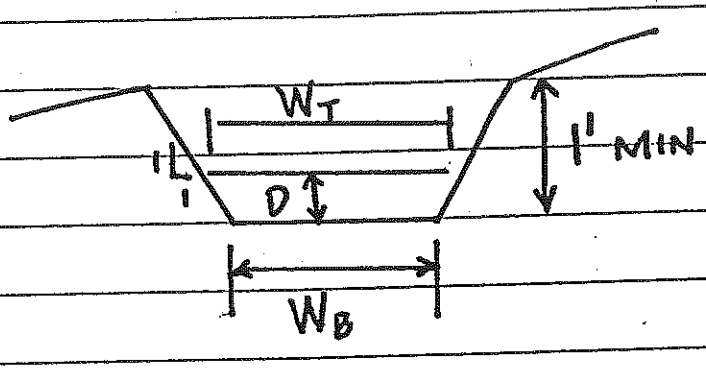
$Q = aci = 1.2 \times 0.5 \times 7.3 = 4.4$ CFS

AVG. SLOPE = 3%

$n = 0.03$

$Z = 1:1$

$W_B = 2'$



COMPUTED: VEL = 4.11 FPS

$D = 0.44'$

$W_T = 2.88'$

$T = yds = 62.4 \times 0.44 \times 0.03 = 0.82$ vs 1.45

GRASS CHANNEL IS OK DUE TO $V < 5$ FPS; USE STRAW W/ NET UNTIL GRASS IS ESTABLISHED.

- CHANNEL (R1)
- PIPES TO CHANNEL = Ø

DRAINAGE AREA = 1.2 ac
C = 0.5
i = 7.3
$Q_{25} = aci = 1.2 \times 0.5 \times 7.3 = 4.4$ CFS

AVG. SLOPE = 14%
n = 0.030 (GRASS)
Z = 1:1
W_B = 2

Vel = 6.95 : TOO HIGH FOR GRASS, USE RIPRAP DITCH

n = 0.032 (9" RIPRAP)
Z = 2:1
W_B = 3

Vel = 5.91 FPS
D = 0.23'
T = yds = $62.4 \times 0.23 \times 0.14 = 2.01$ vs 3.80 Permissible : OK

CHANNEL (D3)

PIPES TO CHANNEL = ϕ

DRAINAGE AREA = 0.5 ac

$C = 0.5$

$i_{25} = 7.3$

$Q_{25} = aci = 0.5 \times 0.5 \times 7.3 = 1.8$ CFS

AVG. SLOPE = 2%

$n = 0.030$ (GRASS)

$Z = 1:1$

$W_B = 2$

Vel = 2.73 FPS

D = 0.30'

T = yds = $62.4 \times 0.30 \times 0.02 = 0.37$ vs 1.45

GRASS CHANNEL IS OK; USE STRAW w/ NET UNTIL GRASS IS ESTABLISHED.

CHANNEL (R3)

PIPES TO CHANNEL = 10.2 CFS FROM (4)

DRAINAGE AREA = 2.6 ac

$C = 0.5$

$i_{25} = 7.3$

$Q_{25} = aci = 2.6 \times 0.5 \times 7.3 = 9.5$ CFS

TOTAL Q = 10.2 + 9.5 = 19.7 CFS

AVG. SLOPE = 4%

$n = 0.030$ (GRASS)

$Z = 1:1$

$W_B = 2$

VEL = 7.05 FPS : TOO HIGH FOR GRASS, USE RIPRAP

$n = 0.032$ (9" RIPRAP)

$Z = 2:1$

$W_B = 3'$

VEL = 6.06 FPS
D = 0.74' } OK FOR RIP-RAP

T = yds = $62.4 \times 0.74 \times 0.04 = 1.85$ vs 3.80 permissible : OK

CHANNEL (D.4)

PIPES TO CHANNEL = ϕ

DRAINAGE AREA = 0.5 ac

$C = 0.5$

$i_{25} = 7.3$

$Q_{25} = 0.5 \times 0.5 \times 7.3 = 1.8$ cfs

AVG. SLOPE = 8%

$n = 0.030$ (GRASS)

$Z = 1:1$

$W_B = 2$

VEL = 4.33 FPS

$D = 0.20'$

$T = y_{ds} = 62.4 \times 0.20 \times 0.08 = 1.00$ vs 1.45 permissible: OK

GRASS CHANNEL IS OK; need straw w/ net until grass is established.

CHANNEL (RS)

PIPES TO CHANNEL = 9.1 CFS FROM (6)

DRAINAGE AREA = 1.2

$C = 0.5$

$i_{25} = 7.3$

$Q_{25} = 1.2 \times 0.5 \times 7.3 = 4.4$ CFS

$Q_{TOTAL} = 4.4 + 9.1 = 13.5$ CFS

AVG SLOPE = 33%

$n = 0.030$ (GRASS)

$Z = 1:1$

$W_B = 2$

VEL = 13.31 FPS : TOO HIGH FOR GRASS, USE RIPRAP

$n = 0.036$ (18" RIPRAP)

$Z = 2:1$

$W_B = 3$

VEL = 10.42 FPS

D = 0.36'

T = yds = $62.4 \times 0.36 \times 0.33 = 7.41$ vs 7.50 permissible : OK

CHANNEL (R6)

PIPES TO CHANNEL = 11.7 CFS FROM (8)

DRAINAGE AREA = 0.7 ac

$C = 0.5$

$i_{25} = 7.3$

$Q_{25} = 0.7 \times 0.5 \times 7.3 = 2.6$ CFS

$Q_{TOTAL} = 2.6 + 11.7 = 14.3$ CFS

AVG. SLOPE = 25%

$n = 0.030$ (GRASS)

$Z = 1:1$

$W_B = 2$

VEL = 12.44 FPS : TOO HIGH FOR GRASS, USE RIPRAP

$n = 0.036$ (18" RIPRAP)

$Z = 2:1$

$W_B = 3'$

VEL = 9.63 FPS

$D = 0.40'$

$T = yds = 62.4 \times 0.40 \times 0.25 = 6.24$ vs. 7.50 permissible: OK

CHANNEL (D5)

PIPES TO CHANNEL = $\emptyset$

DRAINAGE AREA = 0.4 ac

$C = 0.5$

$i_{25} = 7.3$

$Q_{25} = 0.4 \times 0.5 \times 7.3 = 1.5$ CFS

AVG. SLOPE = 14%

$n = 0.030$ (GRASS)

$Z = 1:1$

$W_B = 2'$

VEL = 4.84 FPS

$D = 0.15'$

$T = yd_s = 62.4 \times 0.15 \times 0.14 = 1.31$ vs 1.45

GRASS CHANNEL IS OK; USE STRAW W/ NET UNTIL GRASS IS ESTABLISHED.

CHANNEL (R8)

PIPES TO CHANNEL = 25.2 CFS FROM (10)

DRAINAGE AREA = 2.2 ac
$C = 0.5$
$i_{25} = 7.3$
$Q_{25} = 2.2 \times 0.5 \times 7.3 = 8.0$ CFS
$Q_{TOTAL} = 8.0 + 25.2 = 33.2$ CFS

AVG. SLOPE = 17%
$n = 0.030$ (GRASS)
$z = 1:1$
$W_B = 2'$

VEL = 13.74 FPS : TOO HIGH FOR GRASS; USE RIPRAP

$n = 0.036$ (18" RIPRAP)
$z = 2:1$
$W_B = 3'$

VEL = 10.78 FPS
$D = 0.70'$
$T = yds = 62.4 \times 0.70 \times 0.17 = 7.43$ vs 7.50 permissible : OK

CHANNEL (R9)

PIPES TO CHANNEL = 11.0 CFS FROM (14)

DRAINAGE AREA = 1.7 ac

$C = 0.5$

$i_{25} = 7.3$

$Q_{25} = 1.7 \times 0.5 \times 7.3 = 6.2$ CFS

$Q_{TOTAL} = 6.2 + 11.0 = 17.2$ CFS

AVG. SLOPE = 4%

$n = 0.030$ (GRASS)

$Z = 1:1$

$W_B = 2'$

VEL = 6.82 FPS : TOO HIGH FOR GRASS, USE RIPRAP

$n = 0.032$ (9" RIPRAP)

$Z = 2:1$

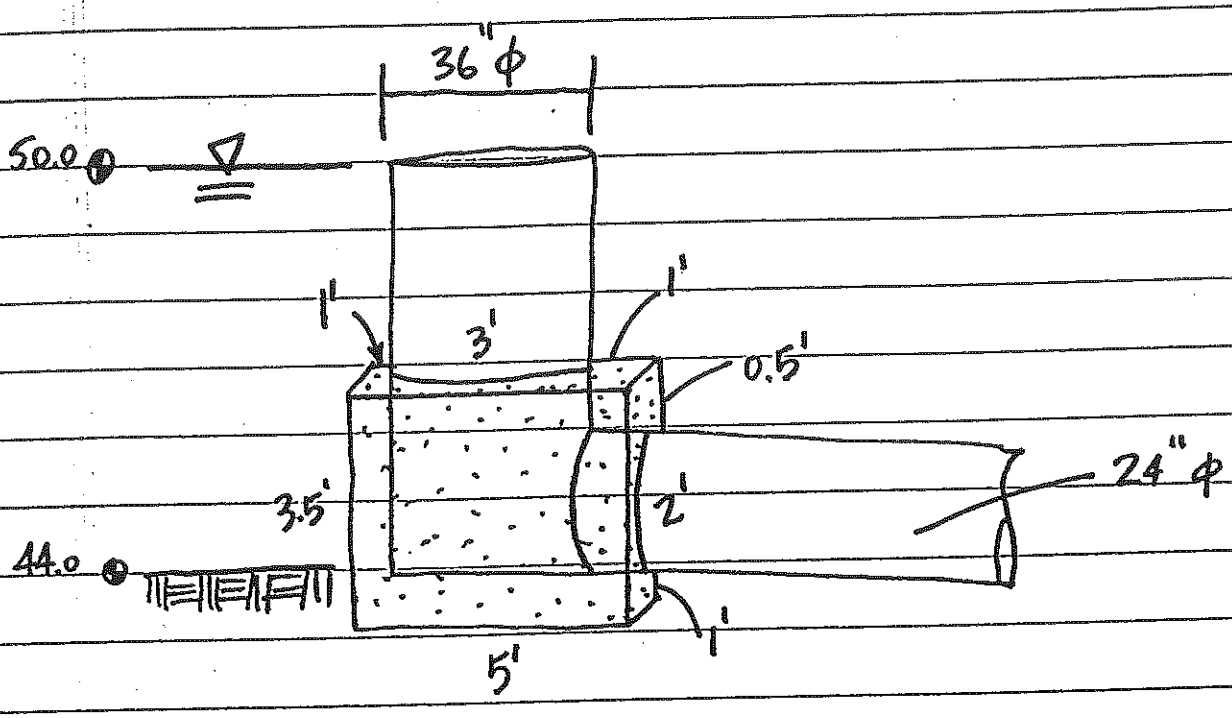
$W_B = 3$

VEL = 5.84

$D = 0.69$

$T = yd_s = 62.4 \times 0.69 \times 0.04 = 1.72$ vs 3.80 permissible : OK

FLOTATION BLOCK CALC. AT 36" RISER AT BASIN (D)



WATER DISPLACED BY RISER:

$\pi r^2 D = 3.14 \times 1.5^2 \times 6' = 42.39\ CF \times 62.4\ ^{\#}/_{CF} = 2645\#$

SAFETY FACTOR OF 1.5 = **3968 # OF CONC. REQ'D.**

OK

CONC BLOCK = $3.5' \times 5' \times 5' = 87.5\ CF$

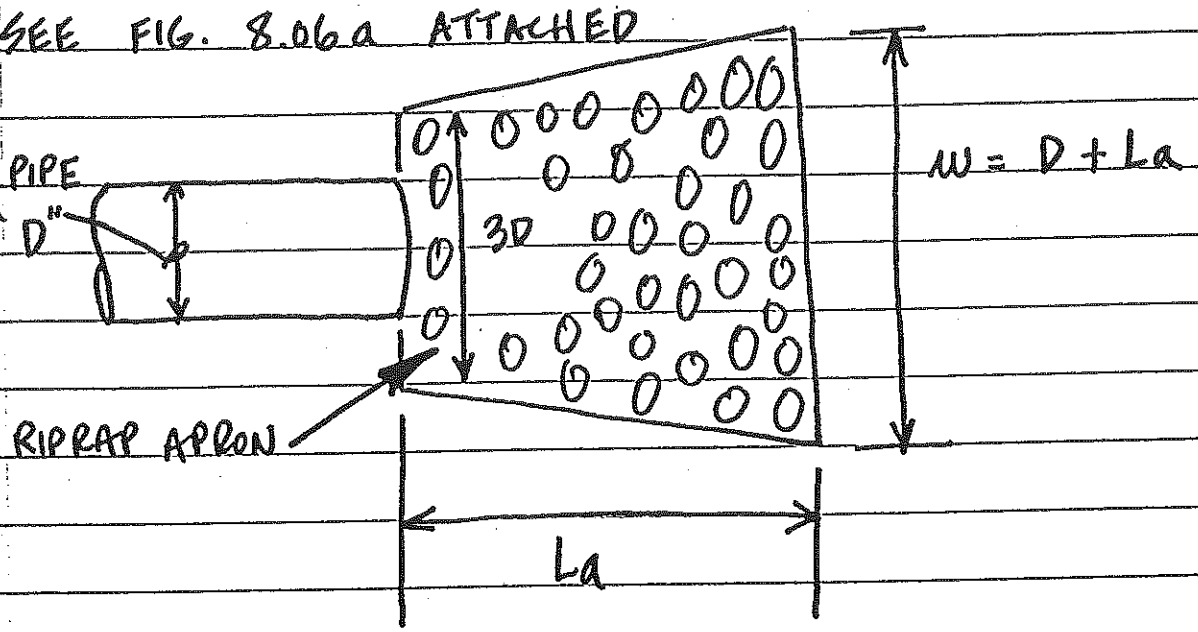
LESS 36" $(\pi r^2 \times 3.5') = -24.7\ CF$

LESS 24" $(\pi r^2 \times 1') = -3.1\ CF$

$59.7\ CF \times 150\ ^{\#}/_{CF} =$ **8,955 CF PROVIDED**

RIPRAP APRON SIZING

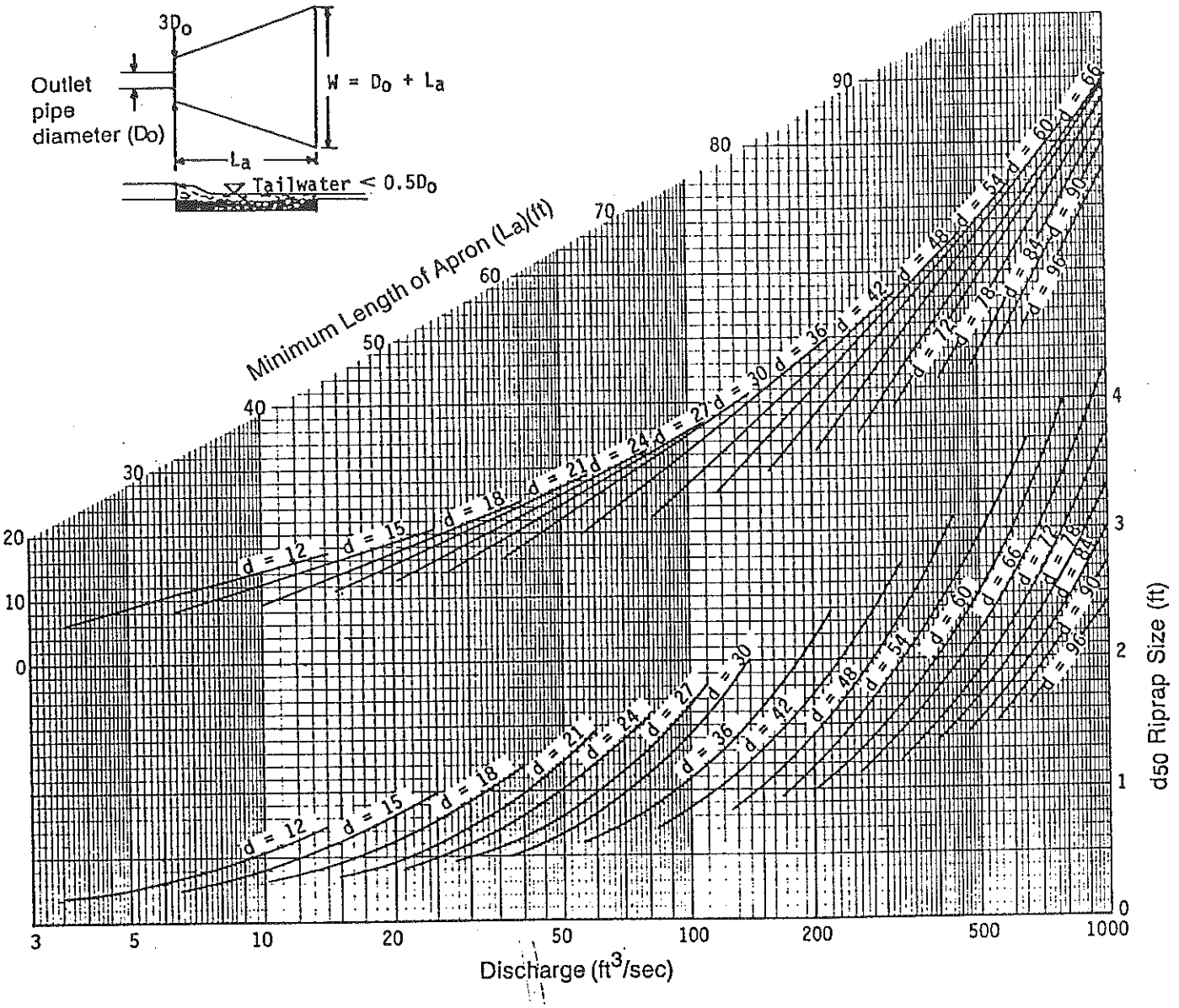
SEE FIG. 8.06a ATTACHED



PIPE OUTLET	"D"	FLOW (CFS)	3D	La	W	d_{50}
S3	12"	5.8	3'	10'	11'	9"
S6	12"	6.6	3'	11'	12'	9"
S8	12"	2.9	3'	6'	7'	9"
S10	12"	3.3	3'	6'	7'	9"
S13	18"	6.6	5'	10'	12'	9"
S16	18"	4.4	5'	10'	12'	9"
S18	12"	4.4	5'	8'	9'	9"

RIPRAP APRON SIZING (CONT.)

PIPE OUTLET	"D"	FLOW (CFS)	3D	La	W	d_{50}
2	18	10.2	5'	10'	12'	9"
4	18	10.2	5'	10'	12'	9"
6	18	9.1	5'	10'	12'	9"
8	18	11.7	5'	11'	13'	9"
10	30	25.2	8'	16'	19'	9"
14	24	11.0	6'	14'	16'	9"
18	36	35.5	9'	20'	23'	9"



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).

TYPICAL PERIPHERAL DITCH ALONGSIDE GRAVEL ACCESS

MAX. Q_{25} TO ANY DITCH SECTION (@ ①) = 0.2 CFS

TYPICAL SLOPE = 2%
$n = 0.030$ (GRASS)
$Z = 2:1$
$W_B = 1'$

VEL = 4.35 FPS
$D = 0.87'$
$T = yds = 62.4 \times 0.87 \times .02 = 1.09$ vs. 1.15 permissable

GRASS CHANNEL is OK; need straw w/ net until grass is established.

ATTACHMENT D

Wetlands Survey

ATTACHMENT E

Additional Geotechnical and Geosynthetic Analysis

Terra Consultants, Inc.
The Engineering and Science of Soils and Groundwater
Post Office Box 16527 • Asheville, North Carolina 28816
(704) 667-1103

MEMORANDUM

TO: Jeff Bishop
McGill Associates, P.A.

FROM: Bobby L. Barnes, P.E.

DATE: 8/15/97

REF: Macon Co. MSW Technical Review

We have received a copy of the technical review comments prepared by the Solid Waste Division of the NCDEHNR in Raleigh. Pertaining to these comments, we are responding to the following comment items at your request.

Engineering Plan
Comment #2 - " A 40 mil textured liner is proposed for closure. Does this liner have sufficient strain properties for the intended use?"

Response: Our geotechnical report commented briefly on anticipated post-closure settlements of the landfill waste and cover. In that report, we indicate that total settlement after closure has been historically documented to range between 5 and 20 percent of total waste height for traditional MSW's. Obviously, several factors go into this value such as fill rate, waste composition, efforts of pre-consolidation, etc.. Our current understanding is that the Macon Co. MSW landfill will deposit only about 25 percent traditional waste, while the remainder of waste will be processed through a bailing facility. Literature from the bailer manufacture indicates that bailing density can approach the density that is typically obtained under post-settlement conditions for traditional waste. Further, the infill rate anticipated for the MSW is considered to be below average of landfill evaluation standards. Therefore, we anticipate that post-closure settlement values will be in the lower end, somewhere on the order of 3 to 8 percent of total waste height. HDPE liners typically do not develop yielding or plastic deformation until strains exceed 7 to 15 percent. To induce strains of greater than 7 percent, to landfill cover would have to experience differential settlements in excess of 3.5 feet over a 10 feet distance. Given the total settlement potentials anticipated for the landfill, we do not feel that such a magnitude of differential settlement would occur. Concluding, the proposed 40 mil HDPE cover liner is considered to have sufficient strain properties for the proposed landfill.

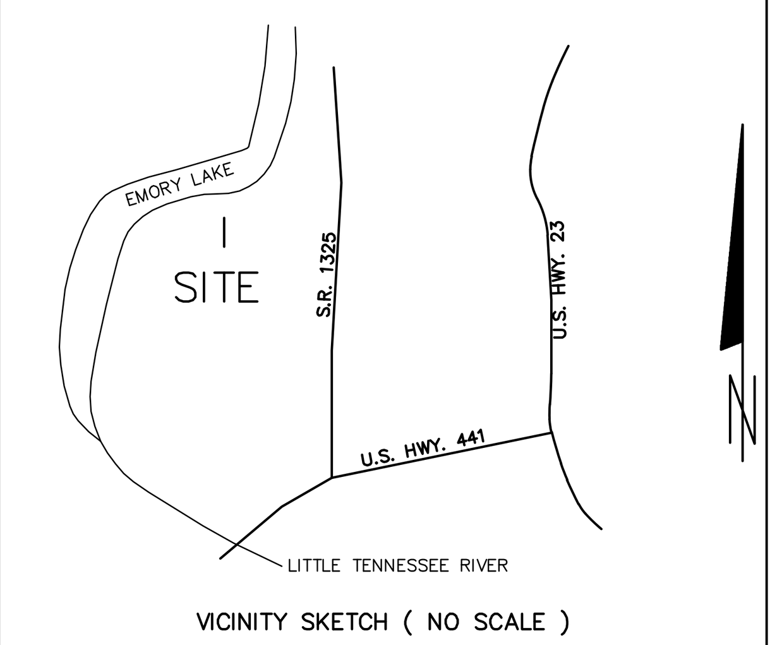
Comment #5 - " ...permeability tests provided were run at conservative (2.5 psi) confining pressures. ..."

Response: It is our understanding that the construction specifications for the new landfill liner stipulate that hydraulic conductivity values of 1 x 10^{-7} cm/sec or less shall be obtained at a confining pressure not exceeding 15 psi. Typically, the standards for laboratory testing are to apply an assumed ¼ psi for every foot of waste surcharging the liner system. At 15 psi, this confining pressure would equate to approximately 60 feet of waste. Given proposed base and final grade elevations, we believe this construction testing requirement to be appropriate. Concerning the borrow evaluation testing at a confining pressure of 2.5 psi, Terra selected this pressure to be intentionally conservative since our laboratory samples were prepared as remolded composites of the borrow profile. While it is reasonable to expect that select strath of the borrow materials could possibly obtain permeability requirements will minimal to no bentonite additive, construction efforts will most likely encounter some lenses of sandier materials from the borrow area that must have bentonite to achieve permeability. Obviously, close observations would be required for selective determination of which borrow materials did require additive and which borrow soils did not. Terra selected the conservative confining pressure because of this significant variability in the borrow.

Comment #10 - " Has veneer stability of the closure cap been evaluated under saturated conditions?"

Response: Terra's previous report provided comments and calculations on cover veneer stability assuming cover soils at a saturated unit weight, but not including any uplifting hydrostatic pressures. It was assumed by our previous evaluation that the geocomposite drain beneath the soil cover would be properly selected for capacity to prevent any head pressure development. Subsequently, Terra requested that McGill provide HELP computer modeling runs to predict the amount of head that might develop above the geocomposite drain on the cover slopes. It is reported that 0.01 inches of head will develop at the bottom of the soil cover for the 4h:1v sloped areas. Based on this predicted water level, and using infinite slope stability calculations as presented in the USEPA's seismic guidance document, Terra has calculated that the factor of safety against veneer sloughing under seismic conditions would be on the order of 1.04 assuming no inherent cohesion within the cover soils. Yield acceleration, k_y, was calculated to be on the order of 0.25g, again assuming no implied cohesion within the cover soils. Our earlier report presented calculations and results of cover displacement for a maximum crest acceleration of 0.5g (twice that of the k_y given above), and found maximum displacement to be on the order of 4 inches. This amount of permanent displacement is considered negligible. . It is our opinion that a conservative value 150 psf implied cohesion should be assigned to the cover soils, both to account for the soil cohesion and the reinforcing affects of the grass root structure. Using this cohesion value, the calculated k_y value increases to 0.97. Previous analysis reported indicates that cover accelerations would not reach this magnitude.

We understand that your office is preparing responses to the remaining comments.



VICINITY SKETCH (NO SCALE)

WETLANDS A AREA = 2.94 ACRES

Line	Bearing	Distance
L421	S 59°-06'-23" E	89.86'
L422	S 10°-48'-58" E	55.73'
L423	N 36°-41'-10" E	87.15'
L424	N 40°-58'-13" E	94.73'
L425	N 55°-58'-36" E	162.24'
L426	N 42°-46'-20" E	238.43'
L427	N 63°-06'-51" E	116.79'
L428	N 3°-51'-10" W	16.39'
L429	N 14°-06'-35" E	23.32'
L430	N 39°-35'-05" E	17.63'
L431	S 73°-39'-56" E	45.33'
L432	N 34°-39'-06" E	39.12'

WETLANDS B AREA = .49 ACRES

Line	Bearing	Distance
L449	S 55°-43'-28" W	80.78'
L450	N 62°-50'-39" W	35.61'
L451	S 89°-14'-32" W	17.03'
L452	N 8°-20'-47" W	70.70'
L453	N 1°-55'-47" E	64.25'
L454	N 35°-06'-06" E	66.41'
L455	S 53°-21'-32" E	49.15'
L456	S 41°-45'-50" E	108.40'
L457	S 49°-35'-25" E	57.74'
L458	S 75°-53'-46" W	36.10'
L459	S 85°-45'-47" W	35.33'

WETLANDS C AREA = .28 ACRES

Line	Bearing	Distance
L433	N 71°-20'-29" W	56.12'
L434	N 23°-41'-39" W	23.22'
L435	N 9°-44'-51" W	22.90'
L436	N 1°-47'-41" W	43.77'
L437	N 27°-08'-11" E	22.82'
L438	N 48°-24'-12" E	12.65'
L439	N 87°-01'-49" E	22.73'
L440	S 82°-38'-14" E	20.25'
L441	S 73°-07'-12" E	15.70'
L442	S 64°-42'-09" E	19.52'
L443	S 43°-52'-57" E	28.17'
L444	S 15°-55'-02" E	17.29'
L445	S 20°-07'-13" W	34.00'
L446	S 34°-40'-27" W	26.06'
L447	S 42°-21'-26" W	24.38'
L448	S 37°-24'-59" W	14.64'

REFERENCES:

SUBJECT PARCEL ID#6595.10-36-7772
D.B.I-18 P.G.578

A SURVEY BY G.L. SPRINKLE R.L.S. L-1454
DATED SEPTEMBER 20, 1991 DWG. NO.1162-LF

A SURVEY BY G.L. SPRINKLE R.L.S. L-1454
DATED APRIL 16, 1993 DWG. NO.437

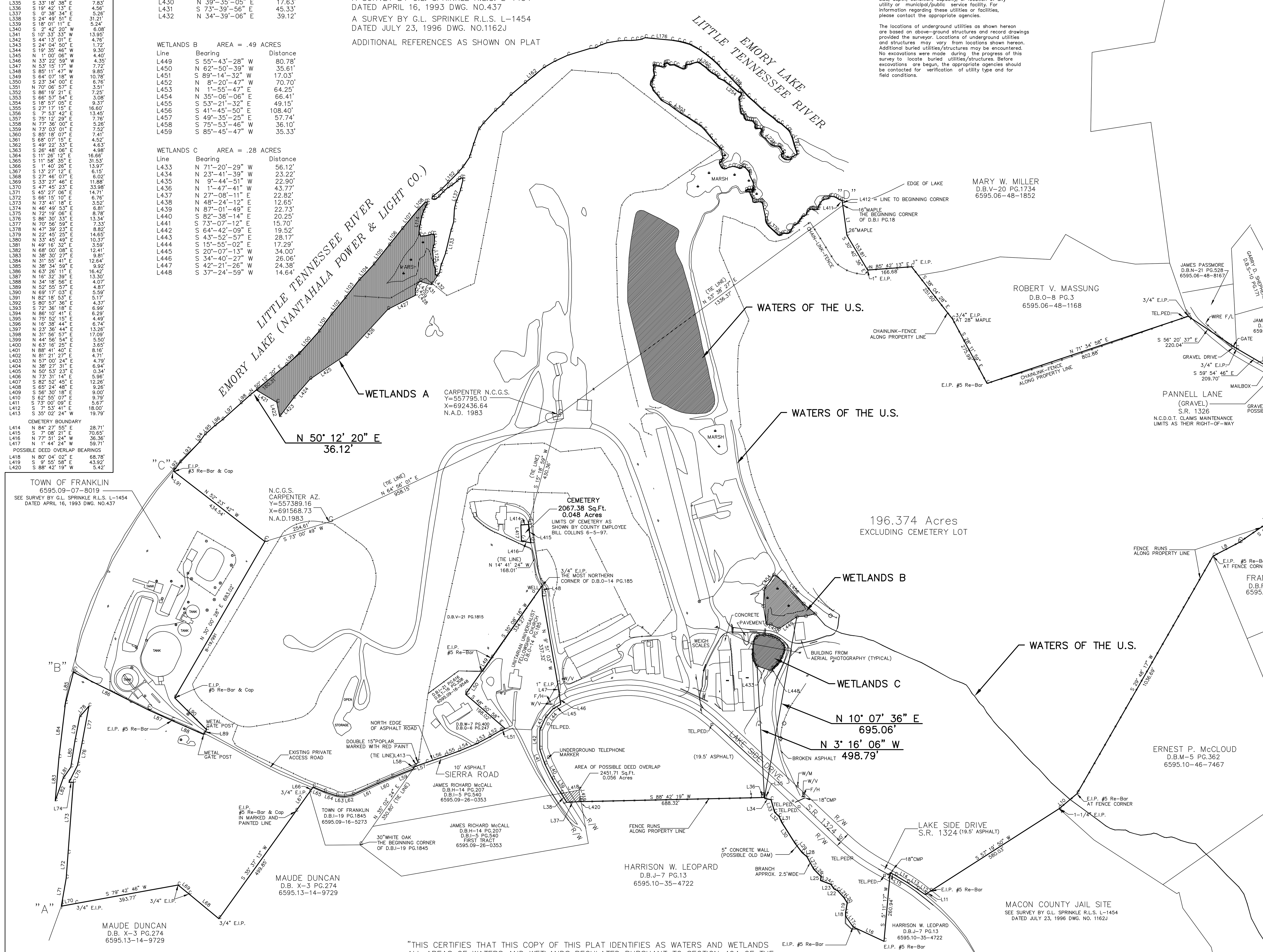
A SURVEY BY G.L. SPRINKLE R.L.S. L-1454
DATED JULY 23, 1996 DWG. NO.1162J

ADDITIONAL REFERENCES AS SHOWN ON PLAT

Except as specifically stated or shown on this plat, this survey does not purport to reflect any of the following which may be applicable to the subject real estate: easements, other than possible easements that were visible at the time of making of this survey, zoning or other land use regulations, and any other facts that an accurate and current title search may disclose.

No attempt has been made as a part of this boundary survey to obtain or show data concerning existence, size, depth, condition, capacity, or location of any utility or municipal/public service facility. For information regarding these utilities or facilities, please contact the appropriate agencies.

The locations of underground utilities as shown hereon are based on above-ground structures and record drawings provided the surveyor. Locations of underground utilities and structures may vary from locations shown hereon. Additional buried utilities/structures may be encountered. No excavations were made during the progress of this survey to locate buried utilities/structures. Before excavations are begun, the appropriate agencies should be contacted for verification of utility type and for field conditions.



"THIS CERTIFIES THAT THIS COPY OF THIS PLAT IDENTIFIES AS WATERS AND WETLANDS ALL AREAS OF WATERS AND WETLANDS REGULATED PURSUANT TO SECTION 404 OF THE CLEAN WATER ACT AS DETERMINED BY THE UNDERSIGNED ON THIS DATE. UNLESS THERE IS A CHANGE IN THE LAW, OR OUR PUBLISHED REGULATIONS, THIS DETERMINATION MAY BE RELIED ON FOR A PERIOD NOT TO EXCEED FIVE YEARS FROM THIS DATE. THIS DETERMINATION WAS MADE UTILIZING THE 1987 CORPS OF ENGINEERS WETLAND DELINIATION MANUAL."

U.S. ARMY CORPS OF ENGINEERS REPRESENTATIVE

TITLE

DATE

NOTES:

COORDINATES SHOWN ON THIS MAP ARE RELATIVE TO NCGS STATIONS "CARPENTER" & "CARPENTER AZ".

ALL ELEVATION ARE NGVD 1929 AND ARE RELATIVE TO NCGS STATION "CARPENTER"

DISTANCES SHOWN ON THIS PLAT ARE GRID LENGTHS. TO OBTAIN HORIZONTAL GROUND DISTANCES THEY MUST BE DIVIDED BY A COMBINED SCALE AND SEA LEVEL FACTOR OF 0.999778100.

PROPERTY IS SUBJECT TO RIGHTS-OF-WAY & EASEMENTS OF RECORD

NOTE:

LINES "A" THROUGH "B" AND LINES "C" THROUGH "D" ARE PROJECT BOUNDARY CONTOUR LINE 2000.22' OF THE NANTAHALA POWER & LIGHT COMPANY.

FEATURES LEGEND:

- ...POINT NOT SET
- ...IRON PIPE OR PIN SET
- ...SPIKE OR NAIL SET
- E.I.P. = EXISTING IRON PIPE OR PIN
- —x—x— FENCE LINE
- L= LINE (SEE LINE TABLE)
- ...CONCRETE MONUMENT
- M.H.= MANHOLE
- U.P.= UTILITY POLE
- U.P.L.= UTILITY POLE (LIGHT)
- U.P.ELEC.= UTILITY POLE (ELECTRIC)
- U.P.TEL.= UTILITY POLE (TELEPHONE)
- U.P.E&T.= UTILITY POLE (ELECTRIC & TELEPHONE)
- TEL. PED.= TELEPHONE PEDESTAL
- E/T= ELECTRIC & TELEPHONE
- O/H= OVERHEAD
- U/G= UNDERGROUND
- F/H= FIRE HYDRANT
- W/M= WATER METER
- W/V= WATER VALVE
- RCP.= REINFORCED CONCRETE PIPE
- CMP.= CORRUGATED METAL PIPE
- R/W= RIGHT OF WAY

McGill ASSOCIATES ENGINEERING•PLANNING•FINANCE
55 BROAD STREET
ASHEVILLE, NC
PH. (704) 252-0575
FAX (704) 252-2518

WEBB A. MORGAN & ASSOCIATES, P.A.
*** REGISTERED LAND SURVEYORS ***
96 CENTRAL AVENUE, ASHEVILLE, NORTH CAROLINA, 28801
PHONE (704)252-1530
DRAWING FILE 960208
JOB FILE NO.96020-0607

NORTH CAROLINA PROFESSIONAL SEAL 14774 ENGINEER

PHASE 2, CELL 1
MACON COUNTY
MSW LANDFILL
MACON COUNTY, NORTH CAROLINA

JOB NO.: 96117.01
DATE: AUG. 1997
SCALE: 1" = 200'
REVISION:

96117MB1

WETLANDS SURVEY

SHEET ___ OF ___