SNL 35-0223

Bolivar/Hardeman

Hardeman

BOLIVAR/HARDEMAN COUNTY SANITARY LANDFILL OPERATIONS MANUAL & CALCULATIONS CLOSURE/POST CLOSURE PLAN

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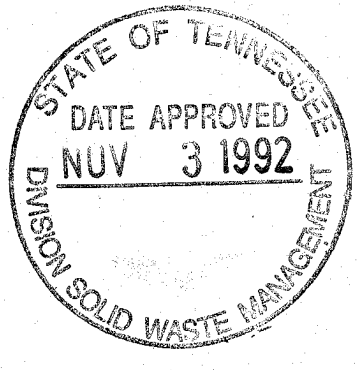

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BOLIVAR/HARDEMAN COUNTY
SANITARY LANDFILL
OPERATIONS MANUAL & CALCULATIONS
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BOLIVAR/HARDEMAN COUNTY SANITARY LANDFILL

OPERATIONS MANUAL & CALCULATIONS

1. GENERAL/PURPOSE

The City of Bolivar presently operates a sanitary landfill which is projected to be exhausted by late 1992. As such, the residents and commercial/industrial establishments of Bolivar and Hardeman County require that an approved disposal method of solid waste be implemented as soon as practical.

Severe environmental and potential legal problems could arise if the City's existing landfill's capacity is reached without the development of a suitable means of disposal of solid waste. The current site can support additional acreage to be permitted in order to continue disposal of solid waste. Approximately 21 acres would be excavated and a total of approximately 25 acres would be permitted.

2. DESCRIPTION AND SEQUENCE OF OPERATION

Two concurrent methods of operation would be used to develop the Bolivar Sanitary Landfill. Initially, the area would be excavated to the grades as shown on sheet 4 of the drawings. Next, the engineered bottom would be constructed as described in Section 3, as follows. Then, solid waste is compacted below the existing grade and in cells 10 feet high. Cover is added until the original grades are restored.

Upon filling of the excavated area, the area fill process will begin by compacting solid waste against a berm over the top of the completed trench.,

This process of excavation and filling would continue and the landfill would receive all daily, intermediate, and final cover until the proposed final grades are achieved.

Concerning the sequence of operation, the proposed landfill will be developed starting in the southeastern corner, and will be developed from southeast to northwest. Page 3 of the Engineering plans shows a progression arrow for the proposed site.

3. ENGINEERED BOTTOM

5'- 1 x 10^{-6} Remolded Silty Clay (geologic buffer)
3'- Completed Materials to support liner
Synthetic Liner
Leachate Collection Drainage/Piping Protection Layer

a) Clear site

b) Strip topsoil - stockpile for future remedial use

c) Excavate and stockpile next 1'-8' depth of material. Stockpile for use in constructing remolded layer (five feet) in bottom of landfill (material to be remolded 1.0 x 10^{-6} through 8.0 x 10^{-7}).

d) Excavate remainder of existing material to plan elevations. Stockpile material for use as daily cover.

e) Geologic Buffer - Construct of brown silty clay from site. Construct in 8"-10" layers, compact to a minimum 95% relative density at optimum moisture content. Test each 10,000 square feet of area in each discrete 8"-10" layer.

f) Liner Support Layer - Construct of material from site. Construct in 8"-10" layers, compact to a minimum 95% relative density at optimum moisture content. Test each 10,000 square feet of area in each discrete 8"-10" layer.

g) Synthetic Liner - Install a 60 mil geomembrane liner on top of geologic buffer with suitable base.

h) Leachate Collection - Install leachate collection piping and holding facilities.

i) Place a 12-inch layer of washed sand over leachate piping for drainage and protection of piping.

j) Begin landfill operation.

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4. ACCESS ROADS

The Bolivar Sanitary Landfill site is readily accessible by automobile or truck. The site is just west of the Bolivar City Limits, approximately 2,500 feet north of U.S. Highway 64 off Walton Lane. The existing access road from Walton Lane will continue to be utilized.

5. ACCESS TO SITE

Use of the Bolivar Landfill site will be restricted to the residents and commercial/industrial establishments of Bolivar and Hardeman County. The landfill supervisor or his representative will be at the landfill site during all hours of operation. At the end of the day, the gate on the access road will be closed and locked to prevent unauthorized dumping of waste material. The operating hours every day will be from 7:00 a.m. to 5:30 p.m.

The Bolivar Landfill property does not have a fence around the boundaries of the property, however the access road is equipped with a locking double swing 20-foot gate which is used to control access to the site. The site has had no problems with unauthorized use of the landfill since its opening in 1988.

6. UNLOADING OF WASTES

The solid waste to be disposed of at the Bolivar Sanitary Landfill will be unloaded by the use of dump trucks. During the progressive trench phase of development, trucks will back down a slope to a point near the working face of the landfill. Here the waste will be dumped below existing grade to facilitate compaction and to prevent scattering and blowing of the solid waste.

During the area fill phase of the Site, the waste is to be dumped near the working face of the landfill. However, this will be above existing grade and may require prompt attention to prevent blowing of the solid waste.

7. BLOWING LITTER

As mentioned in 6. above, the chances of having blowing litter will be reduced by having the waste unloaded as near the working face as possible and by compacting and covering the waste immediately on days when the wind is relatively strong. In addition, should blowing litter occur personnel

assigned to the landfill will gather the litter and place in back in its appropriate location.

8. SPREADING AND COMPACTING OF WASTE

Spreading and compacting of solid waste at the Bolivar Sanitary Landfill will be accomplished by two dozers and a compactor which are currently assigned to the site. The solid waste will be unloaded within one hundred feet of the working face of the facility where it will be compacted against the face of the landfill. The waste should be compacted in layers not to exceed three feet thick to facilitate proper compaction. Should the landfill's equipment experience a major breakdown, backup equipment from Memphis can be obtained in approximately 24 hours,

9. DAILY COVER

Daily cover may consist of native material compacted over all solid waste to a depth of six inches. This "daily cover" is subject to inspection and approval by the Tennessee Division of Solid Waste Management. However, the Bolivar/Hardeman County Landfill is considering the use of a moveable water-proof tarpaulin for use as a daily cover subject to approval by the Division of Solid Waste Management.

10. INTERMEDIATE COVER

In all but the final lift of the sanitary landfill, twelve inches of compacted cover material shall be placed on all surfaces of the landfill which contain waste and will be exposed for a period of over one month. All areas which have intermediate cover will be maintained by the use of mulch, straw, or other methods necessary to prevent erosion.

11. FINAL COVER

A depth of thirty-six inches of compacted cover material shall be placed on the site above waste not later than one week after the final lift is completed. In order to help prevent erosion and surface deterioration, the final cover shall be immediately stabilized to the satisfaction of the Tennessee Division of Solid Waste Management.

Concerning soil balances, the Bolivar/Hardeman County landfill has an agreement with an adjacent property owner to buy suitable cover and bottom material which is of sufficient quantity to last the anticipated life of the proposed landfill.

Cover material availabilities, quality assurances, and quantities are discussed in greater detail in the calculations and Closure/Post Closure Plan.

The Bolivar/Hardeman County Landfill Committee has acquired 80 acres of land in order to have a sufficient quantity of daily, intermediate, and final cover for the proposed landfill. Soil borings indicate an average depth of five feet of very good soil ($1x10^{-6}$ or better) exists upon the 80 acres acquired. This equates to approximately 645,000 cubic yards of available material.

12. SILT CONTROL

The drainage area is limited to the approximate size of the area requested to be permitted. Diversion ditches will be constructed to divert surface runoff from the disturbed areas where practical. As a final control, a silt pond will be utilized. The run-on and run-off facilities have been designed to handle a 24-hour, 25-year storm. In addition, the drainage pond has a capacity in excess of this volume and is equipped with a spillway sufficient to handle a 24-hour 100-year storm.

Design velocities have been limited to approximately 6 feet/sec. But in critical areas, as shown on the drawings, rip rap has been placed to further minimize any erosion in the silt pond spillway and dike.

13. LEACHATE COLLECTION FACILITIES

The proposed landfill is to be equipped with a leachate collection installed on a grid network. The leachate collection system is designed to handle a 24-hour, 25-year storm over the maximum area to have intermediate cover at any given time. The holding facilities are designed to store the volume of leachate which is anticipated to be generated in any given 30-day period. All concrete storage facilities will be coated with bitumastic to prevent degradation of the facilities. A total volume of 30,000 gallons is provided for leachate storage (30 day capacity). In addition, Mr. Lloyd Bell will monitor the leachate holding facility every two weeks. Mr. Sammy Webster, Chief Operator of the Wastewater Treatment Facility, will sample, analyze, and record the contents of the leachate.

14. SEEDING AND REVEGETATION

Seeding shall consist of placing grass seed, fertilizer, mulch, straw and other such material as needed to promote a stand of grass on the target areas. Seeding should be performed as soon as possible once final grades are completed. No seeding shall be done during periods of high wind.

15. SITE DRAINAGE AND GRADING

The proposed Bolivar Landfill site is to be operated in a manner which will provide adequate drainage during all phases of development. Berms and diversion ditches are to be constructed to prevent surface water from flowing into the areas which are being trenched.

The off-site runoff will be diverted as required to prevent run on onto the active landfill. This runoff will be piped and ditched around the landfill. Rip rap will be placed in areas with potential erosion problems as indicated on the drawings. No erosion is anticipated with design velocities approximately 6 feet per second. The pipe sizing and ditch profile calculations are provided later in this manual.

The proposed final grading of the site will divert surface water around areas which contain waste. The top of the landfill site will maintain a sufficient slope to insure proper drainage of water which falls directly on the site. The proposed final contours of the site are shown on the plans.

The landfill site is not within any FEMA flood restricted areas.

16. OPEN BURNING

Presently no open burning is proposed at the Bolivar Sanitary Landfill site. However, any burning of waste on the site must have prior approval from the Tennessee Division of Solid Waste Management and the Division of Air Pollution Control.

17. FIRE PROTECTION

If proper daily cover is maintained at the landfill site, the chance of a fire occurring is remote. However, the site

is readily accessible by the Hardeman County Fire Department if needed.

The City of Bolivar presently has a 4-inch water line on Walton Lane. The City will extend 4-inch water service to the landfill site from this line as shown on the Drawings. While this line may not be able to fight a major fire, having water at the site for maintenance of the grounds may prevent a fire.

A fire extinguisher is to be kept on the equipment and one is to be kept in the equipment building.

To help prevent fires from occurring, vents will be installed to prevent the site from retaining potentially explosive methane gas. In addition, no smoldering wastes will be allowed to be deposited in the active section of the landfill.

18. SIGNS

A sign will be erected on the gate across the access road which will read:

Bolivar/Hardeman County Sanitary Landfill
Hours of Operation:
7:00 A.M. - 5:30 P.M.
Contact: Fred F. Kessler
(901)658-2020
Permit Number:
This Facility Does Not Accept the Following
(1) Hazardous Waste
(2) Infectious Waste
(3) Liquids
(4) Lead Acid Batteries

19. SALVAGE OPERATIONS

No salvage operations will be permitted at the proposed Bolivar Sanitary Landfill.

20. SPECIAL WASTES HANDLING

No hazardous, dangerous, or difficult to manage waste will be allowed to be dumped at the landfill site. The landfill operator will refuse to accept any difficult to handle or suspected hazardous waste.

Dead animals will be disposed of as follows:

(a) Dead animals will be covered upon receipt with a minimum of two feet of cover and placed in an area which will receive additional waste and cover within 48 hours; or covered with three feet of compacted cover soil if placed in an area which will not receive additional waste and cover within 48 hours.

(b) Dead animals will not be disposed of in an area of a landfill which will not accommodate a minimum of five feet of depth from the finished landfill surface elevation when final cover has been put in place.

(c) Dead animals will be distributed for disposal over the landfill area in such a manner as to minimize the occurrences of future sinks and depressions in the final landfill cover caused by carcass decay.

21. DOMESTIC ANIMALS

No domestic animals will be allowed to linger at the Bolivar Sanitary Landfill site. This situation is not anticipated to be a problem. However if domestic animals persist in coming to the site, appropriate preventive or deterrent action will be taken.

22. VECTOR CONTROL

Unfavorable conditions for the breeding of insects, rodents, and other vectors are best maintained by performing routine operations of the landfill in a prompt, efficient manner. If this practice does not prove effective in controlling vectors, supplemental vector control measures will be incorporated as necessary.

23. DUST CONTROL

Adequate dust control may be achieved at the Bolivar Sanitary Landfill site by dampening disturbed areas during extended period of dry weather. This can easily be accomplished with the 4-inch water line as shown on the plans. In addition, post-type hydrants will be installed to facilitate the spraying of water as needed.

24. CONTAMINATION CONTROL

The threat of contamination is best minimized by constructing the landfill in accordance with the restrictions stated by the Tennessee Division of Solid Waste Management. The restrictions which will be followed in an effort to avoid contamination are as follows:

A. The bottom of the landfill will be carefully constructed per the Division's new regulations and will contain a constructed geologic buffer, a compacted layer for the liner, and a synthetic liner per the Division's approval.

B. A distance of 200 feet must be maintained between the streams and the placement of waste.

C. The ponds on will be closed prior to development of areas within 200 feet upgradient of the ponds.

D. All bore holes and existing ground water monitoring wells to be abandoned shall be plugged with bentonite grout having a maximum permeability of 1X 10E - 8 cm/sec. This fill will be to an elevation at least ten feet greater than the elevation of the lowest point of the landfill base or to the ground surface if the site will be excavated less than ten feet below grade.

25. SUPERVISION OF OPERATIONS

The City of Bolivar will be responsible for the operation of the proposed sanitary landfill. Mr. DeWayne Lax will be the supervisor of operations for the site. Mr. Lax has nearly twenty years of experience in sanitary landfill operations.

26. ACCIDENT PREVENTION AND SAFETY

A safe working environment is to be maintained at the proposed Bolivar Sanitary Landfill. All TOSHA Requirements are to be fully complied with. First aid equipment will be available at the Bolivar Landfill site (Maintenance Building).

27. ON-SITE STRUCTURE

A new maintenance building is to be constructed at the Bolivar/Hardeman County Landfill. The existing building currently serves the landfill personnel and equipment well.

However, as the proposed landfill is developed, the new building will be built and the existing building demolished as it is in conflict with the disposal area of the proposed landfill.

This building will house maintenance equipment and provide shelter from inclement weather. Also, drinking water, handwashing, and toilet facilities will be provided for the site. Personnel will have radio communication equipment at hand.

28. RECORDS AND REPORTS

Accurate records and reports concerning the activities of the Bolivar Sanitary Landfill will be kept current and in accordance with all requirements of the Tennessee Division of Solid Waste Management.

29. EQUIPMENT

The City of Bolivar will use a tractor/shovel and a loader to develop the proposed landfill.

If the City of Bolivar's equipment is unable to perform for any reason, appropriate equipment will be leased to do the job until the City's equipment is repaired or replaced. Under no circumstances will the proper operation of the landfill be hindered as a result equipment failure.

30. GROUNDWATER MONITORING

Two upgradient and three downgradient monitoring wells (2-inch diameter) are proposed to be installed on the site. However, any additional wells as the Division deems appropriate will be constructed. The well construction and testing parameters will also be established by the Division of Solid Waste Management. These parameters are also discussed in the Closure/Post Closure Plan.

Concerning handling and procedures, the following methods are to be implemented for the Bolivar/Hardeman County Landfill:

A. <u>Groundwater Monitoring System</u>

The proposed groundwater monitoring wells are as shown on Sheet 3 of the Drawings.

1. The borings will be drilled using 3-1/4 inch inside diameter hollow stem augers.

2. The monitoring wells will be two inches in diameter and between 50 and 100 feet deep. The wells will be PVC construction with a 10-foot (No. 10 slot) screen. Granular materials will be added surrounding the screen to a height of two feet above the screened portion of the wells. Next, a layer of bentonite pellets will be placed over the sand as a moisture barrier. The remainder of the bore holes will be grouted to prevent vertical seepage from the surface. Upon completion, a flush-mount 8-inch cap will be installed at each well location.

B. Detection Monitoring Program

The following information details the sampling intervals and required parameters. Each well must be sampled and analyzed on a quarterly schedule for the first year.

I. Ammonia (as N)
II. Calcium
III. Chloride
IV. Iron
V. Magnesium
VI. Manganese, dissolved
VII. Nitrate (as N)
VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

Parameters establishing the ground water quality:

I. Arsenic
II. Barium
III. Cadmium
IV. Chromium
V. Cyanide
VI. Lead
VII. Mercury
VIII. Selenium
IX. Silver

All monitor wells shall be sampled and analyzed for the following parameters at least once every six months after the first year:

I. Ammonia (as N)
II. Calcium
III. Chloride
IV. Iron
V. Magnesium
VI. Manganese, dissolved
VII. Nitrate (as N)
VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

All monitor wells shall be sampled and analyzed for the following parameters at least once every year after the first year:

I. Acetone
II. Acrolein
III. Acrylonitrile
IV. Benzene
V. Bromochloromethane
VI. Bromodichloromethane
VII. 4-Bromofluorobenzene
VIII. Bromoform
IX. Bromomethane
X. 2-Butanone (Methyl Ethyl Ketone)
XI. Carbon Disulfide
XII. Carbon Tetrachloride
XIII. Chlorobenzene
XIV. Chlorodibromomethane
XV. Chloroethane
XVI. 2-Chloroethyl Vinyl Ether
XVII. Chloroform
XVIII. Chloromethane
XIX. Dibromomethane
XX. 1,4-Dichloro-2-Butane
XXI. Dichlorodifluoromethane
XXII. 1,1-Dichlorcethane
XXIII. cis-1,2-Dichloropropene
XXIV. trans-1,3-Dichloropropene
XXV. 1,4-Difluorobenzene
XXVI. Ethanol
XXVII. Ethylbenzene
XXVIII. Ethyl Mechacrylate

XXIX. 2-Hexanone
XXX. Iodomethane
XXXI. Methylene Chloride
XXXII. 4-Methyl-2-Pentanone
XXXIII. 1,1-Dichloroethene
XXXIV. Trans-1,2-Dichloroethene
XXXV. Styrene
XXXVI. 1,1,2,2-Tetrachloroethane
XXXVII. Toluene
XXXVIII. 1,1,1-Trichloroethane
XXXIX. 1,1,2-Trichloroethane
XL. Trichloroethane
XLI. Trichlorofluoromethane
XLII. 1,2,3-Trichloropropane
XLIII. Vinyl Acetate
XLIV. Vinyl Chloride

C. Sample Preservation Techniques

Complete and unequivocal preservation of samples, either domestic sewage, industrial wastes, or natural waters, is a practical impossibility. Regardless of the nature of the sample, complete stability for every constituent can never be achieved. At best, preservation techniques can only retard the chemical and biological changes that inevitably continue after the sample is removed from the parent source. The changes that take place in a sample are either chemical or biological. In the former case, certain changes occur in the chemical structure of the constituents that are a function of physical conditions. Metal cations may precipitate as hydroxides or form complexes with other constituents; cations or anions may change valence states under certain reducing or oxidizing conditions; other constituents may dissolve or volatilize with the passage of time. Metal cations may also absorb onto surfaces (glass, plastic, quartz, etc.) such as iron and lead. Biological changes taking place in a sample may change the valence of an element or a radical to a different valence. Soluble constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. The well known nitrogen and phosphorus cycles are examples of biological influence on sample composition.

Methods of preservation are relatively limited and are intended generally to (1) retard biological action, (2) retard hydrolysis of chemical compounds and complexes, and (3) reduce volatility of constituents.

Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing. The following tables show the various preservatives that may be used to retard changes in samples:

Preservative	Action	Applicable To:
$HgCl_2$	Bacterial Inhibitor	Nitrogen forms, Phosphorus forms
Acid (HNO_3)	Metals Solvent, Prevents Precipitation	Metals
Acid (H_2SO_4)	Bacterial Inhibitor	Organic Samples (COD, oil & grease organic carbon), Nitrogen-Phosphorus Forms
	Salt formation with organic bases	Ammonia, amines
Alkali (NaOH)	Salt formation with volatile compounds	Cyanides, Organic acids
Refrigeration	Bacterial Inhibitor, Retards Chemical Reaction Rates	Acidity-alkalinity, organic materials, BOD, color, odor, organic P, organic N, carbon, etc., biological organism (coliform, etc)

In summary, refrigeration at temperatures near freezing or below is the best preservation technique available, but it is not applicable to all types of samples.

The recommended choice of preservatives for various constituents is given in the following table. These choices are based on the accompanying references and on information supplied by various Regional Analytical Quality Control Coordinators.

Recommendation for Sampling and Preservation of Samples According to Measurement

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Acidity	100	P, G (2)	Cool, 4° C	24 Hours
Alkalinity	100	P, G	Cool, 4° C	24 Hours
Arsenic	100	P, G	HNO_3 to pH<2	6 Mos.
BOD	1000	P, G	Cool, 4° C	6 Mos.(3)
Bromide	100	P, G	Cool, 4° C	24 Hours
COD	50	P, G	H_2SO_4 to pH<2	7 Days
Chloride	50	P, G	None Required	7 Days
Chlorine Req.	50	P, G	Det. on Site	No Holding
Color	50	P, G	Cool, 4° C	24 Hours
Cyanides	500	P, G	Cool, 4° C NaOH to pH 12	24 Hours
Dissolved Oxygen Probe	300	G only	Det. on Site	No Holding
Winkler	300	G only	Fix on Site	4 - 8 Hrs.
Fluoride	300	P, G	Cool, 4° C	7 Days
Hardness	100	P, G	Cool, 4° C HNO_3 to pH<2	7 Days
Iodide	100	P, G	Cool, 4° C	24 Hours
MBAS	250	P, G	Cool, 4° C	24 Hours

Metals				
Dissolved	200	P, G	Filter on Site HNO_3 to pH<2	6 Months
Suspended			Filter on Site	6 Months
Total	100		HNO_3 to pH<2	6 Months
Mercury				
Dissolved	100	P, G	Filter HNO_3 to pH<2	38 Days (Glass) 13 Days (Hard Plastic)
Total	100	P, G	HNO_3 to pH<2	38 Days (Glass) 13 Days (Hard Plastic)
Nitrogen				
Ammonia	400	P, G	Cool, 4° C H_2SO_4 to pH<2	24 Hrs(4)
Kjeldahl, Total	500	P, G	Cool, 4° C H_2SO_4 to pH<2	7 Days
Nitrate	100	P, G	Cool, 4° C H_2SO_4 to pH<2	24 Hrs(4)
Nitrite	50	P, G	Cool, 4° C	24 Hrs(4)
NTA	50	P, G	Cool, 4° C	24 Hrs
Oil & Grease	1000	G only	Cool, 4° C H_2SO_4 or HCl to pH<2	24 Hrs
Organic Carbon	25	P, G	Cool, 4° C H_2SO_4 to pH<2	24 Hrs
pH	25	P, G	Cool, 4° C Det. on site	6 Hrs(3)
Phenolics	500	G only	Cool, 4° C H_3SO_4 to pH<4 1.0 g $CuSO_4$/l	24 Hrs

Phosphorus				
Ortho-phosphate, Dissolved	50	P, G	Filter on site Cool, 4° C	24 Hrs(4)
Hydrolyzable	50	P, G	Cool, 4° C H_2SO_4 to pH<2	24 Hrs(4)
Total	50	P, G	Cool, 4° C	7 Days
Total, Dissolved	50	P, G	Filter on site Cool, 4° C	24 Hrs(4)
Residue				
Filterable	100	P, G	Cool, 4° C	7 Days
Non-Filterable	100	P, G	Cool, 4° C	7 Days
Total	100	P, G	Cool, 4° C	7 Days
Volatile	100	P, G	Cool, 4° C	7 Days
Settleable Matter	1000	P, G	None Req.	24 Hours
Selenium	50	P, G	HNO_3 to pH<2	6 Months
Silica	50	P only	Cool, 4° C	7 Days
Specific Conductance	100	P, G	Cool, 4° C	24 Hrs(5)
Sulfate	50	P, G	Cool, 4° C	7 Days
Sulfide	500	P, G	2 ml zinc acetate	24 Hours
Sulfite	50	P, G	Det. on site	No Holding
Temperature	1000	P, G	Det. on site	No Holding
Threshold Odor	200	G only	Cool, 4° C	24 Hours
Turbidity	100	P, G	Cool, 4° C	7 Days

1. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 23, Pgs 72-91 (1973).

2. Plastic or Glass.

3. If sample cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

4. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/l, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.

5. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and the results reported at 25°C.

6. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

D. Chain of Custody Record

The following form will be utilized to track the sampling and testing of the Bolivar/Hardeman County monitoring wells:

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Chain of Custody Record

Location of Sampling: _____

Company's Name _____ Phone (____)_____

Address: _____
No. Street City State Zip

Collector's Name:

_____ Phone (____)_____
Signature

Date Sampled:_____ Time Sampled_____

Field Information: _____

_____

_____

Sample Allocation:

1. _____
Name of Organization

2. _____
Name of Organization

3. _____
Name of Organization

Chain of Possession:

1.	Signature	Title	Inclusive Dates
2.	Signature	Title	Inclusive Dates
3.	Signature	Title	Inclusive Dates

E. Sample Recording and Reporting

The operator of the landfill will keep records of all the groundwater sampling and testing performed through the period of the development and post closure.

All groundwater sample test results will be submitted to the Commissioner of the Department of Conservation and to the Jackson Office of the Division of Solid Waste Management.

If the Commissioner or his authorized representative deems appropriate, the operator of the Bolivar/Hardeman County Landfill will conduct additional sampling and testing of the groundwater per Rule 1200-1-7-.04(7).

31. BUFFER ZONE STANDARDS

The proposed Bolivar Landfill site has been designed to address the following buffer zone standards:

A. Fill areas of landfill are a minimum 100 feet from all property lines.

B. The closest residential property to the fill area is approximately 640 feet from the southern-most portion of the landfill.

C. No drinking water wells are located within 1,000 feet downstream of the fill area.

D. The closest distance to any body of water is approximately 260 feet from the western boundary of the fill area.

E. There is a minimum fifty feet site buffer of all property lines.

F. The total acreage of the site dedicated to buffer zone is 16.8 acres.

32. ECOLOGICAL IMPACT

No endangered or threatened species of plants, fish, or wildlife will be impacted by this facility.

33. GAS MIGRATION CONTROL

A gas vent-monitor system will be installed to prevent the build-up of gasses under the final cover. Approximate locations of the vents are shown in the drawings. A vent will be installed for every acre of final cover. Mr. Lloyd Bell with the City of Bolivar will be responsible for monitoring the gas vents. This monitoring will be performed on a monthly basis and recorded in an appropriate log. In addition, Mr. Bell will be responsible for maintaining the gas vents which will be inspected monthly in conjunction with the gas monitoring program.

34. RANDOM INSPECTION PROGRAM

The City of Bolivar and Hardeman County prior to disposal of solid waste at the proposed landfill site will implement a random inspection program which will include:

1. Random inspection of five percent of the daily incoming loads.

2. Inspection of suspicious loads.

3. Records of all inspections.

4. Training of facility personnel to recognize regulated hazardous waste.

5. Procedures for notifying the proper authorities if a regulated hazardous waste is identified at the facility.

Items 1, 2, and 3 of the program were implemented on July 1, 1992. Training of facility personnel to recognize hazardous waste has already started and will be an on-going project. The Bolivar Fire Department and the Jackson Division of Solid Waste Management will be notified immediately if a regulated hazardous waste is identified at the site.

35. CONSTRUCTION QUALITY ASSURANCE (CQA)

The Construction Quality Assurance Plan begins with a team to implement and monitor the testing as discussed later in this section. The representative of the Owner will take the lead position in the CQA team. Also included in the team will be the earthwork contractor, geomembrane liner supplier/installer, and the geotechnical consultant.

M E E T I N G S

Resolution Meeting

Following the completion of the design, plans, and specifications for the project, a Resolution Meeting may be held. This meeting should include all members of the CQA team.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties, and/or delays in construction, and above all, present the Construction Quality Assurance Plan to all the parties involved. It is very important that the rules regarding testing, repair, etc. be known and accepted by all.

The first part of the Resolution Meeting may be devoted to a review of the design drawings and specifications for completeness and clarity.

This meeting should include (but not be limited to) all of the following activities:

1) Communicate to all parties any relevant documents;

2) Review critical design details of the project;

3) Insure that a site specific addendum is developed, if needed;

4) Make any appropriate modifications to the design criteria, plans, and specifications so that the fulfillment of all design specifications or performance standards can be determined through the implementation of the site specific addendum;

5) Reach a consensus on the quality control procedures, especially on methods of determining acceptability;

6) Assign responsibilities of each party;

7) Establish lines of authority and communication;

8) Prepare a time schedule for all operations; and

9) Any other site specific items pertinent to the project.

The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties. In certain instances, the Resolution Meeting and the Pre-Construction Meeting may be combined, provided that all provisions are addressed.

Pre-Construction Meeting

A Pre-Construction Meeting shall be held at the site. As a minimum, the meeting shall be attended by the CQA team.

Specific topics considered for this meeting include:

1) Develop a site specific addendum;

2) Review the responsibilities of each Party;

3) Review lines of authority and communication;

4) Review methods for documenting and reporting and for distributing documents and reports;

5) Outline procedures for packing and storing archive samples;

6) Review the time schedule for all operations;

7) Conduct a site walk-around;

8) Review testing procedures; and

9) Review repair and replacement procedures.

The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties. In certain instances, the Resolution Meeting and Pre-Construction Meeting may be combined.

Progress/Safety Meetings

Scheduled meetings shall be held between appropriate members of the CQA team and any other concerned parties (sub-contractors). This meeting shall discuss current progress. Any matter requiring action which is raised in this meeting shall be reported to the appropriate parties. Scheduled operations and safe methods to accomplish these will be discussed. Any potential unsafe actions (either witnessed or previously

discussed) will be reviewed and alternative methods determined. A member of the CQA team will be selected to monitor these efforts.

Construction Quality Assurance will be provided for both final cover systems and installed liners (both earthen and geomembrane). The CQA plan for earthen liners and final cover will be as follows:

Construction Quality Assurance (CQA)

The following list represents the required minimum number of tests to be performed on soils to determine their suitability as source materials for liner support layer, geologic buffer, and landfill cap (including earth berms as shown on the Drawings).

Parameter	Test Frequency	Test Method
Atterberg Limits	1/5000 cubic yards	ASTM-D4318
Grain Size	1/5000 cubic yards	ASTM-D422-63
Moisture-Density	1/5000 cubic yards or 1/soil change	ASTM-D698 ASTM-D1557
Permeability	1/each soil change	ASTM-D5084

The following list presents the required minimum number of soil tests to be utilized for monitoring the construction of the liner support layer, geologic buffer, and landfill cap (including earth berms as shown on the Drawings).

Parameter	Test Frequency	Test Method
Field Density	5/Acre/Lift	ASTM D2922 Nuclear Density
Field Density	1/Acre/Lift	ASTM D1556 Sand Cone
Field Moisture	5/Acre/Lift	ASTM D3017 Nuclear Density
Field Moisture	1/Acre/Lift	ASTM F2216 Oven Dry
Permeability	1/3 Acre/Lift or 1/Soil Change	ASTM D5084

The following is a list of test parameters each layer must meet. If these tests are failed, the layers must be reworked and retested. If these test parameters cannot be met, soil will be removed and replaced.

Geologic Buffer -
95% relative density at optimum moisture content.
1×10^{-6} cm/s maximum hydraulic conductivity

Liner Support Layer -
95% relative density at optimum moisture content.
1×10^{-6} cm/s maximum hydraulic conductivity

Landfill Cap -
95% relative density at optimum moisture content.
Goal is 1×10^{-7} cm/s maximum hydraulic conductivity

The CQA Plan for the geomembrane liner will be as follows:

MANUFACTURING:

1-Sampling Frequency

1.1 Raw Materials: A sample from each hopper compartment will be tested.

1.2 Finished Goods: Products must be sampled at least twice per shift. Samples must be taken even if they cannot be tested until a later date. Sampling is done by production personnel.

2-Testing Procedure

2.1 Raw material testing involves short term testing aimed at "fingerprinting" the material supplied. Every resin demonstrates its own individual characteristics that are determined by its chemical makeup and molecular weight. For reference purposes, density and melt index serve to identify the material as being acceptable or not. A visual inspection for contaminants is also performed.;

The melt index (ASTM D1238) is a numerical qualification of the molecular weight of the material as demonstrated by flow through a .0825 inch (2.09 mm) diameter orifice at constant pressure and temperature. Lower molecular weight materials flow faster than higher molecular weight materials, thus giving an exact value particular to any grade of resin.

The density of the material (ASTM D1504) is expressed as the weight per unit volume of the material at 23 degrees C. The density of the material serves as a reference to a range of properties including tensile strength, hardness, and chemical resistance.

A visual inspection of the sample is performed to identify any possible contaminants.

2.2 Finished goods testing involves short and long term testing aimed at confirming the physical properties of the material.

Tensile and elongation properties are determined according to ASTM D638. The tensile strength at yield and break is determined and must meet pre-defined specifications. Elongation at the yield point as well as the ultimate elongation of the material is determined and must meet predefined specifications.

Tensile testing is performed parallel and transverse to the production direction. A 2-inch (50.8 mm) per minute testing rate is used in conjunction with Type IV tensile specimens.

The thickness of the material is tested according to ASTM D1593 and D374. Measurements are taken across the width every seven inches and along the length of the sheet every five minutes.

The carbon black content is monitored according to ASTM D1603. Samples of the liner material are weighed and then pyrolyzed under nitrogen which vaporizes the polyethylene, leaving the carbon black as a residue. The weight of the carbon is taken and the percent carbon black content calculated. Maintaining a minimum carbon black content of two percent ensures resistance to ultraviolet exposure.

A visual inspection is made of the liner material to insure that it is free of pores, pinholes, or other detrimental defects.

Environmental stress crack testing is performed according to ASTM D1693. Notched specimens of sheeting are bent 180 degrees and tested at 50 degrees C. in 10 percent igepal CO-630 solution. No failures should occur.

From the daily production testing, a quality certificate is issued by the laboratory.

CONSTRUCTION

Field quality control testing involves both non-destructive and destructive testing. The non-destructive testing is primarily centered on determining "watertightness," whereas the destructive testing is based on the ASTM D4437 test method.

1- One inch strips cut with the weld centrally located are tested by stressing the weld in a "shear" configuration. That is, the top sheet is stressed in relation to the bottom sheet in a direction away from the weld. A pass result occurs when the upper or lower sheet yields. A fail result occurs when the weld fails.

2- One inch strips cut with the weld centrally located are tested by stressing the top sheet in relation to the overlapped edge of the lower sheet in an effort to peel the weld away. A pass result occurs when the sheeting yields. A fail result occurs when the weld peels.

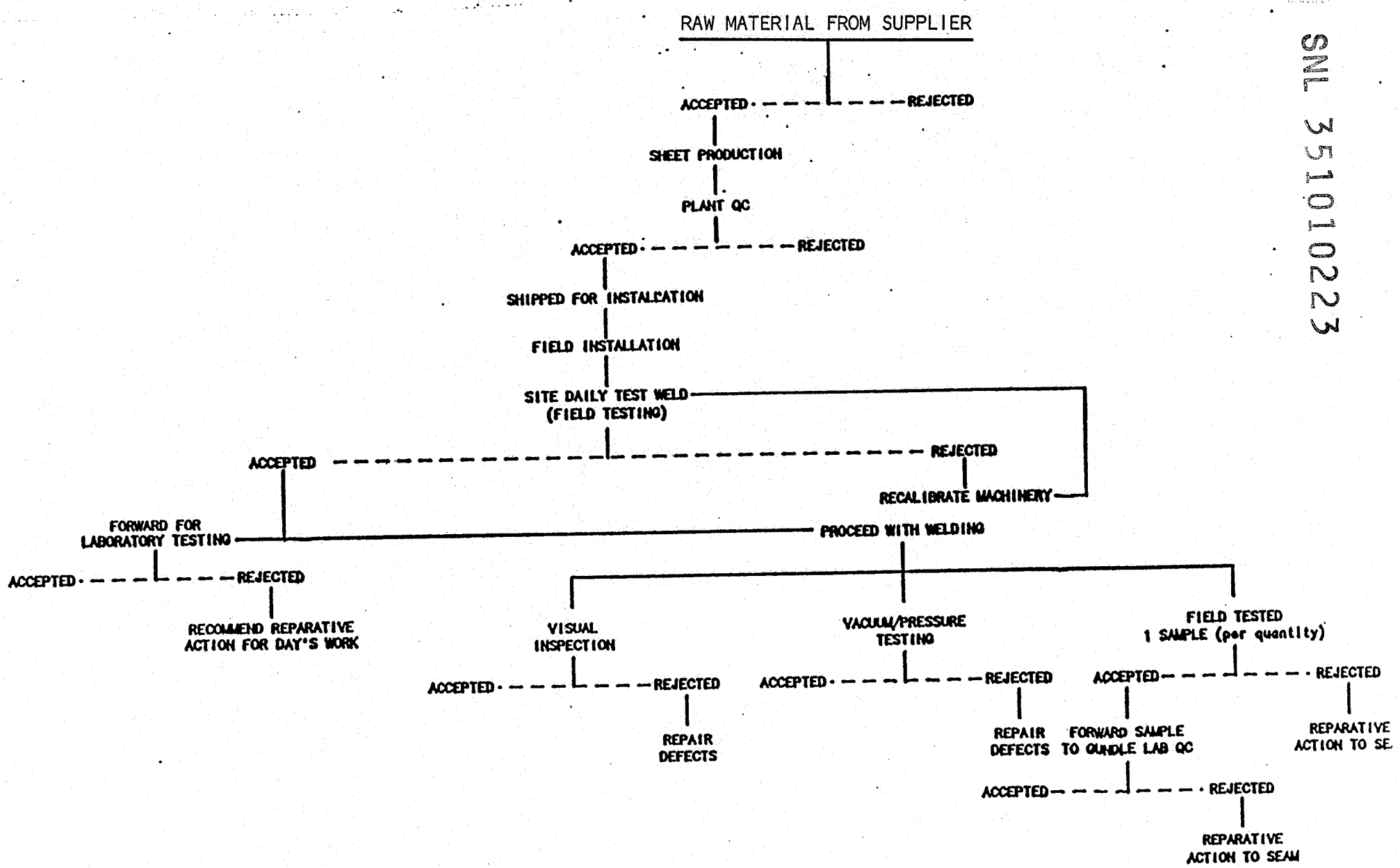
3- A sample weld shall be made twice during each shift with each welding machine. Samples from the weld shall be tested in shear and peel, and no welder may start work until the sample weld has been approved.

4- A visual examination of the seam provides the most useful means of ensuring watertightness. As Gundle

fusion welds are visible on the surface, any suspect areas, brakes, or holes in the weld are easily seen and marked for repair.

5- Destructive shear and peel tests shall be done by random selection of an actual field weld no less than one sample per 500 feet (150 meters) of weld.

6- Vacuum testing follows no specific standard. A glass-faced suction box, typically three feet (1 meter) long and wide enough to cover the weld is placed over a section of the seam which has been wet with a soap solution. Suction is applied to the seam and any leaks are demonstrated by the formation of bubbles. Holes and marked and repaired.



SAMPLE REPORT AND TEST FORMS

GRW Engineers, Inc.
179 Belle Forest Circle, Nashville, Tennessee 37221

SNL351010223

RESIDENT ENGINEER'S DAILY REPORT

CONSTRUCTION ACTIVITIES

CONTRACTOR: _____ CONTRACT NO. _____

OWNER: _____ PROJECT NO. _____

DATE: _____ WEATHER: _____ TEMPERATURE _____ A.M. _____ P.M.

CONTRACTOR'S PERSONNEL:

CLASSIFICATION	NO.	HOURS WORKED

CONTRACTOR'S EQUIPMENT:

DESCRIPTION	NO.	SIZE	HOURS WORKED

SEE REVERSE SIDE FOR SKETCH ☐ YES ☐ NO _____

WORK PERFORMED: _____

PAY ITEMS:

ITEM	NO.	DESCRIPTION	QUANTITY	REMARKS

TESTS PERFORMED: _____

PICTURES TAKEN: _____

VISITORS: _____

RESIDENT'S SIGNATURE _____ REPORT NO. _____

Standard Count	Density	Moisture	NUCLEAR FIELD TEST SHEET	JOB NO.
			GAUGE NO. _____	PROJECT
Total			MOISTURE & DENSITY DATA	DATE
Averages				

TEST NO.								
Test Location								
Depth Below Grade								
Probe Depth								
Density Counts								
TOTAL								
Averages								
Density Ratio								
Moisture Counts								
TOTAL								
Averages								
Moisture Ratio								
Wet Density, pcf								
Water,pcf								
% Moisture								
Dry Density, pcf								
% Rel. Compaction								
Theoretical Wght.								
Reference Curve								

SWI 3510223

PROJECT NAME:

PROJECT NUMBER:

DATE:

SAMPLE I.D.	DRY DENSITY (pcf)	MOIST (%)	LENGTH (cm)	AREA (cm^2)	HEAD (cm)	QUANTITY (cm^3)	ELAPSED TIME (sec)	TEMP (°C)	CORR. FACTOR	COEFFICIENT OF PERMEABILITY K cm/sec
S–1	87.6	8.6	6.3	42.0	70.3	2.4	57,600	20	—	8.9×10^{-8}
S–2	87.8	8.4	6.3	42.0	70.3	1.6	57,600	20	—	5.9×10^{-8}

NOTES:

SNL 351010223

Report of Field Density Tests Sand Cone Method

Job Number _____ Technician _____ Program Name "Date"

Number of Tests _____

(A)	Test Number								(A)
(B)	Date								(B)
(C)	Initial Weight Jar and Sand								(C)
(D)	Weight Jar & Sand Retained								(D)
E.	Weight Sand Used (C-D)								
(F)	Weight Sand in Cone & Plate								(F)
G.	Sand Used in Hole (E-K)								
(H)	Weight Sand per cu. ft.								(H)
I.	Vol. Hole (G/H)								
(J)	Wet Weight Rock Soil & Container								(J)
(K)	Weight Container								(K)
L.	Wet Weight Soil								
M.	Wet Weight Soil/Cu. Ft.								
(N)	Wet Weight Moist. Sample								(N)
(O)	Dry Weight Moist Sample								(O)
P.	Weight Water (N-O)								
Q.	Percent Moisture								
R.	Dry Weight per Cu. Ft.								
(S)	Theoretical Weight (Proctor)								(S)
T.	Percent Compaction								
(U)	Compaction Required								(U)
(V)	Depth Below Grade								(V)
W.	Location								
(X)	Moisture Density Relation-ship								(X)

FIELD REPORT

PROJECT NAME _____ PROJECT NO. _____
DATE _____ WEATHER _____ TEMPERATURE _____
LAW REPRESENTATIVE(S) ON SITE _____ ATTACHMENTS ____NO ___YES

SUMMARY OF OBSERVATIONS/ACTIVITIES:

Time Begin _____ hours
Time End _____ hours
Total Time _____ hours
Vehicle Mileage _____

PREPARED BY:

_____

ACKNOWLEDGED BY:

_____
REPRESENTATIVE ON SITE

QUALITY CONTROL CERTIFICATE
Geomembrane Liner

Date: _____

Material: _____

Batch No: _____

Roll No: _____

Project: _____

_____

Test Parameter	Required Specifications	Test Results	ASTM Test Method
Thickness, mils			D 1593
Density, gms/cm^3			D 1505
Tensile Strength (psi) Yield Break			D 638 Type IV 2 ipm
% Elongation, Break			D 638

Certified by:

_____

Title: _____

SNL

351010225

LABORATORY REPORT NO. _____

DATE: _____

SUBJECT:

Resin Quality Control _____ Batch No. _____

TEST METHOD:

Melt Index	ASTM D1238 E & P
Density	ASTM D1505

TEST RESULTS:

Melt Index,	E	_____ g/10 min
	P	_____ g/10 min
Density		_____ g/cm^3

CONCLUSION:

CERTIFIED BY:

_____

Title_____

SITE WELDING QUALITY CONTROL REPORT

Project _____ Contract No. _____

Site _____ Date _____

Material _____ Thickness _____

Weld Reference _____

Weld Inspection _____ Observations _____

Weld Re-Inspection _____ Observations _____

Sample Weld Location _____

Sampled by: _____

Sample Weld Test Results

Sample West No.	Specimen	Peel Results
	1	
	2	
	1	
	2	
	1	
	2	

Certified by:

_____

Title _____

CALCULATIONS

BOLIVAR SANITARY LANDFILL

PHASE I - TRENCHING OPERATION

A. The Bolivar Landfill is currently disposing of approximately 55,000 cubic yards of solid waste each year.

B. On an average day, the landfill will accept approximately 150 cubic yards of solid waste (55,000/365).

C. As shown on Sheet 4 of the plans, an area of 570,000 square feet will be utilized for trenching operations.

D. As shown in Sheet 10 of the plans, the dimensions of a typical daily cell (excluding cover) are 20 feet wide by 20.25 feet long by 10 feet high (150 cubic yards).

E. Also, as shown on Sheet 10 of the plans, the daily requirement for cover is 36.08 cubic yards.

F. Each day, 150 cubic yards of solid waste are disposed of and 36.08 cubic yards of earth are used for cover. Therefore, the site will be 80.6% compacted solid waste (150/186.08) and 19.4% earth.

G. From C. above, an area of 570,000 square feet is to be utilized for trenching. Using an average depth of cut = 11.2 feet, the total available volume of the trenching phase = 6,384,000 cubic feet = 236,440 cubic yards.

H. From F. above, 19.4% of the volume is required for cover (daily & intermediate), therefore 45,869 cubic yards of earth are dedicated for cover.

I. The total volume which can be utilized to dispose of solid waste is 190,571 cubic yards.

J. From A. above, the landfill will accept 55,000 cubic yards of solid waste each year. Therefore, the total life of the trenching phase should be approximately 3.46 years (190,571/55,000).

K. The trenching operation as described should require approximately 3.8 acres per year.

L. It is estimated that 142,950 cubic yards of earth will be available for use in the fill operations upon completion of the trenching phase (190,571 X 75% theoretical).

PHASE II - AREA FILL OPERATION

A. The Bolivar Landfill is currently disposing of 55,000 cubic yards of solid waste each year.

B. On an average day, the landfill will accept approximately 150 cubic yards of solid waste (55,000/365).

C. As shown on Sheet 4 of the Plans, an area of 1,069,000 square feet will utilize 1,718,180 cubic yards of available volume.

D. As shown on Sheet 11 of the Plans, the dimensions of a typical daily cell (excluding cover) are 20 feet wide by 20.25 feet long by 10 feet high (150 cubic yards).

E. Also, as shown on Sheet 11, the daily requirement for cover is 36.08 cubic yards.

F. Each day, 150 cubic yards of solid waste are disposed of and 36.08 cubic yards of earth are used for cover. Therefore, the site will be 80.6% compacted solid waste (150/186.08) and 19.4% earth.

G. From F. above, 19.4% of the volume is required for cover (daily and intermediate), therefore 266,950 cubic yards of earth are dedicated for cover (19.4% of 1,376,030 cubic yards).

H. The total volume which can be utilized to dispose of solid waste is 1,109,080 cubic yards.

I. From A. above, the landfill will accept 55,000 cubic yards of solid waste each year. Therefore, the total life of the area fill phase should be approximately 20.17 years (1,109,080/55,000).

J. The area fill operation as described should require approximately 3.40 acres per year (excluding side slopes), assuming 10 feet height of cells.

K. Additional earth is required to build the earth berms. At final grade there will be approximately 28,400 linear feet of berm constructed. With a cross-sectional area of 250 square feet, 262,960 cubic yards of earth will be required.

L. For final cover of the landfill, 79,190 cubic yards will be required to complete the three feet minimum cover.

M. An approximate total of 609,100 cubic yards of earth are required to complete all phases in the fill operation. With

an excess of 142,930 cubic yards of earth from the trenching operations available, a shortage of 466,170 cubic yards remains. As the landfill reaches capacity, the City will need to make provisions to import acceptable cover material.

N. The total life of the site based on current usage is calculated to be approximately 24 years. For purposes of allowing for population increases and safety factors, a life of approximately 15 years is anticipated.

PHASE III - DRAINAGE CALCULATIONS

Perimeter drainage to prevent run-on from off-site on to Landfill limits.

Calculation drainage pipe sizes for v piping starting at east property line (Catch Basin 1) to south property line (Catch Basin 2).

Size piping between Catch Basins 1 and 2.

Drainage Area = 12 acres

Calculate Tc Try $T = 0.42\ (CnL)\ 0.8/\ P_2\ SW\ o.4) E_Q 1$

P 2yr 24hr = 4.08

S = 36′/900′ = 0.04

n = 0.45

From EQ1, t= 92 mins use tc = 30 minutes

For Tc = 30 minutes, 100 yr, I = 4.8 in/hr
C = 0.40
A = 12 acres

Q_1 = CIA = 23 cfs

For piping from Catch Basin 2 to outfall
Drainage Area = 49 acres
Tc = 30 minutes I = 48 in/hr
C = 0.40

Q_2 = CIA = 94 cfs

Size culvert pipe sizes
from Catch Basins 1 to 2

Q = 100 yrs = 23 cfs

$Q = 1.49/n\ (A)(r_H) \wedge 2/3\ \ s$

Try 30" rcp @ 0.004 slope $A = 4.9087\ in^2$
$r_H = 0.625$

$Q = (1.49/0.013)(4.9087)(0.625)^{2/3}\ 0.004^{1/2}$

$Q = 26$ cfs

30" rcp is acceptable

From Catch Basin 2 to outfall
Q from CB 1 to 2 - 23 cfs

Q from Area into CB 2 = 94 cfs

Q = 117 cfs

Try 48" RCP @ 0.09 slope $A = 12.5664$ in ^{2}

$r_H = 1$

Q = 137 cFs

48" RCP is acceptable

Design ditches to capture runoff from Landfill to take to pond.

Figure I shows the 25-year 24 hour rainfall to be approximately 6.3 inches for this area.

Figure II shows the peak discharge for 19 acres and 24-hour runoff of 6.3 inches to be 50 cfs. (19 acres is the maximum acres either ditch will be responsible for)

The ditches on the north and south sides of the proposed landfill will be designed to carry the peak runoff rate of 50 cfs.

Ditch Design $v = 1.49/n\ (r_H)^{2/3}\ S^{1/2}$

$n = 0.027$

$S = 0.05$

$Q = VA = 50$ cfs

Figure III shows ditch detail

$A = 8\ ft^2$

$p = 22.3246$

$V = 6.2$ ft/sec

$Q = VA = 50$ cfs

ditches have enough capacity to carry required design.

The runoff at this velocity should safely pass through the ditches with no erosion damage if the grass in the ditches is in good condition. As an additional safeguard, areas in the ditches will be rip rapped (see Drawing Sheet 5).

The ditch south of the existing landfill will be designed to carry 130 cfs (flow from the 48" RCP and additional surface runoff).

The critical ditch profile for this runoff is a trapezoid shaped ditch with a 30-foot bottom, a depth of 5 feet at 3:1 side slopes, and a center line slope of 4.2%.

After trial and error, the final ditch design is:

$V = 1.49/n\ (r_H)^{2/3}\ S^{1/2}$

$n^2\ 0.027$

$S = 0.042$

$Q = VA = 130$ cfs

At a depth of 0.85'

$A = 27.67\ ft^2$

$P = 70.48$

$V = 5.1$ ft/sec

$Q = 141.6$ cfs

This ditch and design velocities show safe passage of the design runoff. But to further protect the site and silt pond dike, rip rap will be placed as indicated on Drawing Sheet 3.

PHASE IV - POND CALCULATIONS

A. Assume sediment loss will be 1.0 inch over the site (37 acres).

B. Volume of sediment will be 134,310 cubic feet.

C. The bottom area of the pond (elevation 415.00) has an area of approximately 93,000 square feet. The water/sediment depth is 1.4 feet which equals a volume of 140,300 cubic feet. Sediment should be removed if or when it reaches 30% of the pond capacity (elevation 418.75).

D. The pond will have a spillway at Elevation 424.00. It will be 45 feet wide with 3:1 side slopes.

E. The capacity of the sediment pond is 1,060,000 cubic feet at Elevation 424.00.

F. The volume of a 25 year 24 hour storm is 850,000 cubic feet (6.3 inches of rainfall over 37 acres).

G. The volume of a 100 year 24 hour storm is 1,034,000 cubic feet (7.7 inches of rainfall over 37 acres).

H. Pond can retain a 100 year 24-hour storm. However, the spillway can pass this storm at a velocity of approximately 3.7 fps down a 3:1 slope. This velocity does not warrant any further protection from erosion other than a good stand of grass. However, to protect the pond against high velocity flows and poor spillway conditions the spillway and channel to the surface water will be rip rapped. See Drawing Sheet 3.

FIGURE I

SNL 3510 10223

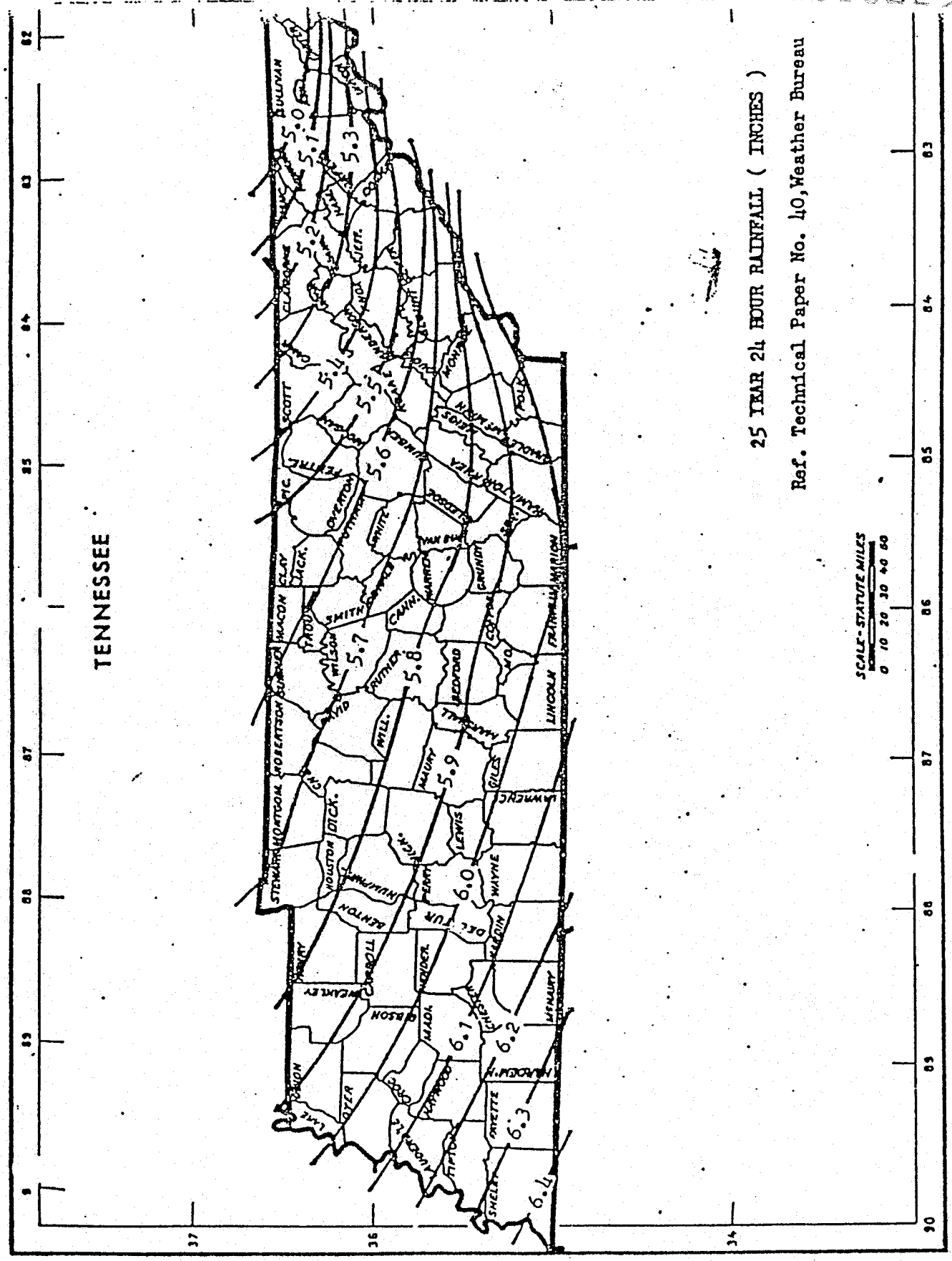
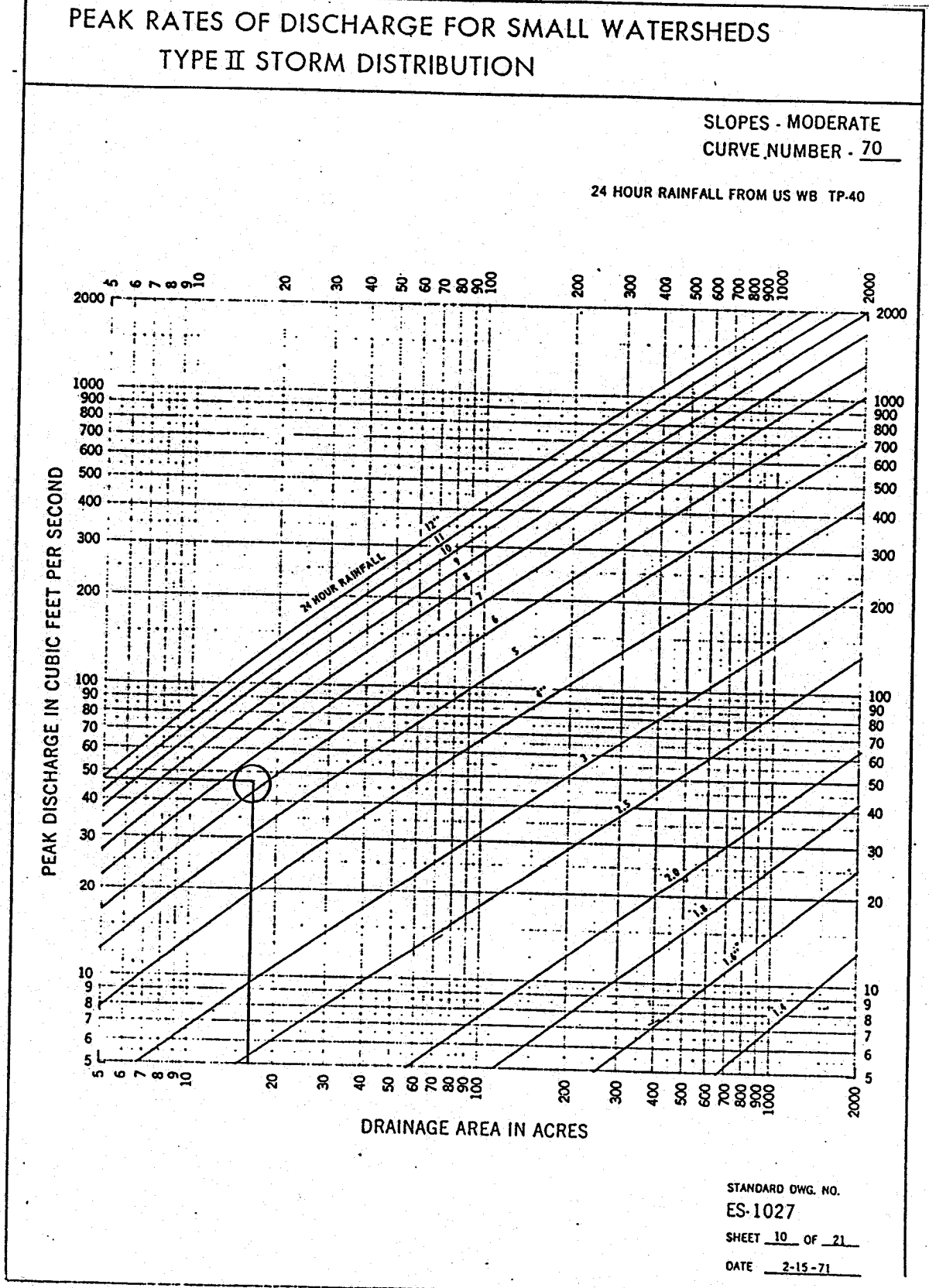
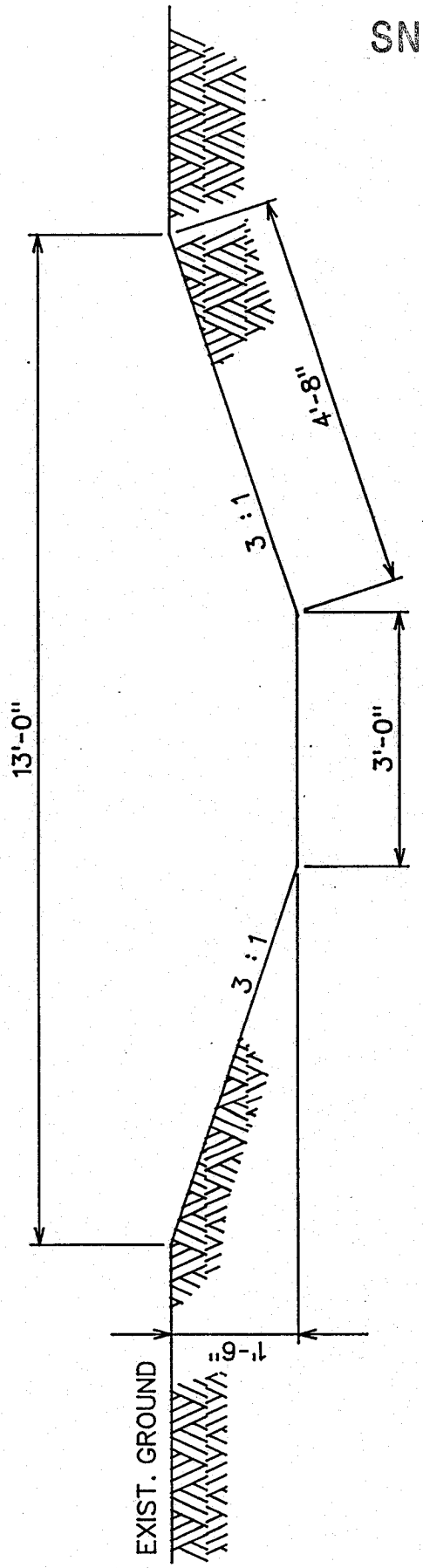


FIGURE II



SNL 351010223



DITCH DETAIL

SCALE :½" =1'-0"

FIGURE 3

BOLIVAR/HARDEMAN COUNTY SANITARY LANDFILL

Closure/Post Closure Plan

I. INTRODUCTION

INTRODUCTION

A. Facility Description

The Bolivar Sanitary Landfill will be a Class I facility and is located just west of the Bolivar City Limits, approximately 2,500 feet north of Highway 64 off Walton Lane.

The proposed landfill will be approximately 23 acres. The fill progression will implement two operations. Initially, the area will develop with trenches cut to a maximum depth of thirty-five (35) feet. Once the landfill is filled back to original grade, filling operations will continue above the completed trench in cell layers of ten feet approximate heights to the final grades which are from 60 to 105 feet above existing grade.

B. Operational History

The current Bolivar Sanitary Landfill was issued a State permit on March 1, 1988.

To date, the landfill has experienced no significant operational problems. The landfill serves Hardeman County residents and commercial/industrial establishments. No hazardous wastes are accepted at the landfill. Special wastes accepted at the landfill are from the following:

ASCO
P. O. Box No. 42
Mickey TN 38359
800/729-1889

Dover Elevator
P. O. Box No. 370
Middleton TN 38052
901/376-8444

Grand Valley Lakes
Route One
Saulsbury TN 38067
901/376-0116

Harman International
127 Tate Road/Box 329
Bolivar TN 38008
901/658-5212

Lucerne Products
Route 1 - Box 212
Bolivar TN 38008
901/658-4771

Master Slack
P. O. Box No. 226
Bolivar TN 38008
901/658-5247

TN Highway Department
Highway 18 North
Bolivar TN 38008
901/658-2836

Waste Management
137 Lawrence Switch Rd
Jackson TN 38301
901/423-2532

Hayes Herron Construction
Route 3 - Box 388
Bolivar TN 38008
901/658-3321

Western Mental Health
Institute
Western Institute TN 38074
901/658-5141

Kilgore Corporation
Bradford Road - Box 99
Toone TN 38381
901/658-5231

Mr. James Wilson
104 Porter Street
Bolivar TN 38008
901/658-6648

The proposed landfill will utilize a separate portion of the current site.

C. Expected Year of Closure

The proposed Bolivar Sanitary Landfill has an expected life of fifteen years. As such, the anticipated year of closure is 2007.

D. Facility Contact

Fred F. Kessler
Bolivar City Administrator
115 North Washington Street
Bolivar, Tennessee 38008

901/658-2020

II. FACILITY CLOSURE

FACILITY CLOSURE

A. Partial Closure

If the proposed Bolivar Sanitary Landfill would need to be closed for any reason prior to its intended completion date, the following steps would be implemented:

1. The Division of Solid Waste Management would be notified at least sixty days prior to closure.

2. Revised drawings would be submitted to the Division of Solid Waste Management to show:

   a. Contours
   b. Drainage
   c. Leachate Collection
   d. Methane Collection
   e. Other steps as requested by the Division of Solid Waste Management

3. Vegetative cover would be established.

4. Final cover and final grading would be performed.

5. Borrow areas and other disturbed areas would be stabilized.

6. The drainage system of the landfill would be stabilized.

7. If not already performed, the leachate handling system would be completed.

8. The methane gas collection system, including vents, would be installed.

9. The groundwater monitoring system as described in the post closure utilities would be implemented immediately.

10. The closure will be certified by the operator and approval will be obtained from the Division of Solid Waste Management. This not only applies to partial closure but to final closure.

B. Complete Closure Steps

1. Final Cover

The final cover will be documented to establish compliance with standards of 3 feet cover thickness and permeability of 1 x 10-7 cm/sec. for two feet as follows:

The borrow area will be tested prior to excavation and compacting on landfill. The permeability will be lab tested and grain size analyzed for suitability. This testing will be periodically repeated to insure the borrow area remains consistent with the Standards.

Once the fill is placed and compacted, additional permeability field tests and density tests will be performed. Depth of the final cover will be checked with hand augers. If the limit for permeability is not met, the cover will be reworked and retested. If the limit still cannot be met, final cover will be removed and replaced.

This work will be monitored by geotechnical engineers experienced in closure operations and follow the proposed testing procedures as recommended by the Tennessee Division of Solid Waste Management listed on the following page.

Lloyd Bell, with the City of Bolivar, is the person responsible with coordinating the testing and record keeping. These records will be kept at Bolivar City Hall in the Office of the City Administrator and will be sent to the Jackson office of the Division of Solid Waste Management. In addition, the services of a Consulting Engineer may be utilized to assist the City/County during closure.

Currently, the Bolivar/Hardeman County Landfill is using the services of PSI and CML Laboratories for its soil testing program.

CONSTRUCTION QUALITY ASSURANCE (CQA)

The following list represents the required minimum number of tests to be performed on soils to determine their suitability as source materials for clay liner and/or final cover construction.

Parameter	Test Frequency	Test Method
Atterberg Limits	1/5000 cubic yards	ASTM D4318
Grain Size	1/5000 cubic yards	ASTM D422-63
Moisture-Density	1/5000 cubic yards or 1/soil change	ASTM D698 ASTM D1557
Permeability	1/each soil type	ASTM D5084

The following list presents the required minimum number of soil tests to be utilized for monitoring the construction of clay liners.

Parameter	Test Frequency	Test Method
Field Density	5/Acre/Lift	ASTM D2922 Nuclear Density
Field Density	1/Acre/Lift	ASTM D1556 Sand Cone
Field Moisture	5/Acre/Lift	ASTM D3017 Nuclear Density
Field Moisture	1/Acre/Lift	ASTM D2216 Oven Dry
Permeability	1/3 Acres/Lift or 1/Soil Change	ASTM D5084

2. Drainage System

The drainage system in place is designed based on the 25-year, 24-hour storm (approximately 6.3 inches of rainfall). The drainage system will continue to be monitored and appropriate measures will be taken for any corrective action. Mr. Lloyd Bell is responsible for maintaining the drainage system at the Bolivar/Hardeman County Landfill.

3. Vegetative Cover

Mr. Lloyd Bell will be responsible for establishing and maintaining the vegetative cover for the proposed landfill. The products and execution of the products required is as follows:

a. Products

(1) Soil Amendments

(a) Lime: Natural dolomitic limestone containing not less than 85 percent of total carbonates with a minimum of 30 percent magnesium carbonates, ground so that not less than 90 percent passes a 10-mesh sieve and not less than 50 percent passes a 100-mesh sieve.

(b) Commercial Fertilizer: Complete fertilizer of neutral character, with some elements derived from organic sources and containing the following percentages of available plant nutrients:

i. For lawns, provide fertilizer with percentage of nitrogen required to provide not less than one pound of actual nitrogen per 1,000 square feet of lawn area and not less than 4 percent phosphoric acid and 2 percent potassium. Provide nitrogen in a form that will be available to the lawn during initial period of growth; at least 50 percent of nitrogen is to be organic form.

(2) Grass Materials

Grass Seed: Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America. Provide seed

mixture composed of grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, as specified below:

Kentucky 31 Fescue 75%
Creeping Red Fescue ... 10%
Italian Rye Grass 10%
Dutch White Clover 5%

(3) Miscellaneous Materials

(a) Anti-Erosion Mulch: Provide clean, seed-free salt hay or threshed straw of wheat, rye, oats, or barley.

b. Execution

(1) Preparation for Planting

(a) Loosen topsoil to a minimum depth of four inches. Remove stones measuring over 1-1/2 inches in any dimension. Remove sticks, roots, rubbish, and other extraneous matter. Limit preparation to areas which will be planted promptly after preparation.

Add specified soil amendments and mix thoroughly into upper four inches of top soil.

(b) Fine grade areas to smooth, even surface with loose, uniformly fine texture. Roll, rake, and drag areas, remove ridges and fill depressions as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.

(c) Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting. Do not create a muddy soil condition.

(2) Seeding

(a) Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.

(b) Sow seed using a spreader or seeding machine. Do not seed when wind velocity

exceeds five miles per hour. Distribute seed evenly over entire area by sowing equal quantity in two directions at right angles to each other.

(c) Sow not less than four pounds per 1,000 square feet of seed mix specified above.

(d) Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with a fine spray.

(e) Protect seeded slopes against erosion with erosion netting or other methods acceptable to the Engineer.

(f) Protect seeded areas against erosion by spreading specified lawn mulch after completion of seeding operations. Spread uniformly to form a continuous blanket not less than 1-1/2 inches loose measurement over seeded areas.

4. Leachate Collection

Leachate collection will be accomplished with a series of perforated and non-perforated PVC piping below the landfill and collected and monitored in a precast concrete structure. The leachate will be hauled offsite to the Bolivar wastewater treatment plant to be treated. Mr. Lloyd Bell will be responsible for monitoring and transporting the leachate to the Bolivar Wastewater Treatment Facility. Mr. Sammy Webster, Chief Operator of the Bolivar Wastewater Treatment Facility will be responsible for treating the leachate generated by the landfill.

5. Gas Collection

As part of closure of the facility, a gas venting network will be installed prior to final cover. Vents will be spaced one per acre over the area of closure.

During closure of the facility, Mr. Lloyd Bell will be responsible for installation of the gas collection system. In addition, Mr. Bell will be responsible for monitoring methane gas production at the landfill.

6. Closure Scheduling

o o	Landfill reaches capacity	Jun 2017
o o	Final Cover Placed: 2 feet of clay and 1 foot of topsoil	Jul - Sep 2017
o o	Establish vegetative growth	Aug - Sep 2017

It is noted that partial closure of the facility is not anticipated. However, should the need arise for partial closure, it will be performed in accordance with Paragraph A (Partial Closure) of this manual.

7. Closure of Active and Future Active Portions of Facility

Currently, Bolivar/Hardeman County is operating a sanitary landfill which was approved in 1988. A closure/post closure plan submitted to the Division of Solid Waste Management in December 1991 addressed the active and future active portions of the facility currently in use. This closure plan specifically addresses the proposed Bolivar/Hardeman County facility. As such, there are no presently active portions on this site. However, once permitted and in service, the future active portions will receive closure care per this manual.

III.

POST CLOSURE ACTIVITIES

POST CLOSURE ACTIVITIES

A. Duration of Post Closure Activities

As the Bolivar/Hardeman County Landfill would be a Class I facility, post closure care and financial assurance must continue for a period of 30 years after completion of the closure of the facility.

B. Groundwater Monitoring System

The groundwater monitoring wells and surface water monitoring point are to be installed in locations as shown on Page 3 of the Drawings. For additional information, refer to Section 30, "Groundwater Monitoring" in the Operations Manual.

1. The borings will be drilled using 3-1/4 inch inside diameter hollow stem augers.

2. The monitoring wells will be two inches in diameter and will be as deep as directed by the Tennessee Division of Solid Waste Management (50'-100', dependent upon the ground elevation of the well location). The wells are PVC construction with a 10-foot (No. 10 slot) screen. Granular materials have been added surrounding the screen to a height of two feet above the screened portion of the wells. Next, a layer of bentonite pellets was placed over the sand as a moisture barrier. The remainder of the bore holes will be grouted to prevent vertical seepage from the surface. Upon completion, a flush-mount eight-inch cap will be installed at each well location.

C. Detection Monitoring Program

The following information details the sampling intervals and required parameters. Each well and surface water location must be sampled and analyzed on a quarterly schedule for the first year. The monitoring and sampling program will continue throughout the post closure care period unless the permit is modified in writing. All monitoring data will be submitted to the Division of Solid Waste Management's Director within 30 days after completion of the analyses. For additional information, refer to Section 30 "Groundwater Monitoring" in the Operations Manual.

I. Ammonia (as N)
II. Calcium
III. Chloride

IV. Iron
V. Magnesium
VI. Manganese, dissolved
VII. Nitrate (as N)
VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

Parameters establishing the ground water quality:

I. Arsenic
II. Barium
III. Cadmium
IV. Chromium
V. Cyanide
VI. Lead
VII. Mercury
VIII. Selenium
IX. Silver

All monitor wells shall be sampled and analyzed for the following parameters at least once every six months after the first year.

I. Ammonia (as N)
II. Calcium
III. Chloride
IV. Iron
V. Magnesium
VI. Manganese, dissolved
VII. Nitrate (as N)
VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

All monitor wells shall be sampled and analyzed for the following parameters at least once every year after the first year unless the permit is modified to establish a different monitoring and sampling program.

Acetone
Acrolein
Acrylonitrile
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
1,4-Difluorobenzene

Benzene	Ethanol
Bromochloromethane	Ethylbenzene
Bromodichloromethane	Ethyl Mechacrylate
4-Bromofluorobenzene	2-Hexanone
Bromoform	Iodomethane
Bromomethane	Methylene Chloride
2-Butanone (Methyl Ethyl Ketone)	4-Methyl-2-Pentanone
Carbon Disulfide	1,1-Dichloroethene
Carbon Tetrachloride	Trans-1,2-Dichloroethene
Chlorobenzene	Styrene
Chlorodibromomethane	1,1,2,2- Tetrachloroethane
Chloroethane	Toluene
2-Chloroethyl Vinyl Ether	1,1,1-Trichloroethane
Chloroform	1,1,2-Trichloroethane
Chloromethane	Trichloroethane
Dibromomethane	Trichlorofluoromethane
1,4-Dichloro-2-Butane	1,2,3-Trichloropropane
Dichlorodifluoromethane	Vinyl Acetate
1,1-Dichlorcethane	Vinyl Chloride

D. Notice in Property Deed

The City of Bolivar/Hardeman County ensures that within 90 days of completion of final closure of the facility and prior to sale or lease of the property on which the facility is located, there is recorded, in accordance with state law, a notation on the deed to thye property or on some other instrument which is normally examined during title search that will in perpetuity notify any person conducting a title search that the land has been used as a disposal facility.

E. Planned Use of Property During Post-Closure Period

At the present time, the City of Bolivar/Hardeman County Landfill Committee does not have an intended use for the landfill site during the post closure care period.

F. Post Closure Care of Closed, Active, and Future Active Portions of the Facility

As this post-closure plan is for a proposed facility, there are no current closed or active areas on the site. However, post closure care will be provided for the permitted area for a period of 30 years after closure in accordance with this manual.

G. Post Closure Care Activities

1. Final Contours and Drainage System

During the 30-year post closure care period, the City of Bolivar/Hardeman County must maintain the approved final contours and drainage system of the site in order to:

a. Minimize precipitation run-on from adjacent areas onto the disposal facility or disposal facility parcel

b. Minimize erosion of cover material

c. Optimize drainage of precipitation falling on the disposal facility or disposal facility parcel

d. Provide a surface drainage system which is consistent with the surrounding area and in no way significantly adversely affects proper drainage from these adjacent lands.

The final cap and drainage structures will be inspected monthly. The final cap will be inspected to insure a good vegetative stand. Areas of poor growth or no growth will be reseeded. If erosion is the cause for this lack of vegetation, sod or rip rap will be considered. The drainage structures will be inspected to insure they remain debris free. The drainage ditches will be checked for erosion problems and will be seeded, sodded, or rip rapped as necessary. Headwalls and piping will be replaced as necessary. All inappropriate vegetation such as honesuckle, briars, bushes, and trees shall be kept off the final cap by routine mowing. The maintenance schedule will change with seasonal demands based on monthly inspections.

2. Vegetative Cover

Bolivar/Hardeman County must maintain the vegetative cover established during the closure of the facility for the 30 year post closure care period.

3. Erosion/Sedimentation Control Measures

Bolivar/Hardeman County must maintain the drainage systems, sediment pond, and all other erosion/sedimentation control devices for the 30 year post closure

care period or until such time as the vegetative cover renders such maintenance unnecessary.

4. Leachate System Maintenance

Bolivar/Hardeman County must monitor, collect, transport, and treat any leachate generated at the landfill site for the duration of the post closure care period. The leachate system will be inspected on a monthly basis. Quantities will be monitored and recorded.

5. Gas System Maintenance

Bolivar/Hardeman County must maintain and monitor the gas collection system as installed during closure for the life of the post-closure plan. The gas vents will be monitored monthly to determine the concentration of methane gas present at the landfill site. The concentration of the gases must not exceed 25 percent of the lower explosive limit for the gases. If concentration levels exceed this limit, actions will be taken as necessary.

IV.

COST ESTIMATES

COST ESTIMATE
WORK SHEET A:
CLOSURE ACTIVITIES

1. ESTABLISHING FINAL COVER:

A. Top-Soil

1.	Quantity needed (yd^3)	26,500
2.	Excavation Unit Cost ($/$yd^3$)	1.33
3.	Excavation Cost (1 x 2)	35,245.00
4.	Placement/Spreading Unit Cost ($/$yd^3$)	2.65
5.	Placement Cost (1 x 4)	70.225.00
TOTAL TOP SOIL		**$105,470.00**

B. Landfill Cap

1. **On-Site Clay**

a.	Quantity Needed (yd^3)	-0-
b.	Excavation Unit Cost ($/$yd^3$)	
c.	Excavation Cost (a x b)	
d.	Placement/Spreading Unit Cost ($/$yd^3$)	
e.	Placement Cost (a x d)	
f.	Compaction Unit Cost ($/$yd^3$)	
g.	Compaction Cost (a x f)	
TOTAL ON-SITE CLAY		**$ -0-**

2. **Off-Site Clay**

a.	Quantity Needed (yd^3)	52,700
b.	Purchase Unit Cost ($/$yd^3$)	2.65
c.	Purchase Cost (a x b)	139,655.00
d.	Delivery Unit Cost ($/$yd^3$)	3.98
e.	Delivery Cost (a x d)	209,750.00
f.	Placement/Spreading Unit Cost ($/$yd^3$)	2.65
g.	Placement Cost (a x f)	139,655.00
h.	Compaction Unit Cost ($/$yd^3$)	1.33
i.	Compaction Cost (a x h)	70,100.00
TOTAL OFF-SITE CLAY		**$559,160.00**

3. **Quality Control/Testing of Clay**

a.	Number of Samples to be Tested	Twenty (20)
b.	Clay Testing Unit Cost ($/sample)	1,500.00
c.	Testing Cost (a x b)	30,000.00
TOTAL CLAY TESTING		**$ 30,000.00**

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C.	Synthetic Membrane	
	1. Quantity Needed (yd^2)	-0-
	2. Purchase Unit Cost ($/$yd^2$)	
	3. Purchase Cost (1 x 2)	
	4. Installation Unit Cost ($/$yd^2$)	
	5. Installation Cost (1 x 4)	
	TOTAL SYNTHETIC MEMBRANE	**$ -0-**
D.	Geotextile Filter Fabric	
	1. Quantity Needed (yd^2)	-0-
	2. Purchase Unit Cost ($/$yd^2$)	
	3. Purchase Cost (1 x 2)	
	4. Installation Unit Cost ($/$yd^2$)	
	5. Installation Cost (1 x 4)	
	TOTAL GEOTEXTILE FILTER FABRIC	**$ -0-**
	TOTAL FOR ESTABLISHING FINAL COVER:	**$694,630.00**
2.	ESTABLISHING VEGETATION COVER	
	A. Labor ($/Acre)	1,750.00
	B. Seeding ($/Acre)	
	C. Fertilizing ($/Acre)	
	D. Mulching ($/Acre)	
	E. Number of Acres	25 Ac
	TOTAL FOR ESTABLISHING VEGETATION COVER	**$ 43,750.00**
3.	ESTABLISHING OR COMPLETING A SYSTEM TO MINIMIZE AND CONTROL EROSION/SEDIMENTATION	
A.	Sediment Pond	
	1. Excavation/Construction ($)	
	2. Materials (e.g. pipe, riprap) ($)	
	TOTAL SEDIMENT POND	**$ 55,000.00**
B.	Diversion Ditch	
	1. Construction ($)	
	2. Materials ($)	
	TOTAL DIVERSION DITCH	**$ 15,000.00**
C.	Temporary Structures (e.g. silt fence, swales)	
	1. Construction ($)	2,500.00
	2. Materials ($)	2,500.00
	TOTAL TEMPORARY STRUCTURES	**$ 5,000.00**

TOTAL FOR ESTABLISHING OR COMPLETING A SYSTEM TO MINIMIZE AND CONTROL EROSION AND SEDIMENTATION	**$118,750.00**

4. ESTABLISHING OR COMPLETING LEACHATE COLLECTION REMOVAL, AND TREATMENT SYSTEM

A. Installation	
1. Number of Feet	1,200
2. Unit Cost ($/ft)	4.00
3. Storage Tanks ($)	1,200.00
4. Pumps ($)	-0-
TOTAL FOR ESTABLISHING OR FOR COMPLETING LEACHATE SYSTEM	**$ 6,000.00**

5. ESTABLISHING OR COMPLETING A SYSTEM TO COLLECT OR VENT GASES

A. Installation	
1. Materials (e.g., piping)	15,000.00
2. Equipment (e.g., testing)	
3. Labor (e.g., drilling)	-0-
TOTAL FOR ESTABLISHING OR FOR COMPLETING A SYSTEM TO COLLECT OR VENT GASES	**$ 15,000.00**

6. ESTABLISHING OR COMPLETING GROUNDWATER/ SURFACE WATER MONITORING SYSTEM

A. Installation	
1. Number of Wells	5
2. Drilling Cost (1 x 2)	1,500.00
3. Materials (e.g., casing)(1 x 3)	6,250.00
4. Equipment (e.g., pumps)	750.00
5. Labor	
TOTAL FOR ESTABLISHING OR COMPLETING GROUNDWATER MONITORING SYSTEM	**$ 8,500.00**

TOTAL CLOSURE COSTS: (SUM OF TOTALS FOR SECTIONS 1 THROUGH 6)	**$842,880.00**

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COST ESTIMATE
WORK SHEET B:
POST CLOSURE ACTIVITIES

1.	SURVEYING INSPECTIONS TO CONFIRM FINAL GRADE AND DRAINAGE ARE MAINTAINED	
	A. Transportation	200.00
	B. Labor	1,000.00
	TOTAL FOR SURVEYING INSPECTIONS	**$ 1,200.00**
2.	MAINTAIN HEALTHY VEGETATION	
	A. Transportation	800.00
	B. Labor	7,500.00
	C. Seeding	
	D. Fertilizing	
	E. Mulching	
	F. Rodent Control	1,500.00
	G. Mowing	9,500.00
	TOTAL FOR MAINTAINING HEALTHY VEGETATION	*$ 19,300.00*
3.	MAINTAIN THE DRAINAGE FACILITIES, THE SEDIMENT PONDS AND OTHER EROSION/SEDIMENTATION CONTROL MEASURES	
	A. Transportation	500.00
	B. Labor	
	C. Cleaning Out of System	1,500.00
	D. Repair of Gullies or Rills	
	1. Soil Acquisition	
	a. Quantity (yd^3)	
	b. Purchase Unit Cost ($/$yd^3$)	
	c. Purchase Cost (a x b)	
	d. Delivery Unit Cost ($/$yd^3$)	
	e. Delivery Cost (a x d)	
	Total Soil Acquisition	**2,500.00**
	2. Placement/Spreading/Compaction	200.00
	3. Revegetation	500.00
	Total Repair of Gullies or Rills	**$ 3,200.00**
	TOTAL FOR MAINTAINING DRAINAGE	**$ 5,200.00**

4. MAINTAIN AND MONITOR THE LEACHATE COLLECTION, REMOVAL AND TREATMENT SYSTEM

A. Treatment of Leachate

1. **On-Site**		
a. Quantity (yd^3)		
b. Treatment Unit Cost ($/$yd^3$)		
c. Treatment Costs (a x b)		
d. Sewer Discharge Unit Cost ($/$yd^3$)		
e. Discharge Costs (a x d)		
TOTAL ON-SITE	**$**	**-0-**
2. **Off-Site**		
a. Quantity (yd^3)		50.00
b. Hauling Unit Cost ($/$yd^3$)		5.00
c. Hauling Cost (a x b)		250.00
d. Treatment Unit Cost ($/$yd^3$)		10.00
e. Treatment Cost (a x d)		500.00
TOTAL OFF-SITE	**$**	**750.00**

B. Maintenance of Leachate Collection System

1. Transportation		
2. Labor		
3. Repairs/Materials (e.g., below)		
a. Pumps		
b. Cleaning out System		
c. Leak Detection		
d. Other		
Total Repairs/Materials	**$**	**1,000.00**
TOTAL FOR MONITORING AND MAINTAINING LEACHATE SYSTEM	**$**	**1,750.00**

5. MAINTAIN AND MONITOR THE GAS COLLECTION OR VENTING SYSTEM

A. Transportation		
B. Labor		
C. Repairs/Materials (e.g., below)		
1. Cleaning		
2. Caps		
3. Other		
Total Repairs/Materials	**$**	**-0-**
TOTAL FOR MAINTAINING AND MONITORING GAS CONTROL SYSTEM	**$**	**-0-**

6. MAINTAIN AND MONITOR THE GROUNDWATER AND/OR SURFACE WATER MONITORING SYSTEM

A.	Monitoring of Groundwater System	
1.	Number of Wells/Springs	Five (5)
2.	Number of Samples/Well	One (1)
3.	Unit Cost of Analysis	2,500.00
4.	Cost of Sampling + Analysis (1 x 2 x 3)	12,500.00
5.	Labor Cost per Well	250.00
6.	Labor Costs (1 x 5)	1,250.00
TOTAL MONITORING OF GROUNDWATER SYSTEM		**$ 14,000.00**
B.	Inspection & Maintenance of System	
1.	Transportation	150.00
2.	Labor	500.00
3.	Repairs/Materials	
a.	Caps	
b.	Tubing	
c.	Pumps	
d.	Well Replacement	750.00
e.	Other	
	Total Repairs/Materials	**$ 750.00**
	TOTAL INSPECTION AND MAINTENANCE OF SYSTEM	**$ 1,400.00**
	TOTAL FOR MAINTAINING AND MONITORING THE GROUNDWATER SYSTEMS	**$ 15,400.00**

TOTAL POST CLOSURE COSTS

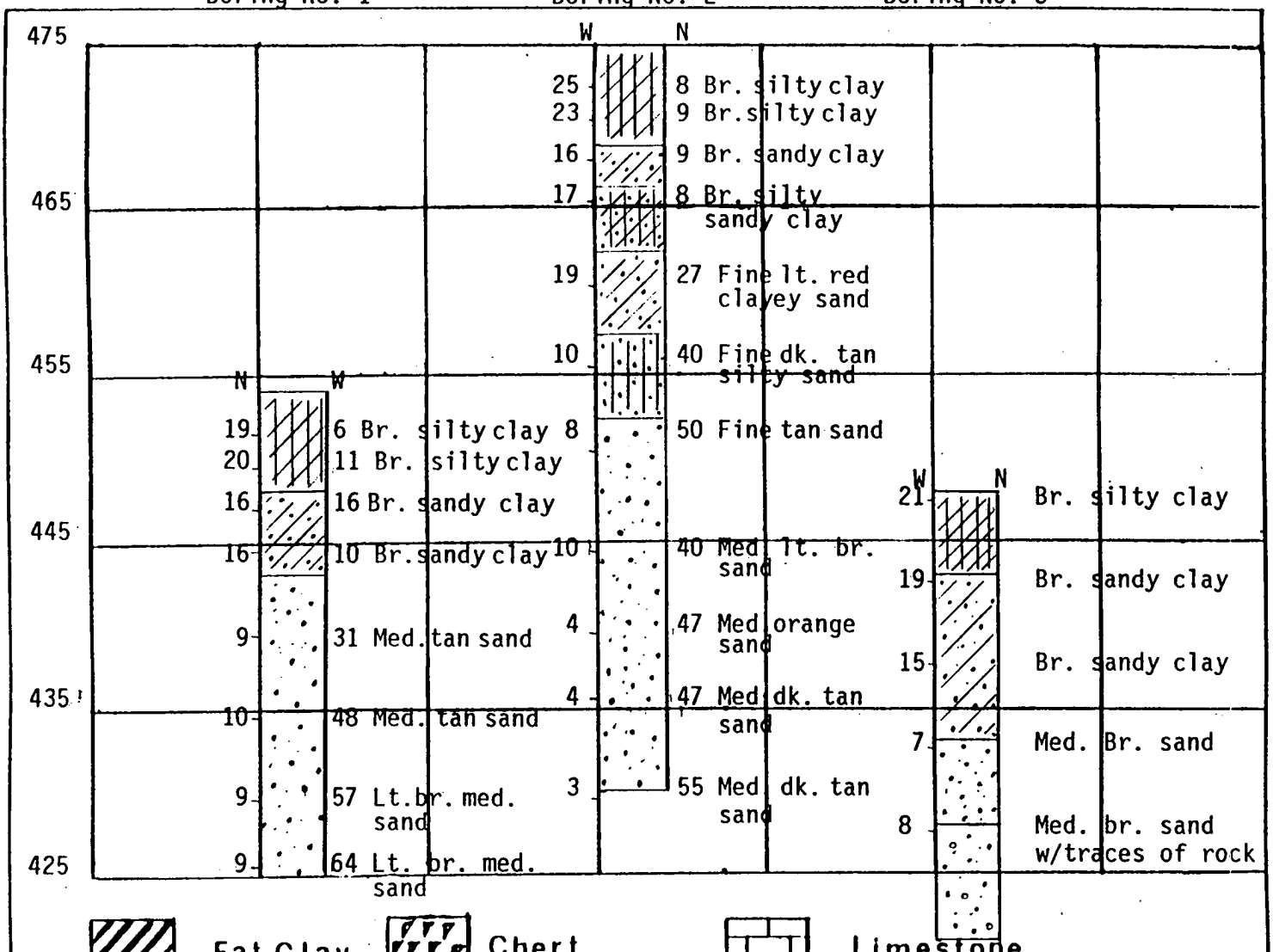
ANNUAL BASIS: (SUM OF TOTALS FOR SECTIONS 1 THROUGH 6)	**$ 42,850.00**
INFLATION RATE UTILIZED	**5%**
30-YEAR BASIS (ANNUAL COST)(INFLATION RATE)(30 YEARS)	**$185,200.00**

APPENDIX

SNL 351010223

BY ..... DATE ..... SUBJECT BOLIVAR LANDFILL SHEET NO. 1 OF .....

CHKD. BY ..... DATE ..... BOLIVAR, TENNESSEE JOB NO. .....



	Fat Clay		Chert		Limestone
	Clay		Volumetric Sample		Fill
	Silt		Water Loss		Water Level
	Sand	90%	Core Loss	w	Moisture Content
	Gravel	R	Refusal	N	Blows Per Foot
	Organic Matter			P	Penetrometer (TSF)
	Shale				GRAPHICAL LOGS
	Sandstone				

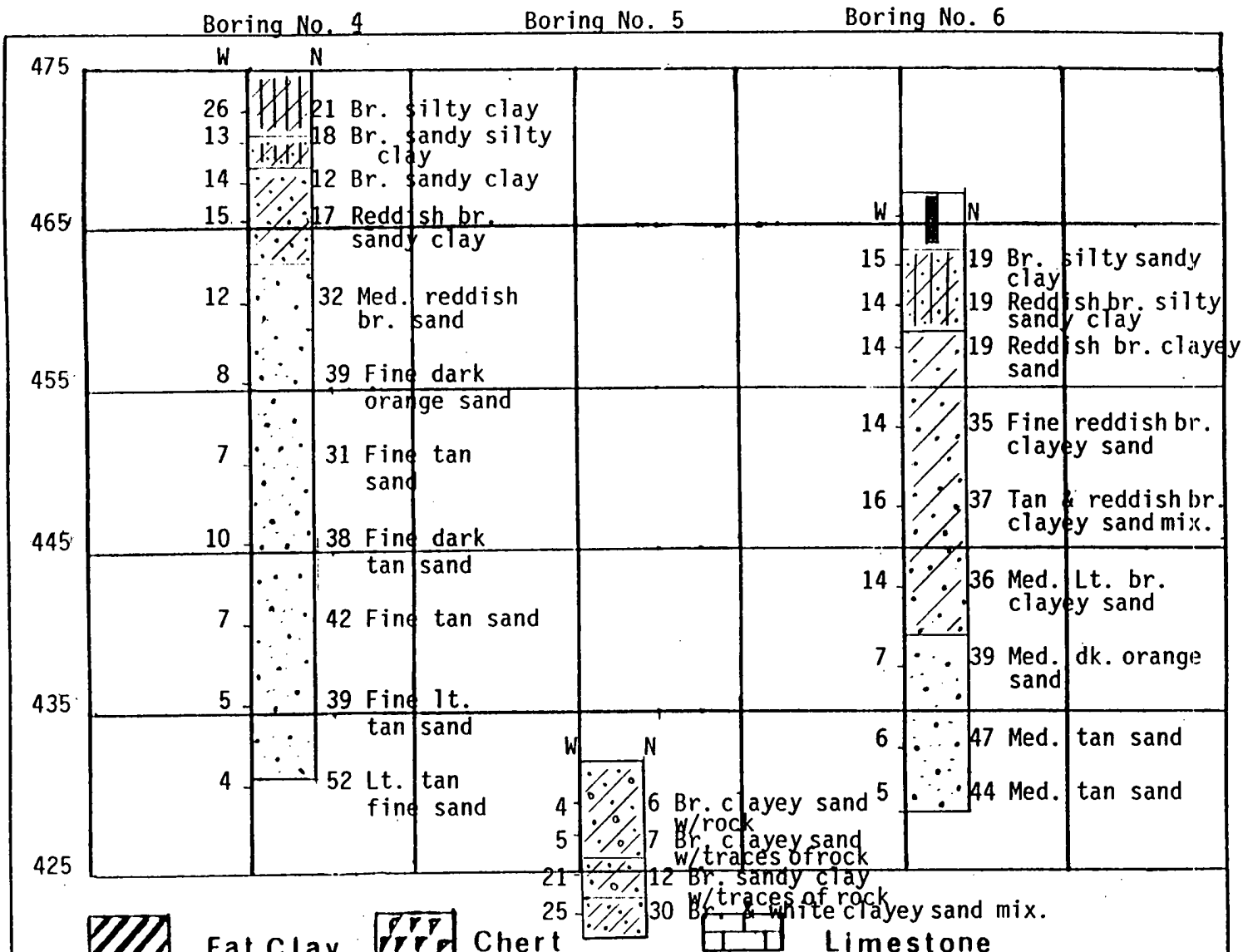
NOTE: Stratum boundaries shown between boring locations are for illustrative purposes only. No guarantee is made or implied regarding actual stratum boundaries.

FIGURE 2

SNL 351010223

BY ..... DATE ..... SUBJECT BOLIVAR LANDFILL SHEET NO. ..... OF .....

CHKD. BY ..... DATE ..... BOLIVAR, TENNESSEE JOB NO. .....



Fat Clay
Clay
Silt
Sand
Gravel
Organic Matter
Shale
Sandstone
Chert
Volumetric Sample
Water Loss
90% Core Loss
R Refusal
Limestone
Fill
Water Level
w Moisture Content
N Blows Per Foot
P Penetrometer (TSF)

GRAPHICAL LOGS

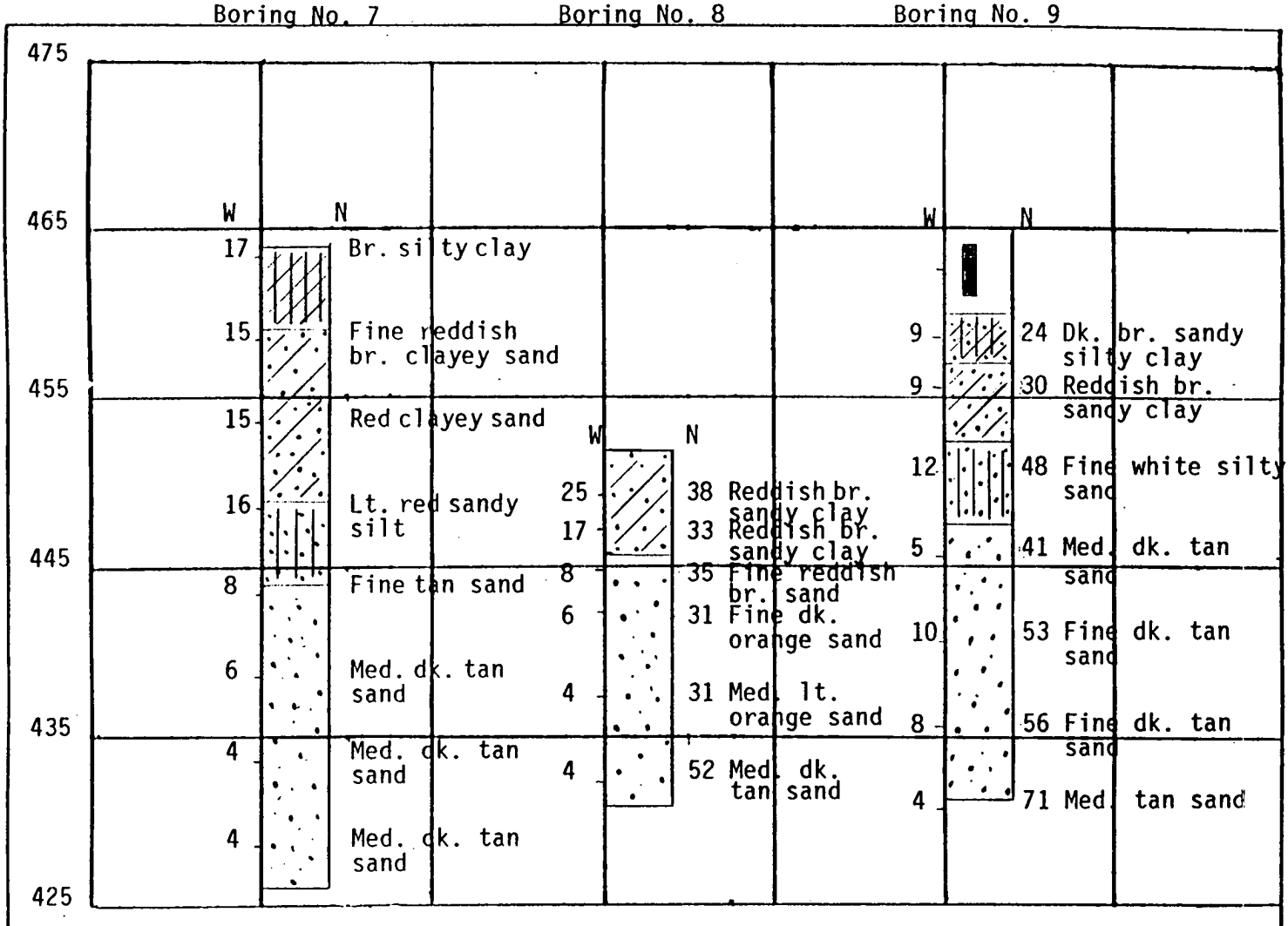
NOTE: Stratum boundaries shown between boring locations are for illustrative purposes only. No guarantee is made or implied regarding actual stratum boundaries.

FIGURE 2

SNL 351010223

BY ..... DATE ..... SUBJECT BOLIVAR LANDFILL SHEET NO. ..... OF .....

CHKD. BY ..... DATE ..... BOLIVAR, TENNESSEE JOB NO. .....



Fat Clay

Clay

Silt

Sand

Gravel

Organic Matter

Shale

Sandstone

Chert

Volumetric Sample

Water Loss

90% Core Loss

R Refusal

Limestone

Fill

Water Level

w Moisture Content

N Blows Per Foot

P Penetrometer (TSF)

GRAPHICAL LOGS

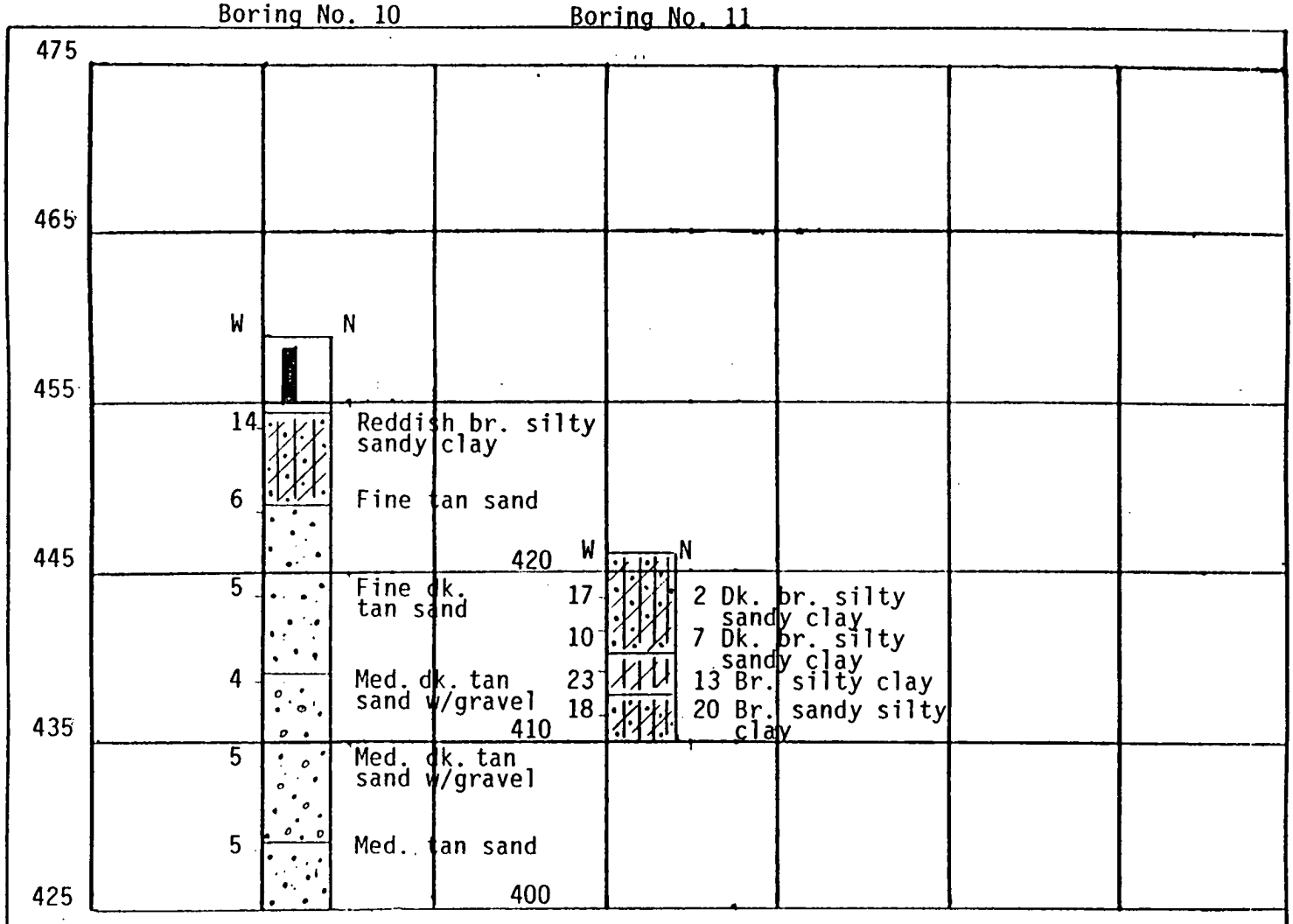
NOTE: Stratum boundaries shown between boring locations are for illustrative purposes only. No guarantee is made or implied regarding actual stratum boundaries.

FIGURE 2

SN: 351010223

BY ..... DATE ..... SUBJECT BOLIVAR LANDFILL SHEET NO. ..... OF .....

CHKD. BY ..... DATE ..... BOLIVAR, TENNESSEE JOB NO. .....



Fat Clay

Clay

Silt

Sand

Gravel

Organic Matter

Shale

Sandstone

Chert

Volumetric Sample

Water Loss

90% Core Loss

R Refusal

Limestone

Fill

Water Level

w Moisture Content

N Blows Per Foot

P Penetrometer (TSF)

GRAPHICAL LOGS

NOTE: Stratum boundaries shown between boring locations are for illustrative purposes only. No guarantee is made or implied regarding actual stratum boundaries.

FIGURE 2

GRW Engineers, Inc.

APR 28 1992

28 April 1992

Mr. Glen Pugh
Tennessee Department of Environment & Conservation
Division of Solid Waste Management
Fourth Floor - Customs House
701 Broadway
Nashville, Tennessee 37243

Re: Bolivar/Hardeman County Landfill
GRW Project No. 7202

Dear Glen:

Please find enclosed two revised sets of drawings, operations manual, and closure/post closure plan for the proposed Bolivar/Hardeman County Landfill. These revisions were performed in response to the Division's Notice of Deficiency dated March 18, 1992.

We and Bolivar/Hardeman County appreciate the timeliness in which the Division responded to the original submission in February 1992.

Please contact me if any additional information would be helpful.

Sincerely,

GRW ENGINEERS, INC.

Robert D. Stigall, P.E.
Project Manager

RDS:ebt

Enclosures

cc to: Mr. James Kelly
Div. Solid Waste Management
Jackson, Tennessee

179 Belle Forest Circle · Nashville, Tennessee 37221 · (615) 662-1977
LEXINGTON. LOUISVILLE. BOWLING GREEN. KY · NASHVILLE. TN

BOLIVAR/HARDEMAN COUNTY
SANITARY LANDFILL
OPERATIONS MANUAL & CALCULATIONS
CLOSURE / POST CLOSURE PLAN

GRW Project No. 7202

January 1992
Revised April 1992

GRW ENGINEERS, INC.
179 Belle Forest Circle
Nashville TN 37221

BOLIVAR/HARDEMAN COUNTY
SANITARY LANDFILL
OPERATIONS MANUAL & CALCULATIONS
Closure/Post Closure Pllan

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BOLIVAR/HARDEMAN COUNTY
SANITARY LANDFILL

OPERATIONS MANUAL & CALCULATIONS

1. GENERAL/PURPOSE

The City of Bolivar presently operates a sanitary landfill which is projected to be exhausted by late 1992. As such, the residents and commercial/industrial establishments of Bolivar and Hardeman County require that an approved disposal method of solid waste be implemented as soon as practical.

Severe environmental and potential legal problems could arise if the City's existing landfill's capacity is reached without the development of a suitable means of disposal of solid waste. The current site can support additional acreage to be permitted in order to continue disposal of solid waste. Approximately 21 acres would be excavated and a total of approximately 25 acres would be permitted.

2. DESCRIPTION AND SEQUENCE OF OPERATION

Two concurrent methods of operation would be used to develop the Bolivar Sanitary Landfill. Initially, the area would be excavated to the grades as shown on sheet 4 of the drawings. Next, the engineered bottom would be constructed as described in Section 3, as follows. Then, solid waste is compacted below the existing grade and in cells 10 feet high. Cover is added until the original grades are restored.

Upon filling of the excavated area, the area fill process will begin by compacting solid waste against a berm over the top of the completed trench.,

This process of excavation and filling would continue and the landfill would receive all daily, intermediate, and final cover until the proposed final grades are achieved.

Concerning the sequence of operation, the proposed landfill will be developed starting in the southeastern corner, and will be developed from southeast to northwest. Page 3 of the Engineering plans shows a progression arrow for the proposed site.

3. ENGINEERED BOTTOM

5'- 1 x 10^{-6} Remolded Silty Clay (geologic buffer)
3'- Completed Materials to support liner
Synthetic Liner
Leachate Collection Drainage/Piping Protection Layer

a) Clear site

b) Strip topsoil - stockpile for future remedial use

c) Excavate and stockpile next 1'-8' depth of material. Stockpile for use in constructing remolded layer (five feet) in bottom of landfill (material to be remolded 1.0 x 10^{-6} through 8.0 x 10^{-7}).

d) Excavate remainder of existing material to plan elevations. Stockpile material for use as daily cover.

e) Geologic Buffer - Construct of brown silty clay from site. Construct in 8"-10" layers, compact to a minimum 95% relative density at optimum moisture content. Test each 10,000 square feet of area in each discrete 8"-10" layer.

f) Liner Support Layer - Construct of material from site. Construct in 8"-10" layers, compact to a minimum 95% relative density at optimum moisture content. Test each 10,000 square feet of area in each discrete 8"-10" layer.

g) Synthetic Liner - Install a 60 mil geomembrane liner on top of geologic buffer with suitable base.

h) Leachate Collection - Install leachate collection piping and holding facilities.

i) Place a 12-inch layer of washed sand over leachate piping for drainage and protection of piping.

j) Begin landfill operation.

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4. ACCESS ROADS

The Bolivar Sanitary Landfill site is readily accessible by automobile or truck. The site is just west of the Bolivar City Limits, approximately 2,500 feet north of U.S. Highway 64 off Walton Lane. The existing access road from Walton Lane will continue to be utilized.

5. ACCESS TO SITE

Use of the Bolivar Landfill site will be restricted to the residents and commercial/industrial establishments of Bolivar and Hardeman County. The landfill supervisor or his representative will be at the landfill site during all hours of operation. At the end of the day, the gate on the access road will be closed and locked to prevent unauthorized dumping of waste material. The operating hours every day will be from 7:00 a.m. to 5:30 p.m.

The Bolivar Landfill property does not have a fence around the boundaries of the property, however the access road is equipped with a locking double swing 20-foot gate which is used to control access to the site. The site has had no problems with unauthorized use of the landfill since its opening in 1988.

6. UNLOADING OF WASTES

The solid waste to be disposed of at the Bolivar Sanitary Landfill will be unloaded by the use of dump trucks. During the progressive trench phase of development, trucks will back down a slope to a point near the working face of the landfill. Here the waste will be dumped below existing grade to facilitate compaction and to prevent scattering and blowing of the solid waste.

During the area fill phase of the Site, the waste is to be dumped near the working face of the landfill. However, this will be above existing grade and may require prompt attention to prevent blowing of the solid waste.

7. BLOWING LITTER

As mentioned in 6. above, the chances of having blowing litter will be reduced by having the waste unloaded as near the working face as possible and by compacting and covering the waste immediately on days when the wind is relatively strong. In addition, should blowing litter occur personnel

assigned to the landfill will gather the litter and place in back in its appropriate location.

8. SPREADING AND COMPACTING OF WASTE

Spreading and compacting of solid waste at the Bolivar Sanitary Landfill will be accomplished by two dozers and a compactor which are currently assigned to the site. The solid waste will be unloaded within one hundred feet of the working face of the facility where it will be compacted against the face of the landfill. The waste should be compacted in layers not to exceed three feet thick to facilitate proper compaction. Should the landfill's equipment experience a major breakdown, backup equipment from Memphis can be obtained in approximately 24 hours,

9. DAILY COVER

Daily cover may consist of native material compacted over all solid waste to a depth of six inches. This "daily cover" is subject to inspection and approval by the Tennessee Division of Solid Waste Management. However, the Bolivar/Hardeman County Landfill is considering the use of a moveable water-proof tarpaulin for use as a daily cover subject to approval by the Division of Solid Waste Management.

10. INTERMEDIATE COVER

In all but the final lift of the sanitary landfill, twelve inches of compacted cover material shall be placed on all surfaces of the landfill which contain waste and will be exposed for a period of over one month. All areas which have intermediate cover will be maintained by the use of mulch, straw, or other methods necessary to prevent erosion.

11. FINAL COVER

A depth of thirty-six inches of compacted cover material shall be placed on the site above waste not later than one week after the final lift is completed. In order to help prevent erosion and surface deterioration, the final cover shall be immediately stabilized to the satisfaction of the Tennessee Division of Solid Waste Management.

Concerning soil balances, the Bolivar/Hardeman County landfill has an agreement with an adjacent property owner to buy suitable cover and bottom material which is of sufficient quantity to last the anticipated life of the proposed landfill.

Cover material availabilities, quality assurances, and quantities are discussed in greater detail in the calculations and Closure/Post Closure Plan.

12. SILT CONTROL

The drainage area is limited to the approximate size of the area requested to be permitted. Diversion ditches will be constructed to divert surface runoff from the disturbed areas where practical. As a final control, a silt pond will be utilized. The run-on and run-off facilities have been designed to handle a 24-hour, 25-year storm. In addition, the drainage pond has a capacity in excess of this volume and is equipped with a spillway sufficient to handle a 24-hour 100-year storm.

13. LEACHATE COLLECTION FACILITIES

The proposed landfill is to be equipped with a leachate collection installed on a grid network. The leachate collection system is designed to handle a 24-hour, 25-year storm over the maximum area to have intermediate cover at any given time. The holding facilities are designed to store the volume of leachate which is anticipated to be generated in any given 30-day period. All concrete storage facilities will be coated with bitumastic to prevent degradation of the facilities.

14. SEEDING AND REVEGETATION

Seeding shall consist of placing grass seed, fertilizer, mulch, straw and other such material as needed to promote a stand of grass on the target areas. Seeding should be performed as soon as possible once final grades are completed. No seeding shall be done during periods of high wind.

15. SITE DRAINAGE AND GRADING

The proposed Bolivar Landfill site is to be operated in a manner which will provide adequate drainage during all phases of development. Berms and diversion ditches are to be constructed to prevent surface water from flowing into the areas which are being trenched.

The off-site runoff will be diverted as required to prevent run on onto the active landfill. This runoff will be piped

18. SIGNS

A sign is erected on the gate across the access road which reads:

Bolivar/Hardeman County Sanitary Landfill
Hours of Operation:
7:00 A.M. - 5:30 P.M.
Contact: Fred F. Kessler
(901)658-2020
Permit Number:

19. SALVAGE OPERATIONS

No salvage operations will be permitted at the proposed Bolivar Sanitary Landfill.

20. SPECIAL WASTES HANDLING

No hazardous, dangerous, or difficult to manage waste will be allowed to be dumped at the landfill site. The landfill operator will refuse to accept any difficult to handle or suspected hazardous waste.

21. DOMESTIC ANIMALS

No domestic animals will be allowed to linger at the Bolivar Sanitary Landfill site. This situation is not anticipated to be a problem. However if domestic animals persist in coming to the site, appropriate preventive or deterrent action will be taken.

22. VECTOR CONTROL

Unfavorable conditions for the breeding of insects, rodents, and other vectors are best maintained by performing routine operations of the landfill in a prompt, efficient manner. If this practice does not prove effective in controlling vectors, supplemental vector control measures will be incorporated as necessary.

23. DUST CONTROL

Adequate dust control may be achieved at the Bolivar Sanitary Landfill site by dampening disturbed areas during extended period of dry weather. This can easily be

accomplished with the 4-inch water line as shown on the plans. In addition, post-type hydrants will be installed to facilitate the spraying of water as needed.

24. CONTAMINATION CONTROL

The threat of contamination is best minimized by constructing the landfill in accordance with the restrictions stated by the Tennessee Division of Solid Waste Management. The restrictions which will be followed in an effort to avoid contamination are as follows:

A. The bottom of the landfill will be carefully constructed per the Division's new regulations and will contain a constructed geologic buffer, a compacted layer for the liner, and a synthetic liner per the Division's approval.

B. A distance of 200 feet must be maintained between the streams and the placement of waste.

C. The ponds on will be closed prior to development of areas within 200 feet upgradient of the ponds.

25. SUPERVISION OF OPERATIONS

The City of Bolivar will be responsible for the operation of the proposed sanitary landfill. Mr. DeWayne Lax will be the supervisor of operations for the site. Mr. Lax has nearly twenty years of experience in sanitary landfill operations.

26. ACCIDENT PREVENTION AND SAFETY

A safe working environment is to be maintained at the proposed Bolivar Sanitary Landfill. All TOSHA Requirements are to be fully complied with. First aid equipment will be available at the Bolivar Landfill site (Maintenance Building).

27. ON-SITE STRUCTURE

A new maintenance building is to be constructed at the Bolivar/Hardeman County Landfill. The existing building currently serves the landfill personnel and equipment well. However, as the proposed landfill is developed, the new building will be built and the existing building demolished

as it is in conflict with the disposal area of the proposed landfill.

This building will house maintenance equipment and provide shelter from inclement weather. Also, drinking water, handwashing, and toilet facilities will be provided for the site. Personnel will have radio communication equipment at hand.

28. RECORDS AND REPORTS

Accurate records and reports concerning the activities of the Bolivar Sanitary Landfill will be kept current and in accordance with all requirements of the Tennessee Division of Solid Waste Management.

29. EQUIPMENT

The City of Bolivar will use a tractor/shovel and a loader to develop the proposed landfill.

If the City of Bolivar's equipment is unable to perform for any reason, appropriate equipment will be leased to do the job until the City's equipment is repaired or replaced. Under no circumstances will the proper operation of the landfill be hindered as a result equipment failure.

30. GROUNDWATER MONITORING

Two upgradient and three downgradient monitoring wells (2-inch diameter) are proposed to be installed on the site. However, any additional wells as the Division deems appropriate will be constructed. The well construction and testing parameters will also be established by the Division of Solid Waste Management. These parameters are also discussed in the Closure/Post Closure Plan.

Concerning handling and procedures, the following methods are to be implemented for the Bolivar/Hardeman County Landfill:

A. <u>Groundwater Monitoring System</u>

The proposed groundwater monitoring wells are as shown on Sheet 3 of the Drawings.

1. The borings will be drilled using 3-1/4 inch inside diameter hollow stem augers.

around the landfill. The pipe sizing calculations are provided later in this manual.

The proposed final grading of the site will divert surface water around areas which contain waste. The top of the landfill site will maintain a sufficient slope to insure proper drainage of water which falls directly on the site. The proposed final contours of the site are shown on the plans.

The landfill site is not within any FEMA flood restricted areas.

16. OPEN BURNING

Presently no open burning is proposed at the Bolivar Sanitary Landfill site. However, any burning of waste on the site must have prior approval from the Tennessee Division of Solid Waste Management and the Division of Air Pollution Control.

17. FIRE PROTECTION

If proper daily cover is maintained at the landfill site, the chance of a fire occurring is remote. However, the site is readily accessible by the Hardeman County Fire Department if needed.

The City of Bolivar presently has a 4-inch water line on Walton Lane. The City will extend 4-inch water service to the landfill site from this line as shown on the Drawings. While this line may not be able to fight a major fire, having water at the site for maintenance of the grounds may prevent a fire.

A fire extinguisher is to be kept on the equipment and one is to be kept in the equipment building.

To help prevent fires from occurring, vents will be installed to prevent the site from retaining potentially explosive methane gas. In addition, no smoldering wastes will be allowed to be deposited in the active section of the landfill.

2. The monitoring wells will be two inches in diameter and between 50 and 100 feet deep. The wells will be PVC construction with a 10-foot (No. 10 slot) screen. Granular materials will be added surrounding the screen to a height of two feet above the screened portion of the wells. Next, a layer of bentonite pellets will be placed over the sand as a moisture barrier. The remainder of the bore holes will be grouted to prevent vertical seepage from the surface. Upon completion, a flush-mount 8-inch cap will be installed at each well location.

B. Detection Monitoring Program

The following information details the sampling intervals and required parameters. Each well must be sampled and analyzed on a quarterly schedule for the first year.

I. Ammonia (as N)
II. Calcium
III. Chloride
IV. Iron
V. Magnesium
VI. Manganese, dissolved
VII. Nitrate (as N)
VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

Parameters establishing the ground water quality:

I. Arsenic
II. Barium
III. Cadmium
IV. Chromium
V. Cyanide
VI. Lead
VII. Mercury
VIII. Selenium
IX. Silver

All monitor wells shall be sampled and analyzed for the following parameters at least once every six months after the first year:

I. Ammonia (as N)
II. Calcium
III. Chloride
IV. Iron
V. Magnesium
VI. Manganese, dissolved
VII. Nitrate (as N)
VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

All monitor wells shall be sampled and analyzed for the following parameters at least once every year after the first year:

I. Acetone
II. Acrolein
III. Acrylonitrile
IV. Benzene
V. Bromochloromethane
VI. Bromodichloromethane
VII. 4-Bromofluorobenzene
VIII. Bromoform
IX. Bromomethane
X. 2-Butanone (Methyl Ethyl Ketone)
XI. Carbon Disulfide
XII. Carbon Tetrachloride
XIII. Chlorobenzene
XIV. Chlorodibromomethane
XV. Chloroethane
XVI. 2-Chloroethyl Vinyl Ether
XVII. Chloroform
XVIII. Chloromethane
XIX. Dibromomethane
XX. 1,4-Dichloro-2-Butane
XXI. Dichlorodifluoromethane
XXII. 1,1-Dichlorcethane
XXIII. cis-1,2-Dichloropropene
XXIV. trans-1,3-Dichloropropene
XXV. 1,4-Difluorobenzene
XXVI. Ethanol
XXVII. Ethylbenzene
XXVIII. Ethyl Mechacrylate

XXIX. 2-Hexanone
XXX. Iodomethane
XXXI. Methylene Chloride
XXXII. 4-Methyl-2-Pentanone
XXXIII. 1,1-Dichloroethene
XXXIV. Trans-1,2-Dichloroethene
XXXV. Styrene
XXXVI. 1,1,2,2-Tetrachloroethane
XXXVII. Toluene
XXXVIII. 1,1,1-Trichloroethane
XXXIX. 1,1,2-Trichloroethane
XL. Trichloroethane
XLI. Trichlorofluoromethane
XLII. 1,2,3-Trichloropropane
XLIII. Vinyl Acetate
XLIV. Vinyl Chloride

C. Sample Preservation Techniques

Complete and unequivocal preservation of samples, either domestic sewage, industrial wastes, or natural waters, is a practical impossibility. Regardless of the nature of the sample, complete stability for every constituent can never be achieved. At best, preservation techniques can only retard the chemical and biological changes that inevitably continue after the sample is removed from the parent source. The changes that take place in a sample are either chemical or biological. In the former case, certain changes occur in the chemical structure of the constituents that are a function of physical conditions. Metal cations may precipitate as hydroxides or form complexes with other constituents; cations or anions may change valence states under certain reducing or oxidizing conditions; other constituents may dissolve or volatilize with the passage of time. Metal cations may also absorb onto surfaces (glass, plastic, quartz, etc.) such as iron and lead. Biological changes taking place in a sample may change the valence of an element or a radical to a different valence. Soluble constituents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. The well known nitrogen and phosphorus cycles are examples of biological influence on sample composition.

Methods of preservation are relatively limited and are intended generally to (1) retard biological action, (2) retard hydrolysis of chemical compounds and complexes, and (3) reduce volatility of constituents.

Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing. The following tables show the various preservatives that may be used to retard changes in samples:

Preservative	Action	Applicable To:
$HgCl_2$	Bacterial Inhibitor	Nitrogen forms, Phosphorus forms
Acid (HNO_3)	Metals Solvent, Prevents Precipitation	Metals
Acid (H_2SO_4)	Bacterial Inhibitor	Organic Samples (COD, oil & grease organic carbon), Nitrogen-Phosphorus Forms
	Salt formation with organic bases	Ammonia, amines
Alkali (NaOH)	Salt formation with volatile compounds	Cyanides, Organic acids
Refrigeration	Bacterial Inhibitor, Retards Chemical Reaction Rates	Acidity-alkalinity, organic materials, BOD, color, odor, organic P, organic N, carbon, etc., biological organism (coliform, etc)

In summary, refrigeration at temperatures near freezing or below is the best preservation technique available, but it is not applicable to all types of samples.

The recommended choice of preservatives for various constituents is given in the following table. These choices are based on the accompanying references and on information supplied by various Regional Analytical Quality Control Coordinators.

Recommendation for Sampling and Preservation of Samples According to Measurement

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(6)
Acidity	100	P, G (2)	Cool, 4° C	24 Hours
Alkalinity	100	P, G	Cool, 4° C	24 Hours
Arsenic	100	P, G	HNO_3 to pH<2	6 Mos.
BOD	1000	P, G	Cool, 4° C	6 Mos.(3)
Bromide	100	P, G	Cool, 4° C	24 Hours
COD	50	P, G	H_2SO_4 to pH<2	7 Days
Chloride	50	P, G	None Required	7 Days
Chlorine Req.	50	P, G	Det. on Site	No Holding
Color	50	P, G	Cool, 4° C	24 Hours
Cyanides	500	P, G	Cool, 4° C NaOH to pH 12	24 Hours
Dissolved Oxygen Probe	300	G only	Det. on Site	No Holding
Winkler	300	G only	Fix on Site	4 - 8 Hrs.
Fluoride	300	P, G	Cool, 4° C	7 Days
Hardness	100	P, G	Cool, 4° C HNO_3 to pH<2	7 Days
Iodide	100	P, G	Cool, 4° C	24 Hours
MBAS	250	P, G	Cool, 4° C	24 Hours

Metals				
Dissolved	200	P, G	Filter on Site HNO_3 to pH<2	6 Months
Suspended			Filter on Site	6 Months
Total	100		HNO_3 to pH<2	6 Months
Mercury				
Dissolved	100	P, G	Filter HNO_3 to pH<2	38 Days (Glass) 13 Days (Hard Plastic)
Total	100	P, G	HNO_3 to pH<2	38 Days (Glass) 13 Days (Hard Plastic)
Nitrogen				
Ammonia	400	P, G	Cool, 4° C H_2SO_4 to pH<2	24 Hrs(4)
Kjeldahl, Total	500	P, G	Cool, 4° C H_2SO_4 to pH<2	7 Days
Nitrate	100	P, G	Cool, 4° C H_2SO_4 to pH<2	24 Hrs(4)
Nitrite	50	P, G	Cool, 4° C	24 Hrs(4)
NTA	50	P, G	Cool, 4° C	24 Hrs
Oil & Grease	1000	G only	Cool, 4° C H_2SO_4 or HCl to pH<2	24 Hrs
Organic Carbon	25	P, G	Cool, 4° C H_2SO_4 to pH<2	24 Hrs
pH	25	P, G	Cool, 4° C Det. on site	6 Hrs(3)
Phenolics	500	G only	Cool, 4° C H_3SO_4 to pH<4 1.0 g $CuSO_4$/l	24 Hrs

Phosphorus				
Ortho-phosphate, Dissolved	50	P, G	Filter on site Cool, 4° C	24 Hrs(4)
Hydrolyzable	50	P, G	Cool, 4° C H_2SO_4 to pH<2	24 Hrs(4)
Total	50	P, G	Cool, 4° C	7 Days
Total, Dissolved	50	P, G	Filter on site Cool, 4° C	24 Hrs(4)
Residue				
Filterable	100	P, G	Cool, 4° C	7 Days
Non-Filterable	100	P, G	Cool, 4° C	7 Days
Total	100	P, G	Cool, 4° C	7 Days
Volatile	100	P, G	Cool, 4° C	7 Days
Settleable Matter	1000	P, G	None Req.	24 Hours
Selenium	50	P, G	HNO_3 to pH<2	6 Months
Silica	50	P only	Cool, 4° C	7 Days
Specific Conductance	100	P, G	Cool, 4° C	24 Hrs(5)
Sulfate	50	P, G	Cool, 4° C	7 Days
Sulfide	500	P, G	2 ml zinc acetate	24 Hours
Sulfite	50	P, G	Det. on site	No Holding
Temperature	1000	P, G	Det. on site	No Holding
Threshold Odor	200	G only	Cool, 4° C	24 Hours
Turbidity	100	P, G	Cool, 4° C	7 Days

1. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 23, Pgs 72-91 (1973).

2. Plastic or Glass.

3. If sample cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

4. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/l, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.

5. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and the results reported at 25°C.

6. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

D. Chain of Custody Record

The following form will be utilized to track the sampling and testing of the Bolivar/Hardeman County monitoring wells:

Chain of Custody Record

Location of Sampling: _____

Company's Name _____ Phone (____)_____

Address: _____
No. Street City State Zip

Collector's Name:
_____ Phone (____)_____
Signature

Date Sampled:_____ Time Sampled_____

Field Information: _____
_____
_____

Sample Allocation:

1. _____
Name of Organization
2. _____
Name of Organization
3. _____
Name of Organization

Chain of Possession:

1.	_____	_____	_____
	Signature	Title	Inclusive Dates
2.	_____	_____	_____
	Signature	Title	Inclusive Dates
3.	_____	_____	_____
	Signature	Title	Inclusive Dates

E. Sample Recording and Reporting

The operator of the landfill will keep records of all the groundwater sampling and testing performed through the period of the development and post closure.

All groundwater sample test results will be submitted to the Commissioner of the Department of Conservation and to the Jackson Office of the Division of Solid Waste Management.

If the Commissioner or his authorized representative deems appropriate, the operator of the Bolivar/Hardeman County Landfill will conduct additional sampling and testing of the groundwater per Rule 1200-1-7-.04(7).

31. BUFFER ZONE STANDARDS

The proposed Bolivar Landfill site has been designed to address the following buffer zone standards:

A. Fill areas of landfill are a minimum 100 feet from all property lines.

B. The closest residential property to the fill area is approximately 640 feet from the southern-most portion of the landfill.

C. No drinking water wells are located within 1,000 feet downstream of the fill area.

D. The closest distance to any body of water is approximately 260 feet from the western boundary of the fill area.

E. There is a minimum fifty feet site buffer of all property lines.

F. The total acreage of the site dedicated to buffer zone is 16.8 acres.

32. ECOLOGICAL IMPACT

No endangered or threatened species of plants, fish, or wildlife will be impacted by this facility.

33. GAS MIGRATION CONTROL

A gas collection and venting system will be installed to prevent the build-up of gasses under the final cover. A vent will be installed for every acre of final cover.

34. RANDOM INSPECTION PROGRAM

The City of Bolivar and Hardeman County prior to disposal of solid waste at the proposed landfill site will implement a random inspection program which will include:

1. Random inspection of five percent of the daily incoming loads.

2. Inspection of suspicious loads.

3. Records of all inspections.

4. Training of facility personnel to recognize regulated hazardous waste.

5. Procedures for notifying the proper authorities if a regulated hazardous waste is identified at the facility.

35. CONSTRUCTION QUALITY ASSURANCE (CQA)

Construction Quality Assurance will be provided for both final cover systems and installed liners (both earthen and geomembrane). The CQA plan for earthen liners and final cover will be as follows:

Construction Quality Assurance (CQA)

The following list represents the required minimum number of tests to be performed on soils to determine their suitability as source materials for clay liner and/or final cover construction.

Parameter	Test Frequency	Test Method
Atterberg Limits	1/5000 cubic yards	ASTM-D4318
Grain Size	1/5000 cubic yards	ASTM-D422-63
Moisture-Density	1/5000 cubic yards or 1/soil change	ASTM-D698 ASTM-D1557
Permeability	1/each soil change	ASTM-D5084

The following list presents the required minimum number of soil tests to be utilized for monitoring the construction of clay liners.

Parameter	Test Frequency	Test Method
Field Density	5/Acre/Lift	ASTM D2922 Nuclear Density
Field Density	1/Acre/Lift	ASTM D1556 Sand Cone
Field Moisture	5/Acre/Lift	ASTM D3017 Nuclear Density
Field Moisture	1/Acre/Lift	ASTM F2216 Oven Dry
Permeability	1/3 Acre/Lift or 1/Soil Change	ASTM D5084

The CQA Plan for the geomembrane liner will be as follows:

MANUFACTURING:

1-Sampling Frequency

1.1 Raw Materials: A sample from each hopper compartment will be tested.

1.2 Finished Goods: Products must be sampled at least twice per shift. Samples must be taken even if they cannot be tested until a later date. Sampling is done by production personnel.

2-Testing Procedure

2.1 Raw material testing involves short term testing aimed at "fingerprinting" the material supplied. Every resin demonstrates its own individual characteristics that are determined by its chemical makeup and molecular weight. For reference purposes, density and melt index serve to identify the material as being acceptable or notl. A visual inspection for contaminants is also performed.;

The melt index (ASTM D1238) is a numerical qualification of the molecular weight of the material as demonstrated by flow through a .0825 inch (2.09 mm) diameter orifice at constant pressure and temperature. Lower molecular weight materials flow faster than higher molecular weight materials, thus giving an exact value particular to any grade of resin.

The density of the material (ASTM D1504) is expressed as the weight per unit volume of the material at 23 degrees C. The density of the material serves as a reference to a range of properties including tensile strength, hardness, and chemical resistance.

A visual inspection of the sample is performed to identify any possible contgaminants.

2.2 Finished goods testing involves short and long term testing aimed at confirming the physical properties of the material.

Tensile and elongation properties are determined according to ASTM D638. The tensile strength at yield and break is determined and must meet pre-defined specifications. Elongation at the yield point as well as the ultimate elongation of the material is determined (kand) must meet predefined specifications.

Tensile testing is performed parallel and transverse to the production direction. A 2-inch (50.8 mm) per minute testing rate is used in conjunction with Type IV tensile specimens.

The thickness of the material is tested according to ASTM D1593 and D374. Measurements are taken across the width every seven inches and along the length of the sheet every five minutes.

The carbon black content is monitored according to ASTM D1603. Samples of the liner material are weighed and then pyrolyzed under nitrogen which varporizes the polyethylene, leaving the carbon (bloack) as a residue. The weight of the carbon is taken and the percent carbon black content calculated. Maintaining a minimum carbon black content of two percent ensures resistance to ultraviolet exposure.

A visual inspection is made of the liner material to insure that it is free of pores, pinholes, or other detrimental defects.

Environmental stress crack testing is performed according to ASTM D1693. Notched specimens of sheeting are bent 180 degrees and tested at 50 detgrees C. in 10 percent igepal CO-630 solution. No failures should occur.

From the daily production testing, a quality certificate is issued by the laboratory.

CONSTRUCTION

Field quality control testing involves both non-destructive and destructive testing. The non-destructive testing is primarily centered on determining "watertightness," whereas the destructive testing is based on the ASTM D4437 test method.

1- One inch strips cut with the weld centrally located are tested by stressing the weld in a "shear" configuration. That is, the top sheet is stressed in relation to the bottom sheet in a direction away from the weld. A pass result occurs when the upper or lower sheet yields. A fail result occurs when the weld fails.

2- One inch strips cut with the weld centrally located are tested by stressing the top sheet in relation to the overlapped edge of the lower sheet in an effort to peel the weld away. A pass result occurs when the sheeting yields. A fail result occurs when the weld peels.

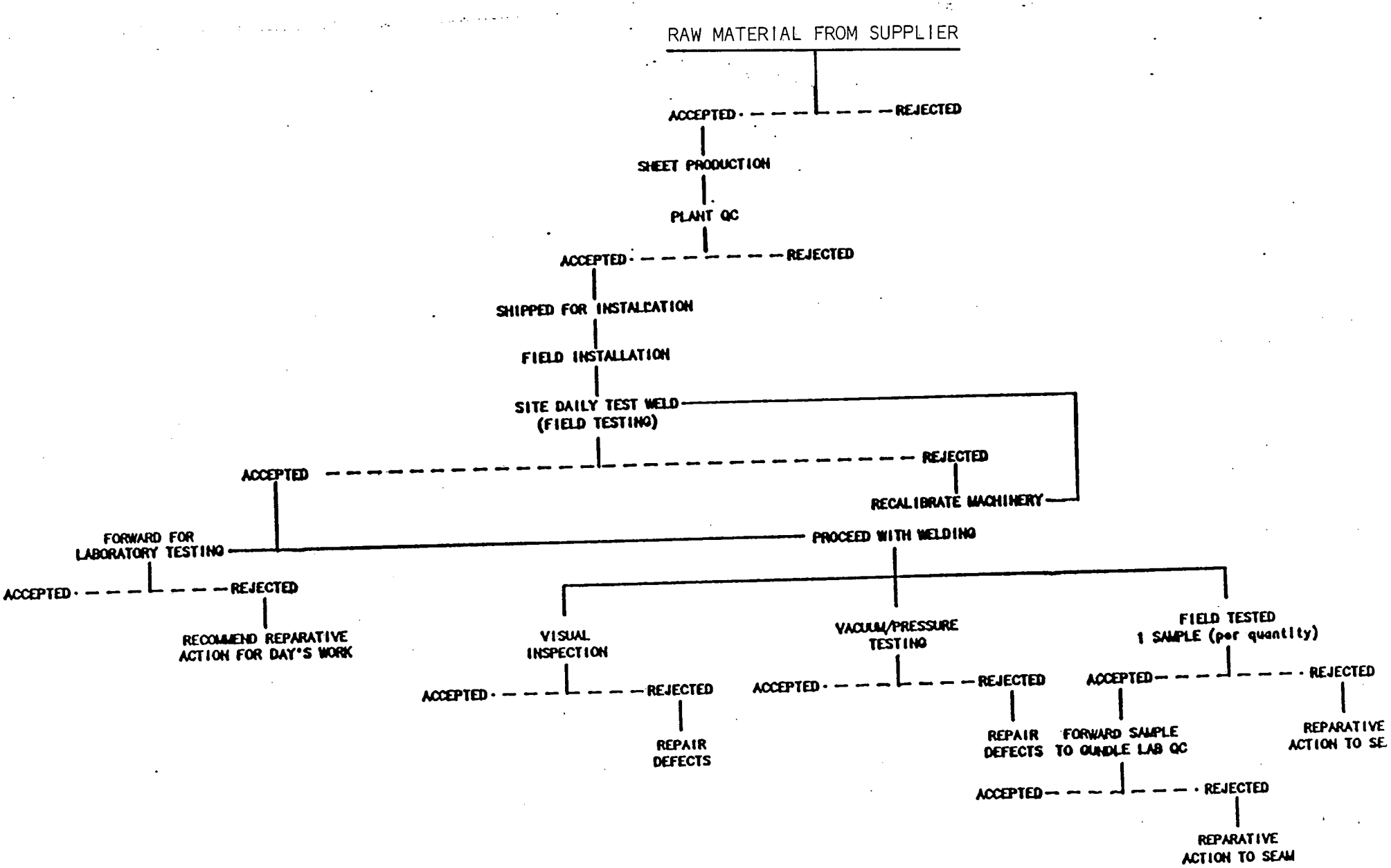
3- A sample weld shall be made twice during each shift with each welding machine. Samples from the weld shall be tested in shear and peel, and no welder may start work until the sample weld has been approved.

4- A visual esamination of the seam provides the most useful means of ensuring watertightness. As Gundle fusion welds are visible on the surface, any suspect areas, brakes, or holes in the weld are easily seen and marked for repair.

5- Destructive shear and peel tests shall be done by random selection of an actual field weld no less than one sample per 500 feet (150 meters) of weld.

6- Vacuum testing follows no specific standard. A glass-faced suction box, typically three feet (1 meter) long and wide enough to cover the weld is placed over a section of the seam which has been wet with a soap solution. Suction is applied to the seam and any leaks

are demonstrated by the formatiuon of bubbles. Holes and marked and repaired.


RAW MATERIAL FROM SUPPLIER
ACCEPTED
REJECTED
SHEET PRODUCTION
PLANT QC
ACCEPTED
REJECTED
SHIPPED FOR INSTALCATION
FIELD INSTALLATION
SITE DAILY TEST WELD (FIELD TESTING)
ACCEPTED
REJECTED
RECALIBRATE MACHINERY
FORWARD FOR LABORATORY TESTING
PROCEED WITH WELDING
ACCEPTED
REJECTED
RECOMMEND REPARATIVE ACTION FOR DAY'S WORK
VISUAL INSPECTION
VACUUM/PRESSURE TESTING
FIELD TESTED 1 SAMPLE (per quantity)
ACCEPTED
REJECTED
REPAIR DEFECTS
ACCEPTED
REJECTED
REPAIR DEFECTS
ACCEPTED
REJECTED
REPARATIVE ACTION TO SE
FORWARD SAMPLE TO GUNDLE LAB QC
ACCEPTED
REJECTED
REPARATIVE ACTION TO SEAM

C A L C U L A T I O N S

BOLIVAR SANITARY LANDFILL

PHASE I - TRENCHING OPERATION

A. The Bolivar Landfill is currently disposing of approximately 55,000 cubic yards of solid waste each year.

B. On an average day, the landfill will accept approximately 150 cubic yards of solid waste (55,000/365).

C. As shown on Sheet 4 of the plans, an area of 570,000 square feet will be utilized for trenching operations.

D. As shown in Sheet 7 of the plans, the dimensions of a typical daily cell (excluding cover) are 20 feet wide by 20.25 feet long by 10 feet high (150 cubic yards).

E. Also, as shown on Sheet 7 of the plans, the daily requirement for cover is 29.63 cubic yards.

F. Each day, 150 cubic yards of solid waste are disposed of and 29.63 cubic yards of earth are used for cover. Therefore, the site will be 83.5% compacted solid waste (150/179.63) and 16.5% earth.

G. From C. above, an area of 570,000 square feet is to be utilized for trenching. Using an average depth of cut = 11.2 feet, the total available volume of the trenching phase = 6,384,000 cubic feet = 236,440 cubic yards.

H. From F. above, 16.5% of the volume is required for cover (daily & intermediate), therefore 39,010 cubic yards of earth are dedicated for cover.

I. The total volume which can be utilized to dispose of solid waste is 197,430 cubic yards.

J. From A. above, the landfill will accept 55,000 cubic yards of solid waste each year. Therefore, the total life of the trenching phase should be approximately 3.59 years (197,430/55,000).

K. The trenching operation as described should require approximately 3.6 acres per year.

L. It is estimated that 348,720 cubic yards of earth will be available for use in the fill operations upon completion of the trenching phase (75% theoretical).

PHASE II - AREA FILL OPERATION

A. The Bolivar Landfill is currently disposing of 55,000 cubic yards of solid waste each year.

B. On an average day, the landfill will accept approximately 150 cubic yards of solid waste (55,000/365).

C. As shown on Sheet 4 of the Plans, an area of 1,069,000 square feet will utilize 1,718,180 cubic yards of available volume.

D. As shown on Sheet 7 of the Plans, the dimensions of a typical daily cell (excluding cover) are 20 feet wide by 20.25 feet long by 10 feet high (150 cubic yards).

E. Also, as shown on Sheet 7, the daily requirement for cover is 29.8 cubic yards.

F. Each day, 150 cubic yards of solid waste are disposed of and 29.8 cubic yards of earth are used for cover. Therefore, the site will be 83.5% compacted solid waste (150/179.63) and 16.5% earth.

G. From F. above, 16.5% of the volume is required for cover (daily and intermediate), therefore 285,500 cubic yards of earth are dedicated for cover.

H. The total volume which can be utilized to dispose of solid waste is 1,434,680 cubic yards.

I. From A. above, the landfill will accept 55,000 cubic yards of solid waste each year. Therefore, the total life of the area fill phase should be approximately 26.09 years (1,434,680/55,000).

J. The area fill operation as described should require approximately 3.40 acres per year (excluding side slopes), assuming 10 feet height of cells.

K. Additional earth is required to build the earth berms. At final grade there will be approximately 28,400 linear feet of berm constructed. With a cross-sectional area of 250 square feet, 262,960 cubic yards of earth will be required.

L. For final cover of the landfill, 79,190 cubic yards will be required to complete the three feet minimum cover.

M. An approximate total of 625,650 cubic yards of earth are required to complete all phases in the fill operation. With an excess of 348,720 cubic yards of earth from the trenching

operations available, a shortage of 276,930 cubic yards remains. As the landfill reaches capacity, the City will need to make provisions to import acceptable cover material.

N. The total life of the site based on current usage is calculated to be approximately 30 years. For purposes of allowing for population increases and safety factors, a life of approximately 15 years is anticipated.

PHASE III - DRAINAGE CALCULATIONS

Perimeter drainage to prevent run-on from off-site on to Landfill limits.

Calculation drainage pipe sizes for v piping starting at east property line (Catch Basin 1) to south property line (Catch Basin 2).

Size piping between Catch Basins 1 and 2.

Drainage Area = 12 acres

Calculate Tc Try $T = 0.42\ (CnL)\ 0.8/\ P_2\ SW\ o.4) E_Q 1$

P 2yr 24hr = 4.08

S = 36'/900' = 0.04

n = 0.45

From EQ1, t= 92 mins use tc = 30 minutes

For Tc = 30 minutes, 100 yr, I = 4.8 in/hr
C = 0.40
A = 12 acres

Q_1 = CIA = 23 cfs

For piping from Catch Basin 2 to outfall
Drainage Area = 49 acres
Tc = 30 minutes I = 48 in/hr
C = 0.40

Q_2 = CIA = 94 cfs

Size culvert pipe sizes
from Catch Basins 1 to 2

Q = 100 yrs = 23 cfs

$Q = 1.49/n\ (A)(r_H)^{\wedge}\ 2/3\ \ s$

Try 30" rcp @ 0.004 slope $A = 4.9087\ in^2$
$r_H = 0.625$

$Q = (1.49/0.013)(4.9087)(0.625)^{2/3}\ 0.004$

$Q = 26$ cfs

30" rcp is acceptable

From Catch Basin 2 to outfall
Q from CB 1 to 2 - 23 cfs

Q from Area into CB 2 = 94 cfs

Q = 117 cfs

Try 48" RCP @ 0.09 slope $A = 12.5664$ in ^{2}

$r_H = 1$

Q = 137 cFs

48" RCP is acceptable

Design ditches to capture runoff from Landfill to take to pond.

Figure I shows the 25-year 24 hour rainfall to be approximately 6.3 inches for this area.

Figure II shows the peak discharge for 19 acres and 24-hour runoff of 6.3 inches to be 50 cfs. (19 acres is the maximum acres either ditch will be responsible for)

Both ditches will be designed to carry the peak runoff rate of 50 cfs.

Ditch Design $v = 1.49/n\ (r_H)^{2/3}\ S^{1/2}$

$n = 0.027$

$S = 0.05$

$Q = VA = 50$ cfs

Figure III shows ditch detail

$A = 8\ ft^2$

$p = 22.3246$

$V = 6.2$ ft/sec

$Q = VA = 50$ cfs

ditches have enough capacity to carry required design.

PHASE IV - POND CALCULATIONS

A. Assume sediment loss will be 1.0 inch over the site (37 acres).

B. Volume of sediment will be 134,310 cubic feet.

C. The bottom area of the pond (elevation 415.00) has an area of approximately 97,000 square feet. The water/sediment depth is 1.5 feet which equals a volume of 134,000 cubic feet. Sediment should be removed if or when it reaches 30% of the pond capacity (elevation 418.75).

D. The pond will have a spillway at Elevation 414.00. It will be 45 feet wide with 3:1 side slopes.

E. The capacity of the sediment pond is 1,101,000 cubic feet at Elevation 424.00.

F. The volume of a 25 year 24 hour storm is 850,000 cubic feet (6.3 inches of rainfall over 37 acres).

G. The volume of a 100 year 24 hour storm is 1,034,000 cubic feet (7.7 inches of rainfall over 37 acres).

H. Pond can retain a 100 year 24-hour storm. However, the spillway can pass this storm at a velocity of approximately 3.7 fps down a 3:1 slope.

FIGURE I

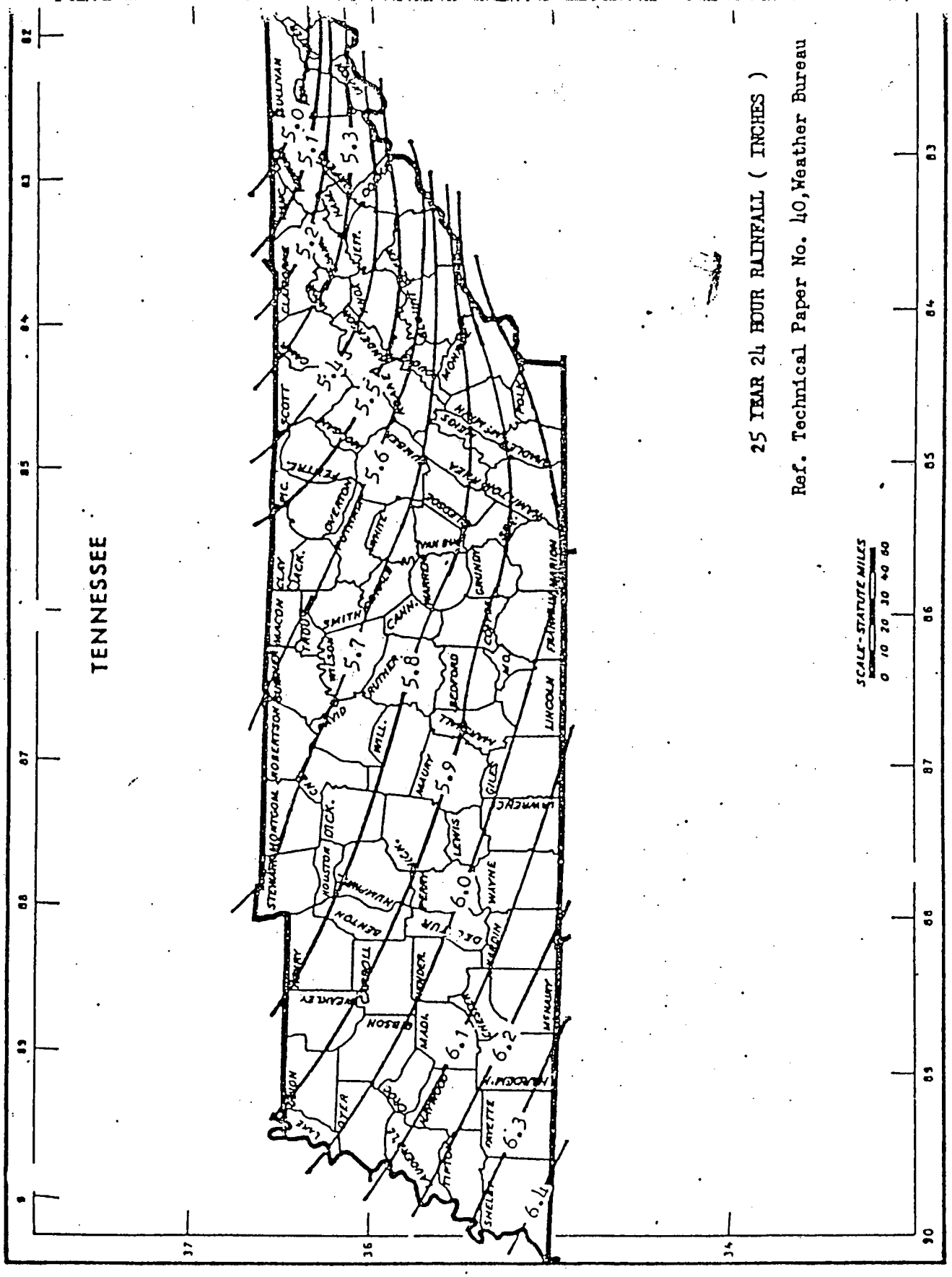
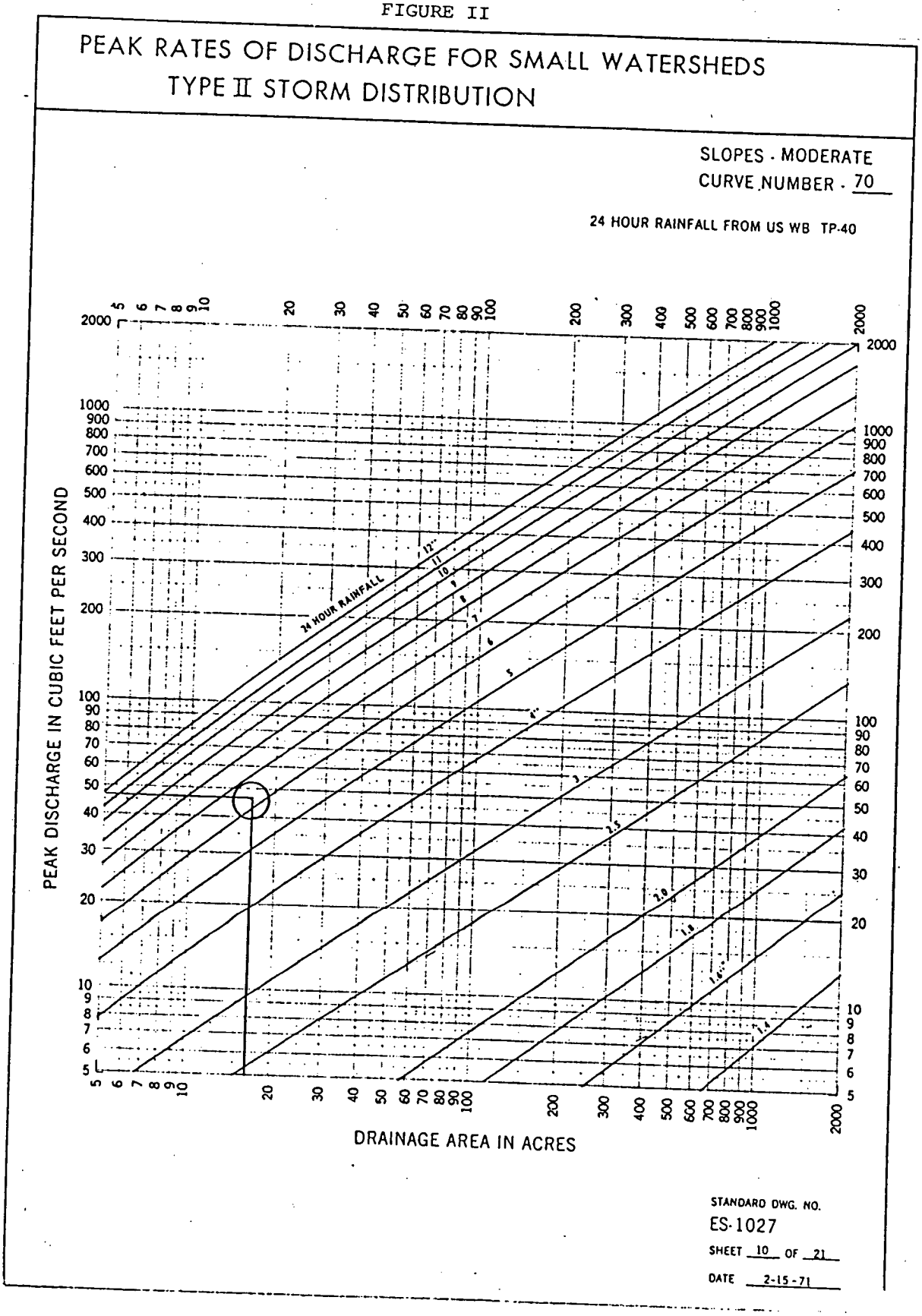
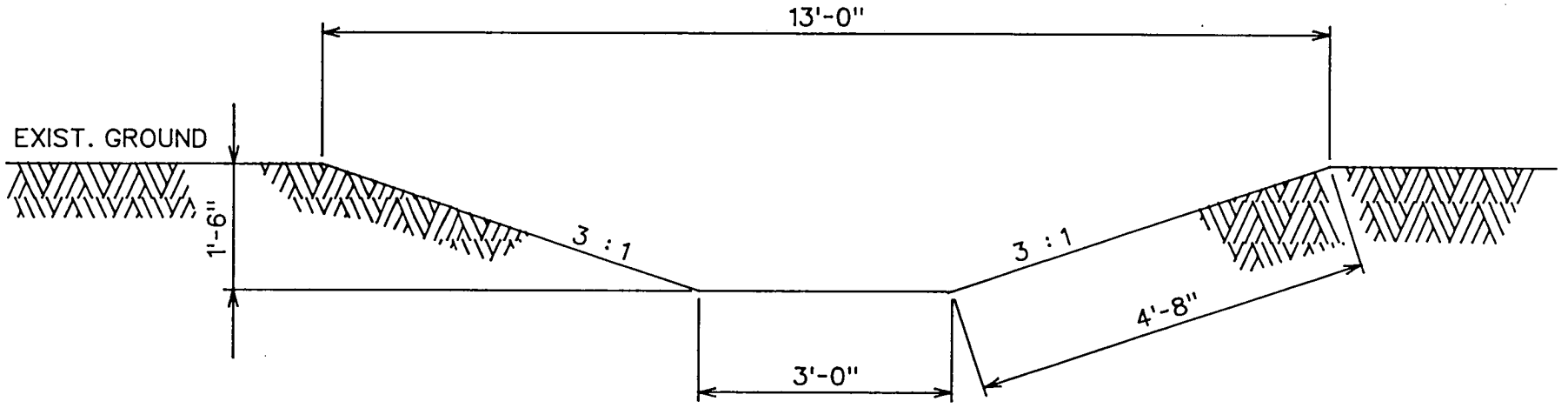

TENNESSEE
25 YEAR 24 HOUR RAINFALL (INCHES)
Ref. Technical Paper No. 40, Weather Bureau
SCALE - STATUTE MILES
0 10 20 30 40 50
5.0
5.1
5.3
5.2
5.4
5.5
5.6
5.7
5.8
5.9
6.0
6.1
6.2
6.3
6.4

FIGURE II


PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE II STORM DISTRIBUTION
SLOPES - MODERATE
CURVE NUMBER - 70
24 HOUR RAINFALL FROM US WB TP-40
PEAK DISCHARGE IN CUBIC FEET PER SECOND
DRAINAGE AREA IN ACRES
24 HOUR RAINFALL
STANDARD DWG. NO.
ES-1027
SHEET 10 OF 21
DATE 2-15-71



DITCH DETAIL

SCALE :½" -1'-0"

FIGURE 3

BOLIVAR/HARDEMAN COUNTY
SANITARY LANDFILL

Closure/Post Closure Plan

I. INTRODUCTION

INTRODUCTION

A. Facility Description

The Bolivar Sanitary Landfill will be a Class I facility and is located just west of the Bolivar City Limits, approximately 2,500 feet north of Highway 64 off Walton Lane.

The landfill will be approximately 25 acres. The fill progression will implement two operations. Initially, the area will develop with trenches cut to a maximum depth of eight feet. Once the landfill is filled back to original grade, filling operations will continue above the completed trench in cell layers of ten feet approximate heights.

B. Operational History

The current Bolivar Sanitary Landfill was issued a State permit on March 1, 1988.

To date, the landfill has experienced no significant operational problems. The landfill serves Hardeman County residents and commercial/industrial establishments. No hazardous or special wastes are accepted at the landfill.

The proposed landfill will utilize a separate portion of the current site.

C. Expected Year of Closure

The proposed Bolivar Sanitary Landfill has an expected life of twenty years. As such, the anticipated year of closure is 2012.

D. Facility Contact

Fred F. Kessler
Bolivar City Administrator
115 North Washington Street
Bolivar, Tennessee 38008

901/658-2020

II. FACILITY CLOSURE

FACILITY CLOSURE

A. Partial Closure

If the proposed Bolivar Sanitary Landfill would need to be closed for any reason prior to its intended completion date, the following steps would be implemented:

1. The Division of Solid Waste Management would be notified at least sixty days prior to closure.

2. Revised drawings would be submitted to the Division of Solid Waste Management to show:

   a. Contours
   b. Drainage
   c. Leachate Collection
   d. Methane Collection
   e. Other steps as requested by the Division of Solid Waste Management

3. Vegetative cover would be established.

4. Final cover and final grading would be performed.

5. Borrow areas and other disturbed areas would be stabilized.

6. The drainage system of the landfill would be stabilized.

7. If not already performed, the leachate handling system would be completed.

8. The methane gas collection system, including vents, would be installed.

9. The groundwater monitoring system as described in the post closure utilities would be implemented immediately.

10. A certificate of closure would be obtained from the Division of Solid Waste Management.

B. Complete Closure Steps

1. Final Cover

The final cover will be documented to establish compliance with standards of 3 feet cover thickness and permeability of 1 x 10-7 cm/sec. for two feet as follows:

The borrow area will be tested prior to excavation and compacting on landfill. The permeability will be lab tested and grain size analyzed for suitability. This testing will be periodically repeated to insure the borrow area remains consistent with the Standards.

Once the fill is placed and compacted, additional permeability field tests and density tests will be performed. Depth of the final cover will be checked with hand augers.

This work will be monitored by geotechnical engineers experienced in closure operations and follow the proposed testing procedures as recommended by the Tennessee Division of Solid Waste Management listed on the following page.

Lloyd Bell, with the City of Bolivar, is the person responsible with coordinating the testing and record keeping. These records will be kept at Bolivar City Hall in the Office of the City Administrator and will be sent to the Jackson office of the Division of Solid Waste Management. In addition, the services of a Consulting Engineer may be utilized to assist the City/County during closure.

Currently, the Bolivar/Hardeman County Landfill is using the services of PSI and CML Laboratories for its soil testing program.

CONSTRUCTION QUALITY ASSURANCE (CQA)

The following list represents the required minimum number of tests to be performed on soils to determine their suitability as source materials for clay liner and/or final cover construction.

Parameter	Test Frequency	Test Method
Atterberg Limits	1/5000 cubic yards	ASTM D4318
Grain Size	1/5000 cubic yards	ASTM D422-63
Moisture-Density	1/5000 cubic yards or 1/soil change	ASTM D698 ASTM D1557
Permeability	1/each soil type	ASTM D5084

The following list presents the required minimum number of soil tests to be utilized for monitoring the construction of clay liners.

Parameter	Test Frequency	Test Method
Field Density	5/Acre/Lift	ASTM D2922 Nuclear Density
Field Density	1/Acre/Lift	ASTM D1556 Sand Cone
Field Moisture	5/Acre/Lift	ASTM D3017 Nuclear Density
Field Moisture	1/Acre/Lift	ASTM D2216 Oven Dry
Permeability	1/3 Acres/Lift or 1/Soil Change	ASTM D5084

2. Drainage System

The drainage system in place is designed based on the 25-year, 24-hour storm (approximately 6.3 inches of rainfall). The drainage system will continue to be monitored and appropriate measures will be taken for any corrective action. Mr. Lloyd Bell is responsible for maintaining the drainage system at the Bolivar/Hardeman County Landfill.

3. Vegetative Cover

Mr. Lloyd Bell will be responsible for establishing and maintaining the vegetative cover for the proposed landfill. The products and execution of the products required is as follows:

a. Products

(1) Soil Amendments

(a) Lime: Natural dolomitic limestone containing not less than 85 percent of total carbonates with a minimum of 30 percent magnesium carbonates, ground so that not less than 90 percent passes a 10-mesh sieve and not less than 50 percent passes a 100-mesh sieve.

(b) Commercial Fertilizer: Complete fertilizer of neutral character, with some elements derived from organic sources and containing the following percentages of available plant nutrients:

i. For lawns, provide fertilizer with percentage of nitrogen required to provide not less than one pound of actual nitrogen per 1,000 square feet of lawn area and not less than 4 percent phosphoric acid and 2 percent potassium. Provide nitrogen in a form that will be available to the lawn during initial period of growth; at least 50 percent of nitrogen is to be organic form.

(2) Grass Materials

Grass Seed: Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America. Provide seed

mixture composed of grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, as specified below:

Kentucky 31 Fescue 75%
Creeping Red Fescue ... 10%
Italian Rye Grass 10%
Dutch White Clover 5%

(3) Miscellaneous Materials

(a) Anti-Erosion Mulch: Provide clean, seed-free salt hay or threshed straw of wheat, rye, oats, or barley.

b. Execution

(1) Preparation for Planting

(a) Loosen topsoil to a minimum depth of four inches. Remove stones measuring over 1-1/2 inches in any dimension. Remove sticks, roots, rubbish, and other extraneous matter. Limit preparation to areas which will be planted promptly after preparation.

Add specified soil amendments and mix thoroughly into upper four inches of top soil.

(b) Fine grade areas to smooth, even surface with loose, uniformly fine texture. Roll, rake, and drag areas, remove ridges and fill depressions as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.

(c) Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting. Do not create a muddy soil condition.

(2) Seeding

(a) Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.

(b) Sow seed using a spreader or seeding machine. Do not seed when wind velocity

exceeds five miles per hour. Distribute seed evenly over entire area by sowing equal quantity in two directions at right angles to each other.

(c) Sow not less than four pounds per 1,000 square feet of seed mix specified above.

(d) Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with a fine spray.

(e) Protect seeded slopes against erosion with erosion netting or other methods acceptable to the Engineer.

(f) Protect seeded areas against erosion by spreading specified lawn mulch after completion of seeding operations. Spread uniformly to form a continuous blanket not less than 1-1/2 inches loose measurement over seeded areas.

4. Leachate Collection

Leachate collection will be accomplished with a series of perforated and non-perforated PVC piping below the landfill and collected and monitored in a precast concrete manhole. The leachate will be hauled offsite to the Bolivar wastewater treatment plant to be treated. Mr. Lloyd Bell will be responsible for monitoring and transporting the leachate to the Bolivar Wastewater Treatment Facility. Mr. Sammy Webster, Chief Operator of the Bolivar Wastewater Treatment Facility will be responsible for treating the leachate generated by the landfill.

5. Gas Collection

As part of closure of the facility, a gas collection and venting network will be installed prior to final cover. The gas collection network consists of a relatively pourous layer which facilitates gas migration and collection. Vents will be spaced one per acre over the area of closure.

During closure of the facility, Mr. Lloyd Bell will be responsible for installation of the gas collection

system. In addition, Mr. Bell will be responsible for monitoring methane gas production at the landfill.

6. Closure Scheduling

o o Landfill reaches capacity	Jun	2012
o o Final Cover Placed: 2 feet of clay and 1 foot of topsoil	Jul - Sep	2012
o o Establish vegetative growth	Aug - Sep	2012

It is noted that partial closure of the facility is not anticipated. However, should the need arise for partial closure, it will be performed in accordance with Paragraph A (Partial Closure) of this manual.

7. Closure of Active and Future Active Portions of Facility

Currently, Bolivar/Hardeman County is operating a sanitary landfill which was approved in 1988. A closure/post closure plan submitted to the Division of Solid Waste Management in December 1991 addressed the active and future active portions of the facility currently in use. This closure plan specifically addresses the proposed Bolivar/Hardeman County facility. As such, there are no presently active portions on this site. However, once permitted and in service, the future active portions will receive closure care per this manual.

III.

POST CLOSURE ACTIVITIES

POST CLOSURE ACTIVITIES

A. Duration of Post Closure Activities

As the Bolivar/Hardeman County Landfill would be a Class I facility, post closure care and financial assurance must continue for a period of 30 years after completion of the closure of the facility.

B. Groundwater Monitoring System

The groundwater monitoring wells and surface water monitoring point are to be installed in locations as shown on Page 3 of the Drawings.

1. The borings will be drilled using 3-1/4 inch inside diameter hollow stem augers.

2. The monitoring wells will be two inches in diameter and will be as deep as directed by the Tennessee Division of Solid Waste Management (50'-100', dependent upon the ground elevation of the well location). The wells are PVC construction with a 10-foot (No. 10 slot) screen. Granular materials have been added surrounding the screen to a height of two feet above the screened portion of the wells. Next, a layer of bentonite pellets was placed over the sand as a moisture barrier. The remainder of the bore holes will be grouted to prevent vertical seepage from the surface. Upon completion, a flush-mount eight-inch cap will be installed at each well location.

C. Detection Monitoring Program

The following information details the sampling intervals and required parameters. Each well and surface water location must be sampled and analyzed on a quarterly schedule for the first year. The monitoring and sampling program will continue throughout the post closure care period unless the permit is modified in writing. All monitoring data will be submitted to the Division of Solid Waste Management's Director within 30 days after completion of the analyses.

I. Ammonia (as N)
II. Calcium
III. Chloride
IV. Iron
V. Magnesium
VI. Manganese, dissolved
VII. Nitrate (as N)

VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

Parameters establishing the ground water quality:

I. Arsenic
II. Barium
III. Cadmium
IV. Chromium
V. Cyanide
VI. Lead
VII. Mercury
VIII. Selenium
IX. Silver

All monitor wells shall be sampled and analyzed for the following parameters at least once every six months after the first year.

I. Ammonia (as N)
II. Calcium
III. Chloride
IV. Iron
V. Magnesium
VI. Manganese, dissolved
VII. Nitrate (as N)
VIII. Potassium
IX. Sodium
X. Sulfate
XI. Chemical Oxygen Demand (COD)
XII. Total Dissolved Solids (TDS)
XIII. Total Organic Carbon (TOC)
XIV. pH

All monitor wells shall be sampled and analyzed for the following parameters at least once every year after the first year unless the permit is modified to establish a different monitoring and sampling program.

Acetone
Acrolein
Acrylonitrile
Benzene
Bromochloromethane
Bromodichloromethane
4-Bromofluorobenzene
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
1,4-Difluorobenzene
Ethanol
Ethylbenzene
Ethyl Mechacrylate
2-Hexanone

Bromoform	Iodomethane
Bromomethane	Methylene Chloride
2-Butanone (Methyl Ethyl Ketone)	4-Methyl-2-Pentanone
Carbon Disulfide	1,1-Dichloroethene
Carbon Tetrachloride	Trans-1,2-Dichloroethene
Chlorobenzene	Styrene
Chlorodibromomethane	1,1,2,2- Tetrachloroethane
Chloroethane	Toluene
2-Chloroethyl Vinyl Ether	1,1,1-Trichloroethane
Chloroform	1,1,2-Trichloroethane
Chloromethane	Trichloroethane
Dibromomethane	Trichlorofluoromethane
1,4-Dichloro-2-Butane	1,2,3-Trichloropropane
Dichlorodifluoromethane	Vinyl Acetate
1,1-Dichlorcethane	Vinyl Chloride

D. Notice in Property Deed

The City of Bolivar/Hardeman County ensures that within 90 days of completion of final closu8re of the facility and prior to sale or lease of the property on which the facility is located, there is recorded, in accordance with state law, a notation on the deed to thye property or on some other instrument which is normally examined during title search that will in perpetuity notify any person conducting a title search that the land has been used as a disposal facility.

E. Planned Use of Property Dluring Post-Closure Period

At the present time, the City of Bolivar/Hardeman County Landfill Committee does not have an intended use for the landfill site during the post closure care period.

F. Post Closure Care of Closed, Active, and Future Active Portions of the Facility

As this post-closure plan is for a proposed facility, there are no current closed or active areas on the site. However, post closure care will be provided for the permitted area for a period of 30 years after closure in accordance with this manual.

G. Post Closure Care Activities

1. Final Contours and Drainage System

During the 30-year post closure care period, the City of Bolivar/Hardeman County must maintain the approved final contours and drainage system of the site in order to:

a. Minimize precipitation run-on from adjacent areas onto the disposal facility or disposal facility parcel

b. Minimize erosion of cover material

c. Optimize drainage of precipitation falling on the disposal facility or disposal facility parcel

d. Provide a surface drainage system which is consistent with the surrounding area and in no way significantly adversely affects proper drainage from these adjacent lands

2. Vegetative Cover

Bolivar/Hardeman County must maintain the vegetative cover established during the closure of the facility for the 30 year post closure care period.

3. Erosion/Sedimentation Control Measures

Bolivar/Hardeman County must maintain the drainage systems, sediment pond, and all other erosion/sedimentation control devices for the 30 year post closure care period or until such time as the vegetative cover renders such maintenance unnecessary.

4. Leachate System Maintenance

Bolivar/Hardeman County must monitor, collect, transport, and treat any leachate generated at the landfill site for the duration of the post closure care period. The leachate system will be inspected on a monthly basis.

5. Gas System Maintenance

Bolivar/Hardeman County must maintain and monitor the gas collection system as installed during closure for the life of the post-closure plan. The gas vents will be monitored monthly to determine the concentration of methane gas present at the landfill site.

IV.

COST ESTIMATES

COST ESTIMATE
WORK SHEET A:
CLOSURE ACTIVITIES

1. ESTABLISHING FINAL COVER:

A.	Top-Soil	
1.	Quantity needed (yd^3)	26,500
2.	Excavation Unit Cost ($/$yd^3$)	1.33
3.	Excavation Cost (1 x 2)	35,245.00
4.	Placement/Spreading Unit Cost ($/$yd^3$)	2.65
5.	Placement Cost (1 x 4)	70.225.00
	TOTAL TOP SOIL	**$105,470.00**
B.	Landfill Cap	
1.	**On-Site Clay**	
a.	Quantity Needed (yd^3)	-0-
b.	Excavation Unit Cost ($/$yd^3$)	
c.	Excavation Cost (a x b)	
d.	Placement/Spreading Unit Cost ($/$yd^3$)	
e.	Placement Cost (a x d)	
f.	Compaction Unit Cost ($/$yd^3$)	
g.	Compaction Cost (a x f)	
	TOTAL ON-SITE CLAY	**$ -0-**
2.	**Off-Site Clay**	
a.	Quantity Needed (yd^3)	52,700
b.	Purchase Unit Cost ($/$yd^3$)	2.65
c.	Purchase Cost (a x b)	139,655.00
d.	Delivery Unit Cost ($/$yd^3$)	3.98
e.	Delivery Cost (a x d)	209,750.00
f.	Placement/Spreading Unit Cost ($/$yd^3$)	2.65
g.	Placement Cost (a x f)	139,655.00
h.	Compaction Unit Cost ($/$yd^3$)	1.33
i.	Compaction Cost (a x h)	70,100.00
	TOTAL OFF-SITE CLAY	**$559,160.00**
3.	**Quality Control/Testing of Clay**	
a.	Number of Samples to be Tested	Twenty (20)
b.	Clay Testing Unit Cost ($/sample)	1,500.00
c.	Testing Cost (a x b)	30,000.00
	TOTAL CLAY TESTING	**$ 30,000.00**

C. Synthetic Membrane

1. Quantity Needed (yd^2)	-0-
2. Purchase Unit Cost ($/$yd^2$)	
3. Purchase Cost (1 x 2)	
4. Installation Unit Cost ($/$yd^2$)	
5. Installation Cost (1 x 4)	
TOTAL SYNTHETIC MEMBRANE	**$ -0-**

D. Geotextile Filter Fabric

1. Quantity Needed (yd^2)	-0-
2. Purchase Unit Cost ($/$yd^2$)	
3. Purchase Cost (1 x 2)	
4. Installation Unit Cost ($/$yd^2$)	
5. Installation Cost (1 x 4)	
TOTAL GEOTEXTILE FILTER FABRIC	**$ -0-**

TOTAL FOR ESTABLISHING FINAL COVER: **$694,630.00**

2. ESTABLISHING VEGETATION COVER

A. Labor ($/Acre)	1,750.00
B. Seeding ($/Acre)	
C. Fertilizing ($/Acre)	
D. Mulching ($/Acre)	
E. Number of Acres	25 Ac
TOTAL FOR ESTABLISHING VEGETATION COVER	**$ 43,750.00**

3. ESTABLISHING OR COMPLETING A SYSTEM TO MINIMIZE AND CONTROL EROSION/SEDIMENTATION

A. Sediment Pond

1. Excavation/Construction ($)	
2. Materials (e.g. pipe, riprap) ($)	
TOTAL SEDIMENT POND	**$ 55,000.00**

B. Diversion Ditch

1. Construction ($)	
2. Materials ($)	
TOTAL DIVERSION DITCH	**$ 15,000.00**

C. Temporary Structures (e.g. silt fence, swales)

1. Construction ($)	2,500.00
2. Materials ($)	2,500.00
TOTAL TEMPORARY STRUCTURES	**$ 5,000.00**

TOTAL FOR ESTABLISHING OR COMPLETING A SYSTEM TO MINIMIZE AND CONTROL EROSION AND SEDIMENTATION	**$118,750.00**

4. ESTABLISHING OR COMPLETING LEACHATE COLLECTION REMOVAL, AND TREATMENT SYSTEM

A. Installation	
1. Number of Feet	1,200
2. Unit Cost ($/ft)	4.00
3. Storage Tanks ($)	1,200.00
4. Pumps ($)	-0-
TOTAL FOR ESTABLISHING OR FOR COMPLETING LEACHATE SYSTEM	**$ 6,000.00**

5. ESTABLISHING OR COMPLETING A SYSTEM TO COLLECT OR VENT GASES

A. Installation	
1. Materials (e.g., piping)	15,000.00
2. Equipment (e.g., testing)	
3. Labor (e.g., drilling)	-0-
TOTAL FOR ESTABLISHING OR FOR COMPLETING A SYSTEM TO COLLECT OR VENT GASES	**$ 15,000.00**

6. ESTABLISHING OR COMPLETING GROUNDWATER/ SURFACE WATER MONITORING SYSTEM

A. Installation	
1. Number of Wells	5
2. Drilling Cost (1 x 2)	1,500.00
3. Materials (e.g., casing)(1 x 3)	6,250.00
4. Equipment (e.g., pumps)	750.00
5. Labor	
TOTAL FOR ESTABLISHING OR COMPLETING GROUNDWATER MONITORING SYSTEM	**$ 8,500.00**

TOTAL CLOSURE COSTS: (SUM OF TOTALS FOR SECTIONS 1 THROUGH 6)	**$842,880.00**

COST ESTIMATE
WORK SHEET B:
POST CLOSURE ACTIVITIES

1.	SURVEYING INSPECTIONS TO CONFIRM FINAL GRADE AND DRAINAGE ARE MAINTAINED	
	A. Transportation	200.00
	B. Labor	1,000.00
	TOTAL FOR SURVEYING INSPECTIONS	**$ 1,200.00**
2.	MAINTAIN HEALTHY VEGETATION	
	A. Transportation	800.00
	B. Labor	7,500.00
	C. Seeding	
	D. Fertilizing	
	E. Mulching	
	F. Rodent Control	1,500.00
	G. Mowing	9,500.00
	TOTAL FOR MAINTAINING HEALTHY VEGETATION	*$ 19,300.00*
3.	MAINTAIN THE DRAINAGE FACILITIES, THE SEDIMENT PONDS AND OTHER EROSION/SEDIMENTATION CONTROL MEASURES	
	A. Transportation	500.00
	B. Labor	
	C. Cleaning Out of System	1,500.00
	D. Repair of Gullies or Rills	
	1. Soil Acquisition	
	a. Quantity (yd^3)	
	b. Purchase Unit Cost ($/$yd^3$)	
	c. Purchase Cost (a x b)	
	d. Delivery Unit Cost ($/$yd^3$)	
	e. Delivery Cost (a x d)	
	Total Soil Acquisition	**2,500.00**
	2. Placement/Spreading/Compaction	200.00
	3. Revegetation	500.00
	Total Repair of Gullies or Rills	**$ 3,200.00**
	TOTAL FOR MAINTAINING DRAINAGE	**$ 5,200.00**

4. MAINTAIN AND MONITOR THE LEACHATE COLLECTION, REMOVAL AND TREATMENT SYSTEM

A. Treatment of Leachate

1. **On-Site**		
a. Quantity (yd^3)		
b. Treatment Unit Cost ($/$yd^3$)		
c. Treatment Costs (a x b)		
d. Sewer Discharge Unit Cost ($/$yd^3$)		
e. Discharge Costs (a x d)		
TOTAL ON-SITE	**$**	**-0-**
2. **Off-Site**		
a. Quantity (yd^3)		50.00
b. Hauling Unit Cost ($/$yd^3$)		5.00
c. Hauling Cost (a x b)		250.00
d. Treatment Unit Cost ($/$yd^3$)		10.00
e. Treatment Cost (a x d)		500.00
TOTAL OFF-SITE	**$**	**750.00**

B. Maintenance of Leachate Collection System

1. Transportation		
2. Labor		
3. Repairs/Materials (e.g., below)		
a. Pumps		
b. Cleaning out System		
c. Leak Detection		
d. Other		
Total Repairs/Materials	**$**	**1,000.00**
TOTAL FOR MONITORING AND MAINTAINING LEACHATE SYSTEM	**$**	**1,750.00**

5. MAINTAIN AND MONITOR THE GAS COLLECTION OR VENTING SYSTEM

A. Transportation		
B. Labor		
C. Repairs/Materials (e.g., below)		
1. Cleaning		
2. Caps		
3. Other		
Total Repairs/Materials	**$**	**-0-**
TOTAL FOR MAINTAINING AND MONITORING GAS CONTROL SYSTEM	**$**	**-0-**

6. MAINTAIN AND MONITOR THE GROUNDWATER AND/OR SURFACE WATER MONITORING SYSTEM

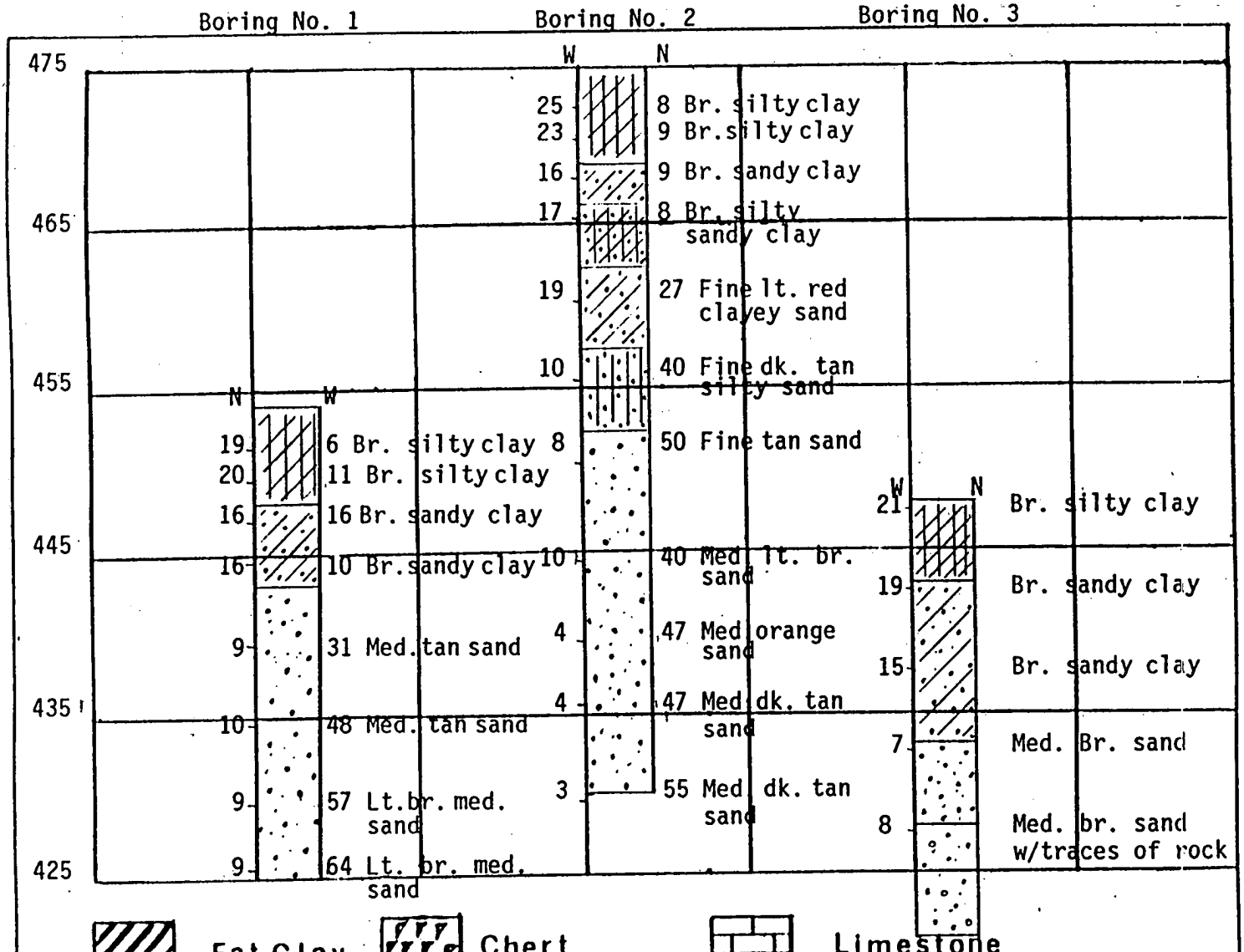
A.	Monitoring of Groundwater System	
1.	Number of Wells/Springs	Five (5)
2.	Number of Samples/Well	One (1)
3.	Unit Cost of Analysis	2,500.00
4.	Cost of Sampling + Analysis (1 x 2 x 3)	12,500.00
5.	Labor Cost per Well	250.00
6.	Labor Costs (1 x 5)	1,250.00
TOTAL MONITORING OF GROUNDWATER SYSTEM		**$ 14,000.00**
B.	Inspection & Maintenance of System	
1.	Transportation	150.00
2.	Labor	500.00
3.	Repairs/Materials	
a.	Caps	
b.	Tubing	
c.	Pumps	
d.	Well Replacement	750.00
e.	Other	
Total Repairs/Materials		**$ 750.00**
TOTAL INSPECTION AND MAINTENANCE OF SYSTEM		**$ 1,400.00**
TOTAL FOR MAINTAINING AND MONITORING THE GROUNDWATER SYSTEMS		**$ 15,400.00**

TOTAL POST CLOSURE COSTS

ANNUAL BASIS: (SUM OF TOTALS FOR SECTIONS 1 THROUGH 6)	**$ 42,850.00**
INFLATION RATE UTILIZED	**5%**
30-YEAR BASIS (ANNUAL COST)(INFLATION RATE)(30 YEARS)	**$185,200.00**

BY ..... DATE ..... SUBJECT BOLIVAR LANDFILL SHEET NO. ..... OF .....

CHKD. BY ..... DATE ..... BOLIVAR, TENNESSEE JOB NO. .....

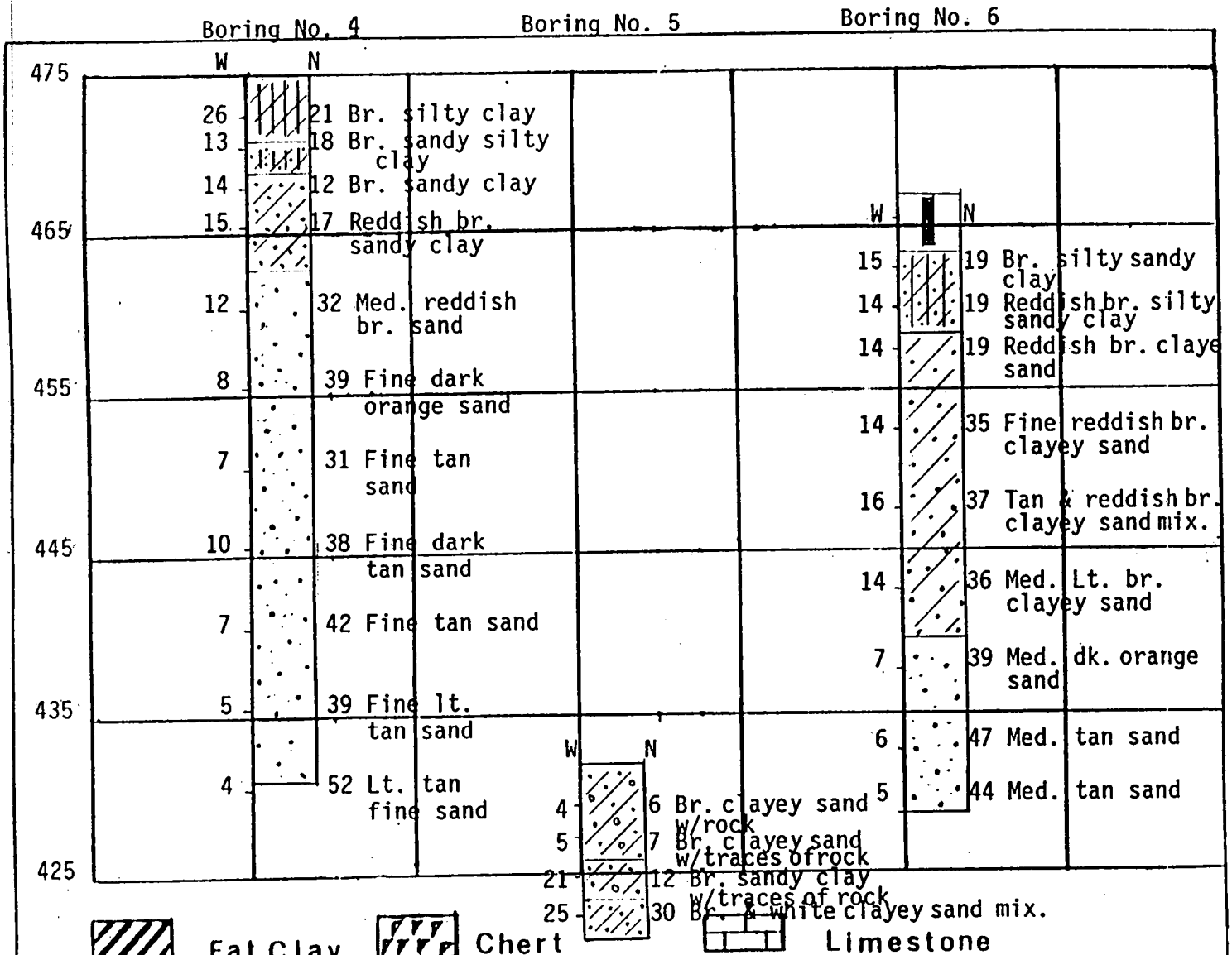


	Fat Clay		Chert		Limestone
	Clay		Volumetric Sample		Fill
	Silt		Water Loss		Water Level
	Sand	90%	Core Loss	w	Moisture Content
	Gravel	R	Refusal	N	Blows Per Foot
	Organic Matter			P	Penetrometer (TSF)
	Shale				GRAPHICAL LOGS
	Sandstone				FIGURE 2

NOTE: Stratum boundaries shown between boring locations are for illustrative purposes only. No guarantee is made or implied regarding actual stratum boundaries.

BY ..... DATE ..... SUBJECT BOLIVAR LANDFILL SHEET NO. ..... OF .....

CHKD. BY ..... DATE ..... BOLIVAR, TENNESSEE JOB NO. .....



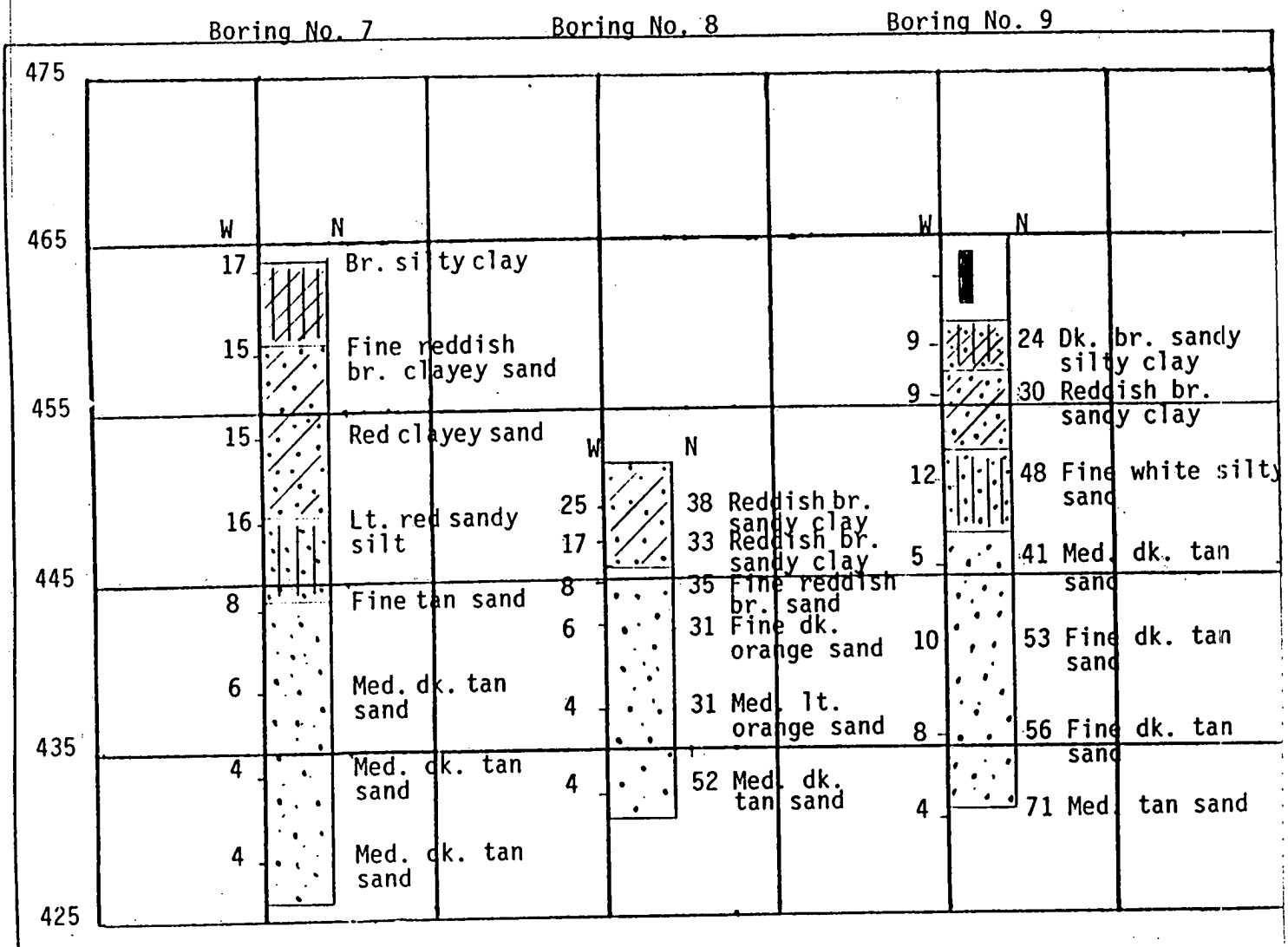
GRAPHICAL LOGS

NOTE: Stratum boundaries shown between boring locations are for illustrative purposes only. No guarantee is made or implied regarding actual stratum boundaries.

FIGURE 2

BY ..... DATE ..... SUBJECT BOLIVAR LANDFILL SHEET NO. ..... OF .....

CHKD. BY ..... DATE ..... BOLIVAR, TENNESSEE JOB NO .....



Fat Clay

Clay

Silt

Sand

Gravel

Organic Matter

Shale

Sandstone

Chert

Volumetric Sample

Water Loss

90% Core Loss

R Refusal

Limestone

Fill

Water Level

w Moisture Content

N Blows Per Foot

P Penetrometer (TSF)

GRAPHICAL LOGS

NOTE: Stratum boundaries shown between boring locations are for illustrative purposes only. No guarantee is made or implied regarding actual stratum boundaries.

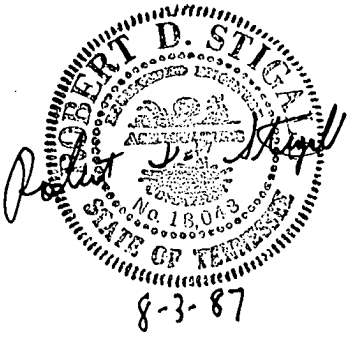
FIGURE 2

35-6-2

SOLID WASTE DISPOSAL
FEASIBILITY STUDY
FOR THE
CITY OF BOLIVAR, TENNESSEE

August 1987

SNL 351010223



GRW ENGINEERS, INC.
179 Belle Forest Circle
Nashville TN 37221

SOLID WASTE DISPOSAL - FEASIBILITY STUDY
CITY OF BOLIVAR, TENNESSEE

Table of Contents

INTRODUCTION

This feasibility report is submitted in compliance with Tennessee regulations governing solid waste processing and disposal.

Solid waste collection and disposal are increasingly important aspects of societal life. Population growths coupled with increasing use of throw-away packaging and limited design life of every day products and appliances are escolating the growth rate of solid waste.

Bolivar, Tennessee has a sanitary landfill that has been in operation since 1975. This 21 acre landfill is facing depletion. Hardeman County has no landfill of its own but utilizes the Bolivar facility.

Prudent management requires that a future means of disposal be identified and planned prior to exhaustion of the existing landfill. Alternatives have been examined in this report to determine the cost effective, acceptable method of solid waste disposal for the City of Bolivar.

BACKGROUND INFORMATION

GENERAL TOPOGRAPHY

Hardeman County, Tennessee is located in southwestern Tennessee and is bounded to the north by Madison County, to the east by Chester and McNairy Counties, to the west by Fayette County, and to the south by Mississippi. The total land area is approximately 690 square miles.

Elevations throughout the county vary from 325 msl in the Hatchie Bottom to 620 msl. The county is characterized by gently rolling to hilly topography dissected by many small streams. The principal of these is the Hatchie River which flows in a southeasterly direction. No topographic features exist which would substantially influence solid waste collection or disposal. The elevation at Bolivar is about 450 feet mean sea level (see Exhibit A).

POLITICAL ENTITIES

Two political entities are directly involved with the proposed solid waste disposal system -- Hardeman County and the City of Bolivar -- however several towns plan to use the facility once a permit has been issued. Grand Junction, Hickory Valley, Hornsby, Middleton, Saulsbury, Silerton, Toone, and Whiteville use the existing facility at this time.

The responsible officials of the proposed Bolivar Sanitary Landfill are Mayor Harold D. Fitts of Bolivar and Mr. Don Clifft, County Executive of Hardeman County.

POPULATION

The population history of Bolivar and Hardeman County is shown below:

	Hardeman County Total		Bolivar		Rural	
Year	Pop.	% Change	Pop.	% Change	Pop.	% Change
1960(Act)	21,517	-0-	3,338	-0-	18,179	-0-
1970(Act)	22,435	+ 4.27	6,674	+99.94	15,761	-13.30
1980(Act)	23,873	+ 6.41	6,770	+ 1.44	17,103	+ 8.51
1990(Est)	25,148	+ 5.34	7,132	+ 5.34	18,016	+ 5.34
2000(Est)	26,491	+ 5.34	7,513	+ 5.34	18,978	+ 5.34

Hardeman County has shown a steady continuous growth and even more growth is anticipated with increasingly available utilities in the area as well as industrial growth in Bolivar. A population density map of Hardeman County is shown as Exhibit B.

TRANSPORTATION

Hardeman County is served by all major modes of transportation with the exception of a significant water way (see Exhibit C). The area has an extensive system of roads consisting of U.S. Highway 64, State Highways 15, 18, 57, 100, 125, and 138, as well as an excellent system of county roads. Interstate 40 is approximately 12 miles north of Hardeman County on Tennessee State Route 138. One railroad runs through Hardeman County. The Southern Railway runs in an east/west direction along the southern edge of the country from Grand Junction to Pocahontas. Hardeman County owns and operates Bolivar-Hardeman County Airport about four miles southwest of Bolivar on Tennessee State Route 18.

MAJOR WASTE PRODUCERS

The major waste producers in Hardeman County are Western State Hospital, Harman Industries, Armira Leather Company (all of Bolivar) and Sequentia of Grand Junction (see Exhibit D). None of these produce waste which is hazardous or is difficult to handle.

EXISTING DISPOSAL FACILITIES

EXISTING DISPOSAL FACILITIES

Bolivar is currently operating an approved solid waste disposal site, Registration No. 110. It is anticipated that the existing site will be exhausted in the spring of 1988. The landfill is on a 21 acre site and was designed for 14 vertical feet of waste. Estimated annual amount of waste processed at this facility is approximately 35,000 cubic yards. The City of Bolivar owns the property involved with the site and pays the operational costs incurred with the landfill. Other towns or entities utilizing the facility contribute financially also.

One man is currently employed full time at this existing facility, and another is employed parttime. Two bulldozers are utilized on this site.

COLLECTION SERVICES

The City of Bolivar offers collection services to those people living within the Bolivar City Limits. Six full time employees and two compactor trucks are required for this service. All collected wastes are disposed of in the existing landfill.

ENVIRONMENTAL EFFECTS OF PRESENT SYSTEM

The current landfill in operation is environmentally acceptable. Legal and environmental problems would arise when the existing landfill's capacity is reached if no alternative site is available. The City would not legally be able to collect and haul city wastes without an approved disposal system, and conceivably garbage could accumulate on city streets and in residents' yards.

ANTICIPATED FUTURE DEVELOPMENTS AFFECTING SOLID WASTES

No future developments or changes are expected which would substantially affect volume or type of solid wastes generated in Bolivar. At present, volumes are fairly stable and no significant seasonal variations are expected.

ALTERNATIVES

Solid waste disposal alternatives available to Bolivar or any municipality are governed by many parameters, some of which are (1) location of the municipality, (2) availability of land, (3) volume of waste generated, (4) location of waste generators, and (5) area land use patterns.

Solid waste in the United States typically has been disposed of by the following methods:

1. Hog feeding,
2. Incineration,
3. Open dumps,
4. Dumping at sea,
5. Grinding and addition to sewage,
6. Sanitary landfill, and
7. Composting

Hog feeding is unacceptable for Bolivar as this method promotes fly and rat breeding and the spread of diseases. It is also unacceptable from a regulatory standpoint as the Division of Solid Waste Management will not approve this method of disposal.

Incineration can be an environmentally acceptable method of solid waste disposal. However, incinerators require a high capital investment and are expensive to operate and maintain. A conventional incinerator fueled by waste normally reaches temperatures of 1300 to 1500 degrees Fahrenheit. Metals and glass are scorched but normally not melted or burned. The unburned materials and ash are 20 percent by volume of the original and must be handled further. High temperature incinerators use supplemental fuels, oil or pulverized coal, to reach 3000° F. The end solid product is a fine ash. Metal and glass have been oxidized, melted, vaporized, and

recondensed to a fine frit. This has by-product use as fill and cover, masonry aggregate, and road subgrade material.

As conventional incinerators result in excess materials to be disposed of, only a high temperature incinerator could be considered for Bolivar. Figure 1 shows the estimated costs for the City of Bolivar to operate a high temperature incinerator.

Open dumps and dumping at sea unfortunately has been done in various locations. However increased environmental awareness and legislation has prohibited both methods.

Grinding and addition to sewage is not acceptable to Bolivar as only garbage can be ground. In addition, the sewage plants which serve the City of Bolivar are not designed to handle such wastes.

A sanitary landfill is an acceptable method for solid waste disposal for the Bolivar area. Sanitary landfills require relatively small initial investments and moderate operating costs. Figure 2 shows the estimated costs for the City of Bolivar to operate a sanitary land fill.

Composting can be a suitable solid waste alternative in certain circumstances. However, the method requires disposal of non-compostable items which is unacceptable to the City of Bolivar.

As shown in Figures 1 and 2, the estimated cost of Bolivar operating an incinerator is $8.17 per ton while the estimated costs per ton of operating a sanitary landfill is $4.96.

It is therefore recommended that the City of Bolivar pursue a permit for a sanitary landfill as an annual savings of $56,200 (17,500 tons/year) would be realized as compared to an incinerator.

FIGURE 1
BOLIVAR SOLID WASTE DISPOSAL FEASIBILITY STUDY
INCINERATION COSTS

I. INITIAL COSTS		COST
(1)	INCINERATOR	$336,000
(2)	SITE PREPARATION	25,000
(3)	BUILDING	25,000
(4)	DUMP TRUCK	40,000
	TOTAL INITIAL COSTS	$426,000

II. ANNUAL OPERATING EXPENSES		
(1)	LABOR	$26,400
(2)	BENEFITS	6,600
(3)	UTILITIES AND FUEL	32,000
(4)	MAINTENANCE	16,500
(5)	DEPRECIATION OF INITIAL COSTS	21,300
	TOTAL ANNUAL OPERATING EXPENSES	$102,800

ANNUAL PAYMENT ON $426,000 FOR 20 YEARS AT 7% IS $40,200
FROM ABOVE, TOTAL ANNUAL OPERATION EXPENSES ARE $102,800

TOTAL ANNUAL COST OF INCINERATION PROCESS IS $143,000

BASED ON 17,500 TONS OF WASTE PER YEAR, COST PER TON IS $8.17 PER TON

FIGURE 2
BOLIVAR SOLID WASTE DISPOSAL FEASIBILITY STUDY
LANDFILL COSTS

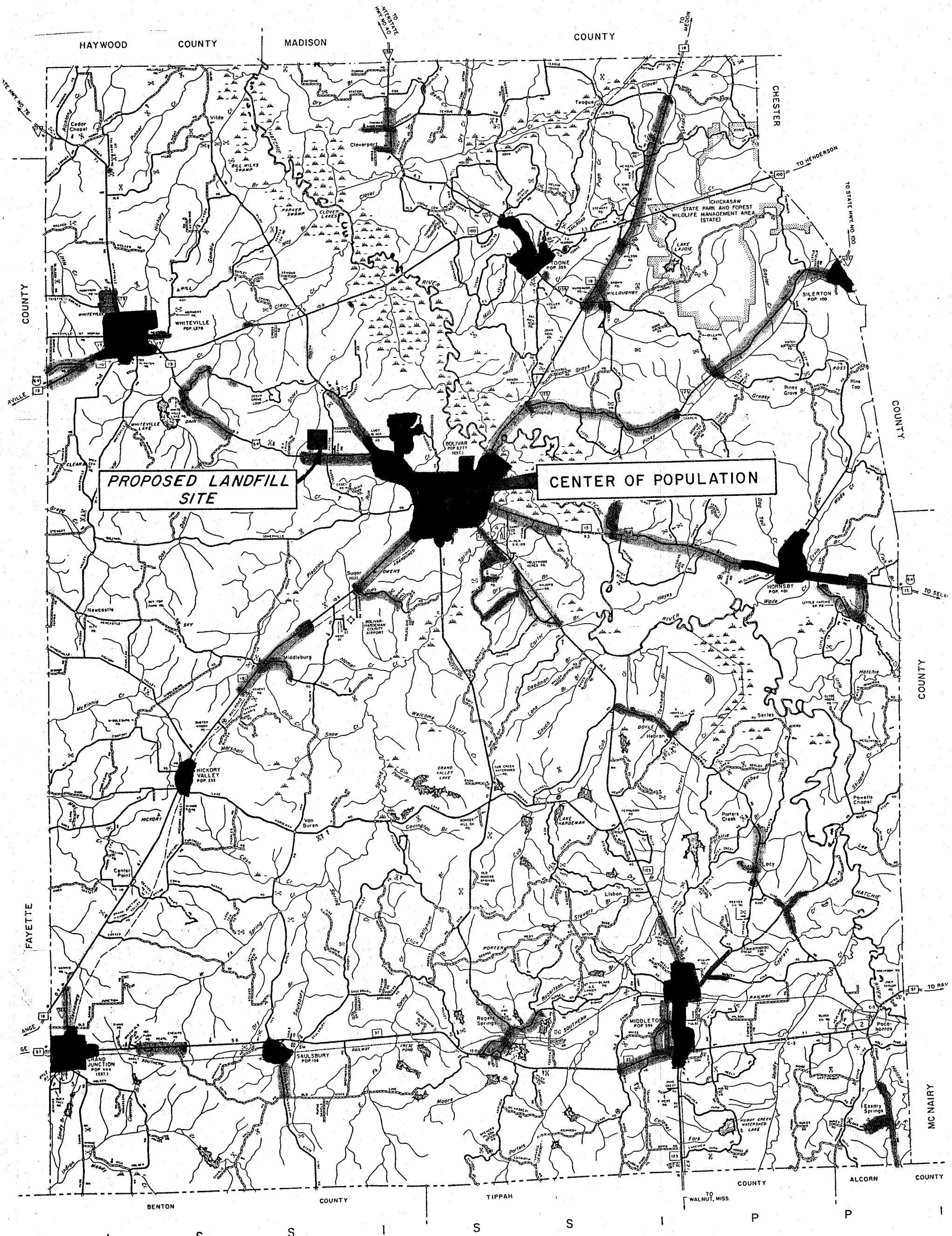
I. INITIAL COSTS		COST
(1)	LAND	$120,000
(2)	HEAVY EQUIPMENT	175,000
(3)	ACCESS ROAD	15,000
	TOTAL INITIAL COSTS	$310,000

II. ANNUAL OPERATING EXPENSES		
(1)	LABOR	$17,600
(2)	BENEFITS	4,400
(3)	FUEL	12,000
(4)	MAINTENANCE	8,000
(5)	DEPRECIATION OF INITIAL COSTS	15,500
	TOTAL ANNUAL OPERATING EXPENSES	$57,500

ANNUAL PAYMENT ON $310,000 FOR 20 YEARS AT 7% IS $29,300
FROM ABOVE, TOTAL ANNUAL OPERATION EXPENSES ARE $57,500

TOTAL ANNUAL COST OF INCINERATION PROCESS IS $86,800

BASED ON 17,500 TONS OF WASTE PER YEAR, COST PER TON IS $4.96 PER TON



1985

HARDEMAN COUNTY
TENNESSEE

POPULATION DENSITY MAP

EXHIBIT "B"

PROPOSED LANDFILL SITE

EXISTING LANDFILL SITE

BOLIVAR , TN

WESTERN STATE HOSPITAL

WESTERN STATE HOSPITAL

Harris Pond

Pleasant Run

Pleasant Run

Pleasant Creek

Parrans Chapel

Sewage Disposal

Gaging Station

Reservoir

Sewage Disposal

Nuckolls Cem

Athletic Field

High Sch

Grds

Zion Ch

Cems

Union Cem

Polk Cem

Cem

Bolivar (BM 453)

BOLIVAR

BOLIVAR

SOMERVILLE ROAD

OLD BOLIVAR ROAD

ROAD

NUCKOLLS

ILLINOIS CENTRAL

BM 460

BM 456

BM 457

BM 351

BM 484

BM 465

BM 469

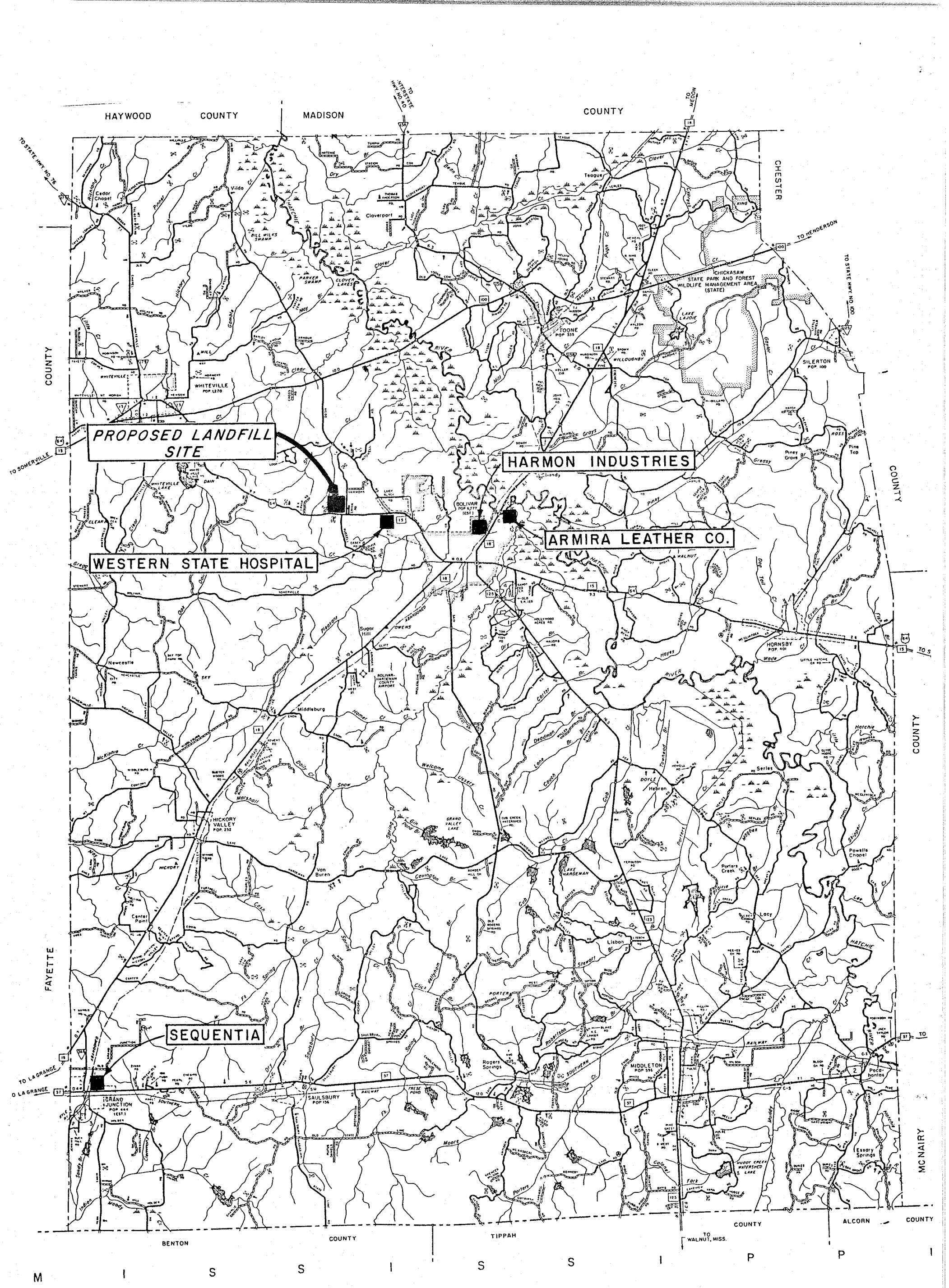
BM 477

BM

WT

EXHIBIT "A"

GENERAL TOPOGRAPHIC MAP



MAJOR WASTE PRODUCERS · · · · · ■

SCALE 0 1 2 3 4 MILES

HARDEMAN COUNTY
TENNESSEE

1985

LOCATION OF MAJOR WASTE PRODUCERS
EXHIBIT "D"

HAYWOOD COUNTY

MADISON COUNTY

CHESTER COUNTY

HENDERSON COUNTY

FAYETTE COUNTY

BENTON COUNTY

TIPPAH COUNTY

ALCORN COUNTY

MCNAIRY COUNTY

MISSISSIPPI

PROPOSED LANDFILL SITE

TO INTERSTATE HWY. NO. 40

TO MEDON

TO HENDERSON

TO STATE HWY NO. 100

TO WALNUT, MISS.

CHICKASAW STATE PARK AND FOREST WILDLIFE MANAGEMENT AREA (STATE)

WHITEVILLE POP 1270

TOONE POP 355

BOLIVAR POP 5777 (EST.)

HICKORY VALLEY POP 252

GRAND JUNCTION POP 444 (EST.)

SAULSBURY POP 156

MIDDLETON POP 596

HORNSBY POP 401

SILERTON POP. 100

Cloverport

Teague

Sugar Hill

Newcastle

Middleburg

Rogers Springs

Sandy

Hebron

Lisbon

Lucy

Essary Springs

Pocahontas

Cedar Chapel

Center Point

Von Buren

Porters Creek

Powells Chapel

Pine Top

Piney Grove

Grassy

Willoughby

Lake Lajoie

Lake Hardeman

Grand Valley Lake

Clover Lakes

Bill Wilks Swamp

Parker Swamp

Bolivar-Hardeman County Airport

RAILROAD

STATE HIGHWAY

U.S. HIGHWAY

AIRPORT

SCALE 0 1 2 3 4 MILES

1985

HARDEMAN COUNTY
TENNESSEE

TRANSPORTATION SYSTEM MAP

EXHIBIT "C"

1) ~~Leachate Tank have coating~~ ?

2) No detail for boot seal

3) will corrugated PVC stand up to stresses

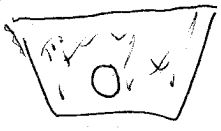
4) Leak Detection for Leachate Tank

5) How will final slopes be protected terraces needed at least every 50'

6) "Windows" in intermediate cover

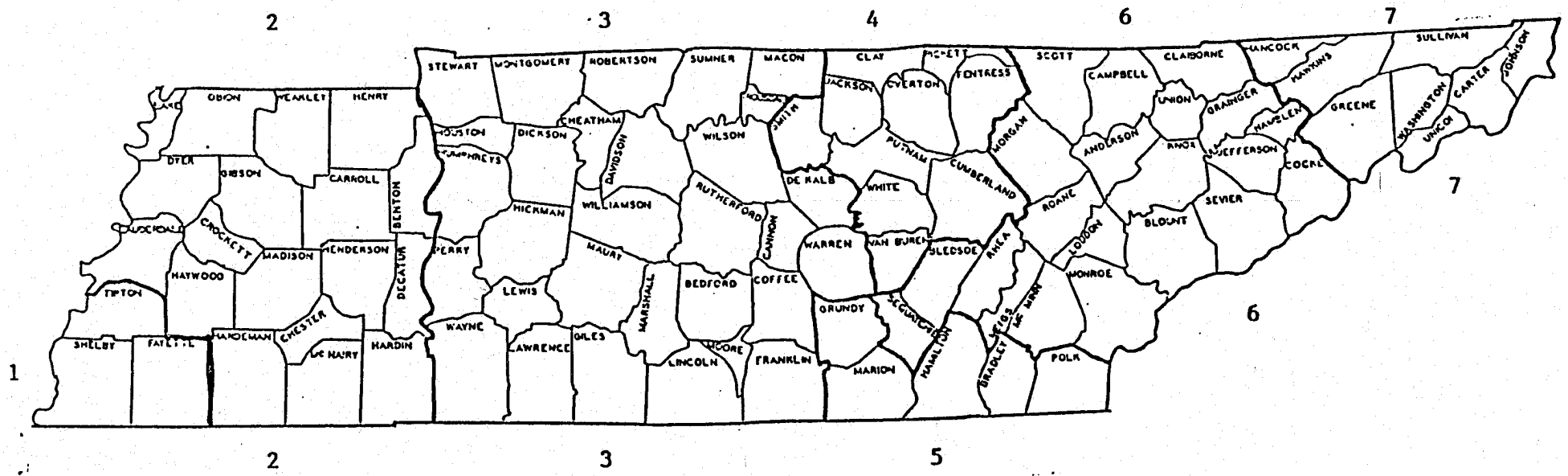
7) "Compacted" fill above drainage layer

8) Liner mtl specified?

9) Detail for leachate lines  vs 

10) How thick is drainage layer

11) will mtl on cut slopes stand up and where is buffer on side slopes



DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF SOLID WASTE MANAGEMENT
CUSTOMS HOUSE - FOURTH FLOOR
701 BROADWAY
NASHVILLE, TENNESSEE 37243-1535
(615) 741-3424
NETWORK: 8-840-3424
FAX # (615) 741-4666

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DIVISION OF SOLID WASTE MANAGEMENT
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PERIMETER PARK
MEMPHIS, TENNESSEE 38115-1511
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4. BARRY ATNIP
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1221 BURGESS FALLS ROAD
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(615) 432-4015
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5. GUY MOOSE
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6. JACK CRABTREE
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(615) 594-6035
NETWORK: 8-250-6466
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7. LARRY GILLIAM
DIVISION OF SOLID WASTE MANAGEMENT
900 NORTH STATE OF FRANKLIN ROAD
JOHNSON CITY, TENNESSEE 37604-3621
(615) 928-6487
NETWORK: 8-240-9182
FAX # (615) 928-2187

G.R.W. ENGINEERS, INC.
179 Belle Forest Circle
P.O. Box 210765
NASHVILLE, TENNESSEE 37221

(615) 662-1977

LETTER OF TRANSMITTAL

DATE	JOB NO.
MAY 3, 1988	7089

ATTENTION: MR. FRANK VICTORY

RE: BOLIVAR SANITARY LANDFILL

TO DIVISION OF SOLID WASTE MANAGEMENT
4th FLOOR CUSTOMS HOUSE
NASHVILLE, TN 37219-5403

RECEIVED
MAY 11 1988
DIV. OF SWM

WE ARE SENDING YOU ☐ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☐ _____

COPIES	DATE	NO.	DESCRIPTION
2			PLANS
2			FEASIBILITY STUDY
2			OPERATIONS MANUAL

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
☒ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☐ For review and comment ☐ _____
☐ FOR BIDS DUE _____ 19_____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS _____

COPY TO _____

SIGNED: Robert S. Stegall

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

MODIFICATIONS

TO

THE

CLOSURE / POST CLOSURE PLAN

FOR

BOLIVAR / HARDEMAN COUNTY SANITARY LANDFILL

PREPARED BY

BARGE, WAGGONER, SUMNER AND CANNON, INC.
THE FORM I BUILDING, SUITE 720
6750 POPLAR AVENUE
MEMPHIS, TENNESSEE 38138
(901)755-7166
(901)755-7844

FILE 31180-00

MODIFICATIONS

TO THE

HARDEMAN COUNTY LANDFILL

CLOSURE / POST CLOSURE PLAN

On November 3, 1992 the Solid Waste Management Division of the Tennessee Department of Health & Environment approved the Closure / Post Closure Plan for the Bolivar / Hardeman County Sanitary Landfill. The landfill is now operated solely by Hardeman County.

The original Closure / Post Closure Plan was based on closing the entire landfill at one time. It has now been decided to close the landfill in two phases, and to use a different method of closure in order to meet permeability requirements. The following are modifications to the original Closure / Post Closure Plan sections, and are numbered the same as the original sections.

III. Facility Closure

A. Partial Closure

There will be a partial closure of the landfill. The partial closure is designated as Phase I and is shown on the plans titled "Phase I Closure Plan".

The "Phase I Closure Plan" includes the following sheets.

1. Cover Sheet
2. Existing contours and Phase I closure lines
3. Proposed contours
4. Typical cross-section
5. Gas vent locations and proposed access road
6. Erosion control plan
7. Cross-sections

Final cover for Phase I includes 18" of compacted topsoil, a drainage geotextile / geonet composite, a 40 mil very low density polyethylene (VLDPE) liner, and 12" of sand. Side slopes will vary from 4:1 to 7:1.

After final grading is completed, the gas vents will be installed as shown on the plans. There will be eight gas vents, four on each side of the access road basically at the top of the slope.

The access road will be fifteen feet wide with a 60 foot diameter turn around at the upper end of the access road. It will be covered with 10" of gravel.

A vegetative cover will be established over the entire Phase I area.

Existing drainage is in place to handle the runoff from Phase I.

There is an existing groundwater monitoring well system in place.

The manager of the landfill operations for Hardeman County is Mr. Steve Robinson.

IV. Cost Estimates

Cost Estimate

Work Sheet A

Phase I Closure Activities

Cost Estimate
Work Sheet A:
Closure Activities

Notes: 1) This worksheet is to be submitted as part of the C/PC Plan.

2) Provide a cost for all activities which apply.

3) Additional cost information may be attached as needed.

1.	Establish final cover:	
A.	Top Soil	
1.	Quantity needed (yd^3)	17,800.00
2.	Excavation unit cost ($/$yd^3$)	0.90
3.	Excavation cost (1. x 2.)	$16,020.00
4.	Placement and spreading unit cost ($/$yd^3$)	0.50
5.	Placement cost (1. x 4.)	$8,900.00
	*TOTAL: Top Soil (3. + 5.)	$24,920.00
B.	Geosynthetic Clay Liner and Geonet	
1.	Geosynthetic Clay Liner and Geonet	
a.	Quantity needed (sy)	
b.	Placement ($/sy)	
	*TOTAL: GCL and Geonet (1. x 2.)	
2.	Sand	
a.	Quantity needed (yd^3)	11,820.00
b	Excavation and Placement ($/$yd^3$)	$1.50
	*TOTAL: Sand	$17,730.00
3.	Quality control / testing of clay	
a.	Number of sample to be tested	
b.	Clay testing unit cost ($/sample)	
c.	Testing cost (a. x. b.)	
	*TOTAL: Clay testing (c)	
C.	Synthetic membrane	
1.	Quantity needed (yd^2)	39,000.00
2.	Purchase unit cost ($/$yd^2$)	4.00
3.	Purchase cost (1. x 2.)	156,000.00
4.	Installation unit cost ($/$yd^2$)	$2.70
5.	Installation cost (1. x 4.)	105,300.00
	*TOTAL: Synthetic membrane (3. x 5.)	$261,300.00

D. Geotextile filter fabric / Geonet

1.	Quantity needed (yd^2)	39,000.00
2.	Purchase unit cost ($/yd^2$)	
3.	Purchase cost (1. x 2.)	
4.	Installation unit cost ($/yd^2$)	$5.50
5.	Installation cost (1. x 4.)	
	*TOTAL: Geotextile filter fabric (3. x 5.)	$214,500.00

TOTAL for Establishing final cover (*): (A + B + C + D) $518,450.00

2. Establishing vegetation cover:

A.	Labor ($/acre)	
B.	Seeding ($/acre)	
C.	Fertilizing ($/acre)	$2,000.00
D.	Mulching ($/acre)	
E.	Number of acres	7.30

TOTAL for Establishing vegetation cover: E x (A. + B. + C. + D.) $14,600.00

3. Establishing or completing a system to minimize and control erosion / sedimentation:

N/A

A. Sediment pond

1.	Excavation/construction ($)	
2.	Materials (e.g. pipe, riprap) ($)	
	*TOTAL: (1. + 2.)	

B. Diversion ditch

1.	Construction ($)	
2.	Materials ($)	
	*TOTAL: (1. + 2.)	

C. Temporary structures (e.g. silt fence, swales)

1.	Construction	
2.	Materials ($)	
	*TOTAL: (1. + 2.)	

TOTAL for establishing or completing a system to minimize and control erosion and sedimentation (*): (A. + B. + C.)

4. Establishing or completing leachate collection removal, and treatment system:

   A. Installation
      1. Number of feet
      2. Unit cost ($/ft)
      3. Storage tanks ($)
      4. Pumps ($)

   TOTAL for Establishing or completing leachate system:
   (1. + 2. + 3. + 4.)

5. Establishing or completing a system to collect or vent gases:

   A. Installation
      1. Materials (e.g. piping) $4,000.00
      2. Equipment (e.g. pumps)
      3. Labor (e.g. drilling) $4,000.00

   TOTAL for Establishing or completing a system to collect or vent gases: (1. + 2. + 3.) $8,000.00

6. Establishing or completing groundwater/surface water monitoring system:

   A. Installation
      1. Number of wells
      2. Drilling Cost (1. x 2.)
      3. Materials (e.g. casing) (1. x 3.)
      4. Equipment (pumps)
      5. Labor

   TOTAL for Establishing or completing groundwater monitoring system: (2. + 3. + 4. + 5.)

TOTAL CLOSURE COSTS:
(Sum of TOTALS for Sections 1. thru 6.) $541,050.00

PSI Information To Build On
Engineering • Consulting • Testing

March 31, 2005

Mr. Randy Hudgings
BWSC, Inc.
6750 Poplar Avenue
The Forum I, Suite 720
Memphis, Tennessee 38138

RE: Hardeman County Landfill
Veneer Slope Stability Analysis
PSI Project 502-55033

Dear Mr. Hudgings;

PSI has performed a slope stability analysis of the proposed veneer for the referenced landfill. The analysis was performed in accordance with the "Subagreement for Professional Services" between BWSC and PSI dated February 15, 2005.

The scope of services consisted of "Calculation of safety factors against sliding failures between the layers of the proposed closure cap taking into consideration static, seepage, and seismic forces as deemed necessary." In addition, this report provides a summary of the results of the stability analysis. Our scope did not include sampling or testing of any materials existing in the landfill or materials proposed to be used for closure. BWSC provided PSI with a proposed cross section and manufacturer data concerning shear strengths at the interfaces of the various synthetic and natural materials proposed for use.

The section provided indicates that the final landfill section will consist of a relatively level but crowned upper surface transitioning into a slope with side slopes ranging from 4H to 1V to 7H to 1V transitioning to a relatively level surface at the toe of the slope. The proposed veneer will consist of 18 inches of compacted topsoil and 12 inches of compacted sand separated by geosythetics. The geosynthetics will consist of a geotextile and a 40 Mil "LLDPE" at the upper crowned surface. The geosynthetics for the slopes will consist of a drainage geonet overlying a geosynthetic clay liner (GCL). Based on the sketches supplied it does not appear that the geotextile or the LLDPE extends for a significant distance down the slope, i.e., there appears to be a 5-foot overlap between systems at the slope crest. The sand rests atop "compacted garbage".

As discussed above, no physical testing was performed for this project. All data concerning shear strengths were taken from the literature provided. Shear strengths of the sands and soil were estimated from previous experience and observations of the behavior of similar coverings on existing landfills. Shear strengths of refuse was taken from published literature. Shear strengths and other parameters utilized in this analysis are as follows.

Material Description	Moist Unit Weight (pcf)	Angle of Friction (degrees)	Cohesion (psf)
Compacted Topsoil	110	25	0
GCL (internal and GCL/soil/sand)	100	18	0
Compacted Sand	115	28	0
Compacted Refuse	80	27	0

The shear strength for the GCL used in the analysis is a conservative value based on the information provided, i.e., the angle of friction was based on the lower boundary of peak angles of friction provided in the documentation.

The section utilized for the analysis was based on a slope of 4H to 1V, the steepest section proposed, having a height of approximately 50 feet. Lesser slope sections, if constructed by similar methods should have higher factors of safety. The analysis was limited to the veneer as requested; global or deep seated failure surfaces were not considered.

The slope stability analyses were performed using GSTABL7, a stability program based on STABL by Purdue University. The GSTABL7 software was developed by Gregory Geotechnical Software. Static and seismic forces were included; however, seepage of leachate is typically relieved below the level of the cap. If this is not the case, please notify us and provide anticipated leachate levels within the landfill system. For seismic loading conditions, a coefficient of horizontal acceleration of 0.06 was utilized for this analysis. This value was based on approximately one half of the Peak Ground Acceleration (PGA) value for a seismic event having a 10% probability of exceedence in 50 years.

Failure surfaces were assumed to be either long circular arcs or planar surfaces within the veneer. Based on the analysis, the veneer is estimated to have a factor of safety of approximately 1.4 or greater (ranged from 1.35 to 1.57) for static loading and 1.1 or greater (ranged from 1.07 to 1.25) for seismic loading conditions. These are considered to be adequate for the proposed veneer.

It is noted that erosion can lead to surface instability if left unrepaired. Based on the sketch provided, BWSC is requiring that erosion be repaired immediately utilizing a geotextile and rip-rap. In addition, in landfill construction, layers of soil

and geotextiles are typically added parallel to the slope by necessity. This results in a natural weak plane at the interface of materials. Effort should be made to ensure a bond between the materials during placement. Placement of materials during or immediately after periods of precipitation should be avoided as soft zones can occur along exposed planes. In addition, we note that benching of the higher slopes can reduce the potential for erosion by slowing the surface water flowing over the face of the slope. In addition, benching can result in a more stable slope. Regardless of the precautions taken, shallow slips can occur within these materials. If these problems arise, they should be repaired as quickly as possible using similar methods as required for erosion zones.

We are pleased to be of service. If questions arise or if we may be of further service, please notify us at your convenience.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

John O. Gordon, P.E.
Chief Engineer

James M. Evans, Jr., P.E.
Project Engineer

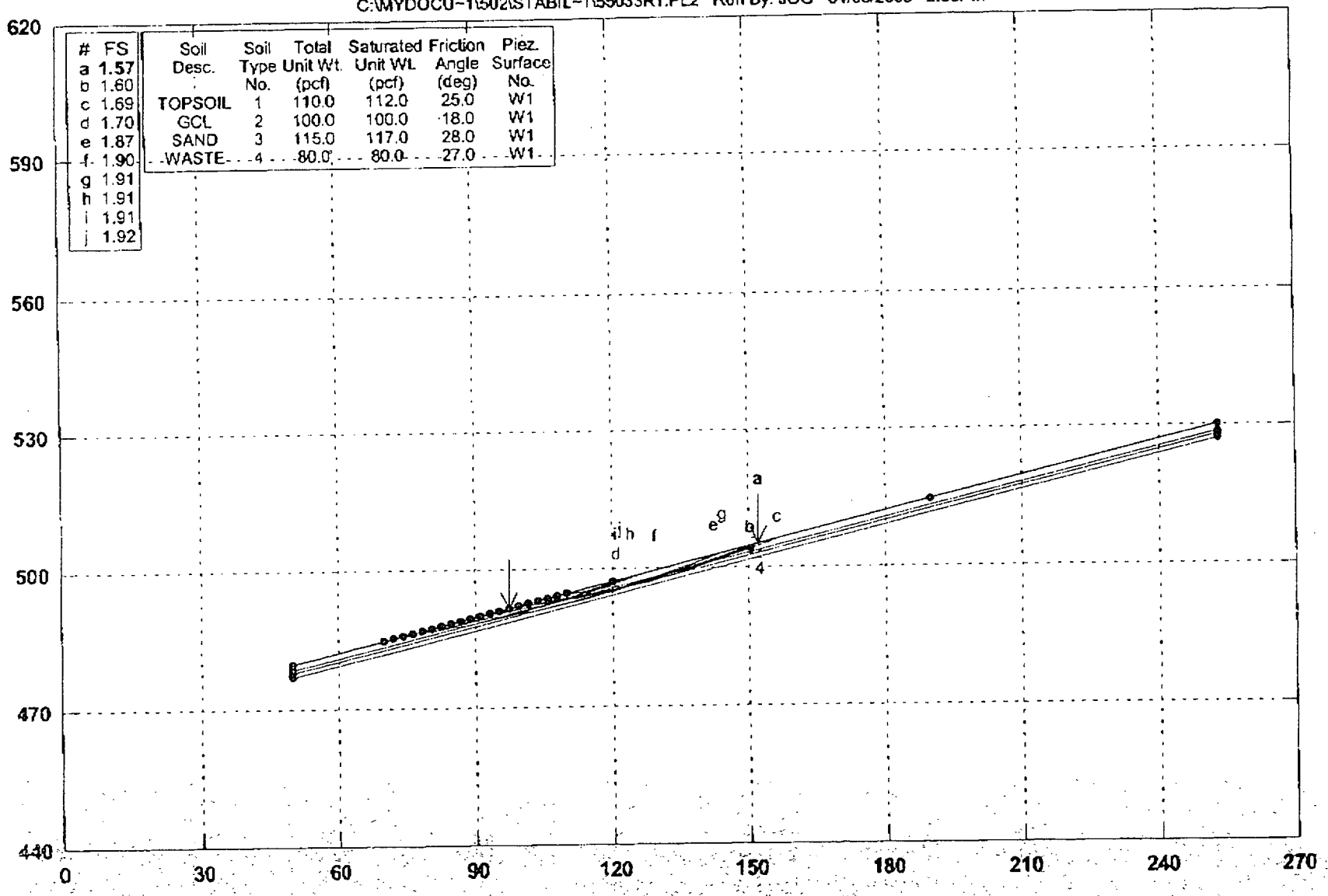
Attachments

Hardeman County Landfill Veneer Analysis

C:\MYDOCU~1\502\STABIL~1\55033R1.PL2 Run By: JOG 04/05/2005 2:38PM

#	FS
a	1.57
b	1.60
c	1.69
d	1.70
e	1.87
f	1.90
g	1.91
h	1.91
i	1.91
j	1.92

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
TOPSOIL	1	110.0	112.0	25.0	W1
GCL	2	100.0	100.0	18.0	W1
SAND	3	115.0	117.0	28.0	W1
WASTE	4	80.0	80.0	27.0	W1



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Safety Factors Are Calculated By The Modified Bishop Method

STED

Hardeman County Landfill Veneer Analysis

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#	FS
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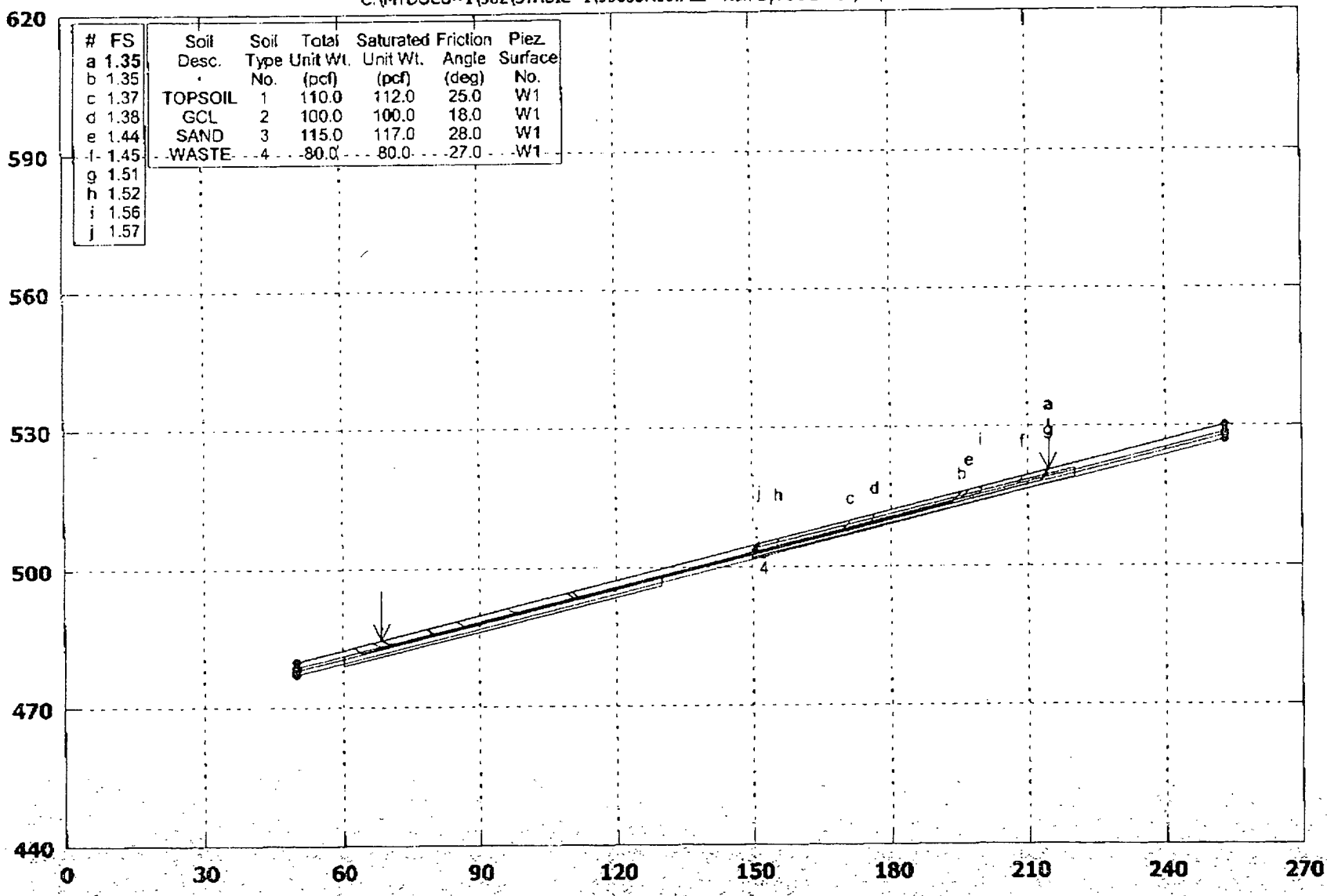
b	1.35
c	1.37
d	1.38
e	1.44
f	1.45
g	1.51
h	1.52
i	1.56
j	1.57

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
TOPSOIL	1	110.0	112.0	25.0	W1
GCL	2	100.0	100.0	18.0	W1
SAND	3	115.0	117.0	28.0	W1
WASTE	4	80.0	80.0	27.0	W1



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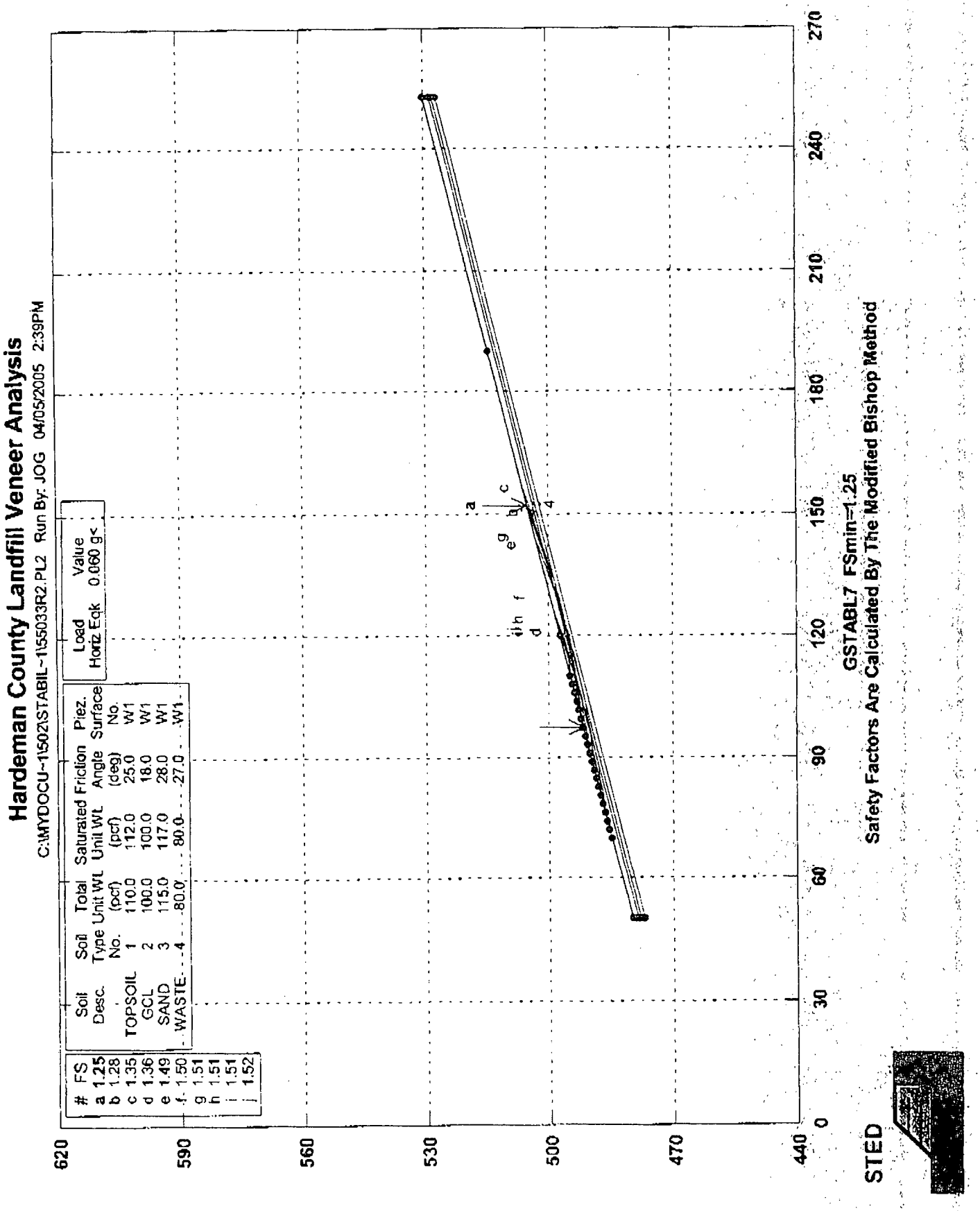
Safety Factors Are Calculated By The Simplified Janbu Method

STED


Hardeman County Landfill Veneer Analysis
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FS
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b 1.28
c 1.35
d 1.36
e 1.49
f 1.50
g 1.51
h 1.51
i 1.51
j 1.52
Soil Desc. | Soil Type No. | Total Unit Wt (pcf) | Saturated Unit Wt (pcf) | Friction Angle (deg) | Piez. Surface No.
TOPSOIL 1 110.0 112.0 25.0 W1
GCL 2 100.0 100.0 18.0 W1
SAND 3 115.0 117.0 28.0 W1
WASTE 4 80.0 80.0 27.0 W1
Load Horiz Eqk Value 0.060 g
620
590
560
530
500
470
440
0
30
60
90
120
150
180
210
240
270
GSTABL7 FSmin=1.25
Safety Factors Are Calculated By The Modified Bishop Method
STED

Hardeman County Landfill Veneer Analysis

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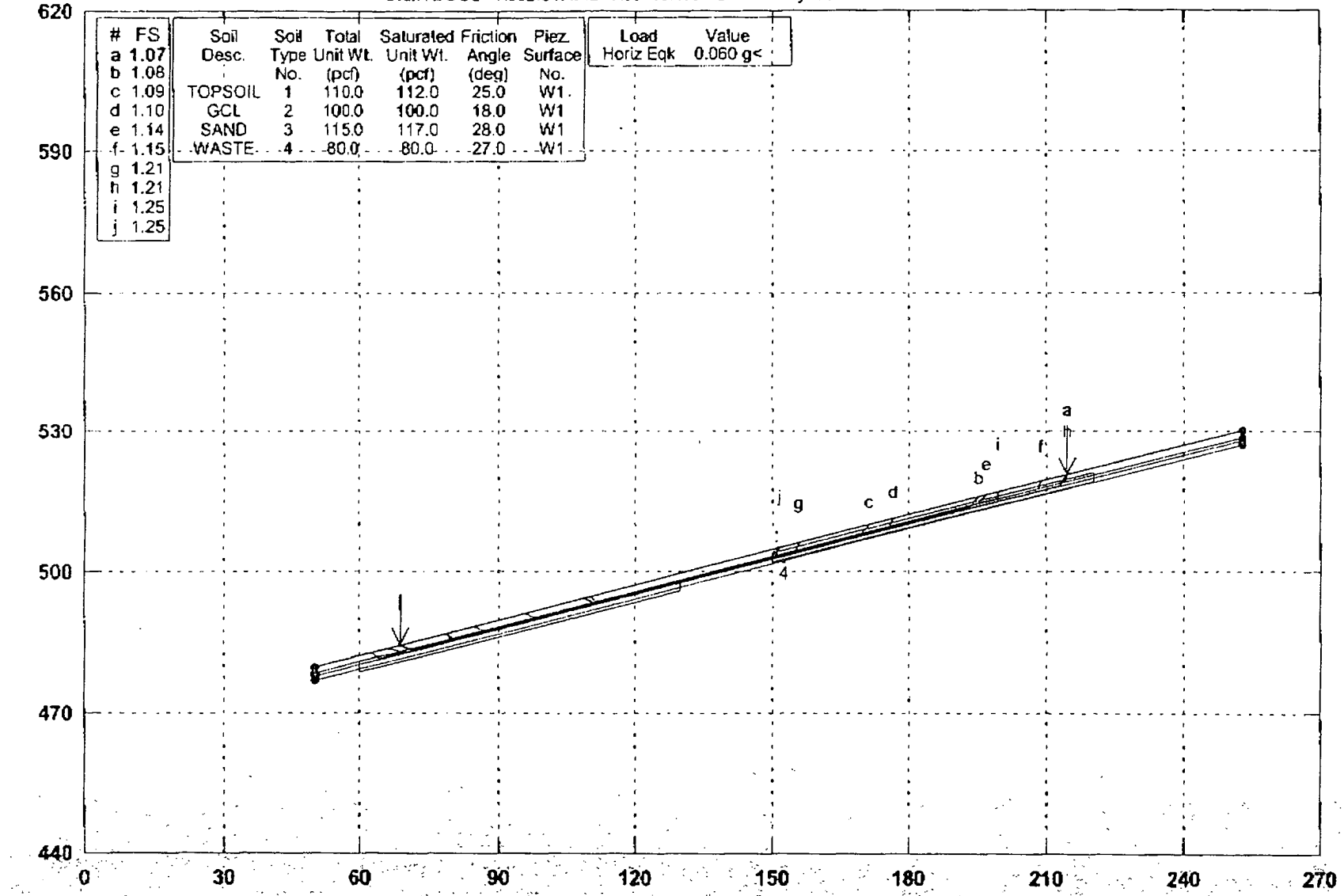
f	1.15
g	1.21
h	1.21
i	1.25
j	1.25

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Friction Angle (deg)	Piez. Surface No.
TOPSOIL	1	110.0	112.0	25.0	W1
GCL	2	100.0	100.0	18.0	W1
SAND	3	115.0	117.0	28.0	W1
WASTE	4	80.0	80.0	27.0	W1

Load	Value
Horiz Eqk	0.060 g<



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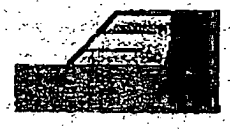
Safety Factors Are Calculated By The Simplified Janbu Method

STED



QUALITY ASSURANCE AND QUALITY CONTROL PLAN

FOR

HARDEMAN COUNTY LANDFILL

PHASE I CLOSURE

PREPARED BY

BARGE, WAGGONER, SUMNER AND CANNON, INC.
THE FORUM I, SUITE 720
6750 POPLAR AVENUE
MEMPHIS, TENNESSEE 38138
PHONE: (901) 755-7166
FAX: (901) 755-7844

FILE NO. 31180-00

A. The proposed closure plan calls for a cross-section of 18" of compacted topsoil, a geotextile/geonet composite, a 40 mil LDPE, and 12" of sand over the compacted garbage.

The purpose of the QA/QC Plan is ensure that all aspects of the construction of the cover are performed properly.

B. QUALITY ASSURANCE

The necessary inspections and evaluation of materials and workmanship will be conducted to document the quality of the constructed facility. This will be supported by conformance testing, construction monitoring and testing.

1. Preconstruction Activity – prior to beginning any construction activity, the landfill operator will review with the quality assurance personnel the design drawings and manual, testing standards, regulatory requirements, and any permit conditions unique to the site.
2. The manufacturers of the geomembrane, geonet and geotextile will furnish certificates of compliance with regard to testing of resin (ASTM D1505, ASTM D3015, ASTM D638, ASTM D1004, ASTM D4716) and manufacturing processes. The number of samples required will be the number necessary to ensure compliance.

3. Construction Monitoring and Testing – As materials are used for the construction of the cover system, they will be monitored and tested.

Quality Assurance personnel will also monitor the installation of the geomembrane liner to check material quality and seaming. Testing of seams and other critical areas by destructive and non-destructive methods will be documented. Similarly, the installation of the geotextile and geonet will be documented.

4. Documentation – Reports which can be used for review by the landfill operator or regulatory personnel will be maintained by quality assurance personnel. The documentation program elements will include:

   a. Daily Field Reports

   b. Laboratory Data Sheets

   c. Details of defects and repairs

   d. Photographic history

The quality assurance program will be conducted by an independent (third party) quality assurance firm, with work conducted under the direction of a registered professional engineer knowledgeable and experienced in similar projects. Responsibilities will be well-defined prior to start of construction activities.

C. QUALITY ASSURANCE

A system of inspections will be implemented to directly monitor and control the quality of construction. The quality control personnel will see that the following geomembrane, geotextile, geonet guidelines are followed:

1. Preparation for Geomembrane Deployment

   a. Prior to commencement of liner deployment, layout drawings shall be produced to indicate the panel configuration and general location of field seams for the project.

   b. Each panel used for the installation shall be given a numeric or alpha-numeric identifier. This panel identification number shall be related to a manufacturing roll number that identifies the resin type, batch number and date of manufacture, and documented as such.

2. Field Panel Placement

   a. Geomembrane deployment will generally not be done during any precipitation, in the presence of excessive moisture (i.e., fog, dew), in an area of standing water, or during high winds.

   b. Installer shall install field panels as indicated on the layout drawing. If the panels are deployed in a location other than that indicated on the layout drawings, the revised location shall be noted in the filed on a record "as-built" drawing which will be modified at the completion of the project to reflect actual panel

locations. Records drawings will be maintained and submitted by installer and /or the Third Party QA Representative.

c. Information relating to geomembrane panel placement, including date, time, panel number and panel dimensions, will be documented on an appropriate form. If a portion of a roll is set aside to be used at another time, the roll number will be written in several places on the remainder of the roll.

d. The method and equipment used to deploy the panels shall not damage the geomembrane or the supporting subgrade surface.

e. No personnel working on the geomembrane will wear shoes that can damage the geomembrane or engage in actions which could result in damage to the geomembrane.

f. Adequate temporary loading and/or anchoring (i.e., sandbags, tires) which will not damage the geomembrane will be placed to prevent uplift of the geomembrane by wind.

g. The geomembrane will be deployed in a manner to minimize wrinkles. Careful attention will be given to changes in ambient temperature.

h. Any area of a panel seriously damaged (torn, twisted, or crimped) will be marked and repaired as described herein.

3. Geomembrane Field Seaming

a. In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. Each seam made in the field shall be numbered and indicated on the record drawings. Seaming information to include seam number, welder ID, machine number, temperature setting, and weather conditions will be documented.

b. All personnel performing seaming operations shall be trained in the operation of the specific seaming equipment being used, and will qualify by successfully welding a test seam as described herein. The project foreman will provide direct supervision of the seaming operations.

c. The project superintendent will decide, based on experience and results of test seams, whether seaming is to be restricted by weather conditions. Many factors, such as the geomembrane temperature, humidity, wind precipitation, etc., can affect the integrity of field seams and must be taken into account when deciding whether seaming should proceed. Test seams, as described herein, are required prior to daily production seaming to determine if the weather conditions will affect the installer's ability to produce quality seams. Additional non-destructive and destructive testing of production seams may be required to substantiate the decision made by the project superintendent to seam on any give day.

d. Fusion welding will be conducted in conformance with the following requirements:

1) Overlap the panels of geomembrane approximately four (4) to six (6) inches prior to welding.

2) Clean the seam area prior to seaming to ensure the area is clean and free of moisture, dust, dirt, or debris of any kind. No grinding is required for fusion welding.

3) Adjust the panels so that seams are aligned, with the fewest possible number of wrinkles and "fishmouths."

4) A movable protective layer may be used, at the discretion of the installer's project superintendent, directly below the overlap of geomembrane that is to be seamed to prevent build-up of dirt or moisture between the panels.

e. Extrusion fillet welding will be conducted in accordance with the following requirements:

1) Extrusion-welded seams will be pre-beveled to heat-tacking into place.

2) Overlap the panels of geomembrane a minimum of three (3) inches.

3) Using a hot-air device, temporarily bond the panels of geomembrane to be welded, taking care not to damage the geomembrane.

4) Clean the seam area prior to seaming to assure the area is clean and free of moisture, dust, dirt, and debris of any kind.

5) Grind seam overlap within one hour prior to welding operation in a manner that does not damage the geomembrane. Grind marks will be covered with extrudate. In all cases, grinding should not extend more than one-quarter (1/4) inch past the edge of the area covered by the extrudate during welding.

6) Purge he extruder prior to beginning the seam to remove all heat-degraded extrudate from the barrel. The purged extrudate will be placed on scrap material so as to prevent contact with installed geomembrane.

7) Keep welding rod clean and dry.

f. Trial welds shall be conducted by welding technicians prior to each seaming period, every five (5) hours, as weather conditions dictate, or as requested by the QC personnel if welding problems are suspected. All trial welds will be conducted under the same conditions as will be encountered during actual seaming. Once qualified by a passing trial weld, welding technicians will not change parameters (temperature, speed, etc.) without performing another trial weld. The trail weld shall be made by joining two (2) pieces of geomembrane at least six (6) inches in width. Trial welds

for fusion welds will be 15 feet long and extrusion weld trial seams will be a minimum of four (4) feet long.

g. Sampling procedures shall be as follows:

1) Visually inspect the seam for squeeze-out, footprint, pressure, and general appearance.

2) Cut three (3) one-inch wide specimens, one from the middle of the seam and one from one (1) foot from each end of the test seam. Specimens shall be obtained using one-inch die cutter. The specimens shall then be tested in peel using a field tensiometer.

3) In order for a trial weld to be considered acceptable, all three specimens must meet the following criteria:

   a) Exhibit Film Tearing Bond (FTB).

   b) Meet or exceed the minimum peel strength values listed in manufacturer's Material Specification Sheet. If any specimens are not in conformance, the entire procedure shall be repeated. In the case of double-track fusion-welded seams, both welds must pass in order to be considered acceptable.

4) If repeat tests utilizing reasonable sets of welding parameters also fail, the seaming apparatus shall not be acceptable and shall not be used for seaming until the

deficiencies are corrected and a passing test seam is achieved.

h. Trial welds shall be documented as follows:

1) QC Coordinator and/or assistant will be present during peel testing and will record date, time, operator, machine number, ambient and operating temperatures, speed setting, peel values, and pass/fail designation.

2) All trial weld records shall be maintained on an appropriate form.

3) The QC Coordinator will give final approval to proceed with welding after observing trial welds.

i. General seaming procedures will be as follows:

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

2) While welding a seam, monitor and maintain the proper overlap.

3) Inspect seam area to assure it is clean and free of moisture, dust, dirt, and debris of any kind.

4) Welding technicians will periodically check machine operating temperature and speed, and will mark this information on the geomembrane.

5) Align wrinkles at the seam overlap to allow welding through the wrinkle.

6) "Fishmouths" or wrinkles at seam overlaps, which can not be welded through, shall be cut along the ridge in order to achieve a flat overlap. The cut "fishmouth" or wrinkle shall be heat-tacked flat and extruded or patched with an oval or round patch of the same geomembrane extending a minimum of three (3) inches beyond the cut in all directions.

7) All cross/butt/seams between two (2) rows of seamed panels shall be welded during the coolest time of the day to allow for contraction of the geomembrane.

8) Prior to welding cross/butt seams, the top and bottom overlap of intersection fusion-welded seams will be ground to flatten the extrusion bead prior to welding butt seams.

9) All "T" joints produced as a result of cross/butt seams shall be extrusion fillet-welded. The overlap on each "leg" of the "T" joint will be trimmed back six (6) inches. Then grind three (3) inches minimum of each of the three (3) legs of the "T" and extrusion-welded all of the area prepared by grinding.

10) Welding technicians will cut a one-inch (1") peel specimen at the end of every seam. Prior to welding the next seam, the specimen will be tested for peel. The QC Coordinator

may request additional trial weld, based on observations of peel test specimens.

j. All seaming operations will be documented by the QC Coordinator or a designated assistant. Welding technicians will mark on the liner with permanent markers at the start of all seams information regarding date, time, welding technician ID, machine number, and machine operating temperature and speed. QC Coordinator or assistant will record date, time, seam number, technician ID, machine ID, set temperature, speed and weather conditions.

k. Welding technicians will periodically check operating temperature and speed and mark this information along the seam.

l. QC Coordinator will make periodic checks on welding operations to verify overlap, cleanliness, ect.

4. Air Testing

a. Air pressure testing shall be in accordance with Test Method GM-6 of the Geosynthetic Research Institute and as follows"

1) An air pump (manual or motor-driven) capable of generating and sustaining a pressure between 20 to 60 psi will be used. A sharp, hollow needle or other approved pressure-feed device with a pressure gauge capable of reading and sustaining a pressure between 0 to 60 psi will be used.

2) Seal both ends of the seam to be tested and insert needle or other approved pressure-feed device into the sealed channel created by the fusion weld.

3) Inflate the test channel to a pressure of approximately 30 psi and maintain the pressure within the range listed in the Initial Pressure Schedule. Close valve, observe and record the initial pressure.

INITIAL PRESSURE SCHEDULE

MATERIAL (mils)	MINIMUM (psi)	MAXIMUM (psi)
40	24	30
60	27	35

4) Observe and record the air pressure five (5) minutes after the initial pressure setting is recorded. If loss of pressure exceeds the following or if the pressure does not stabilize, locate the suspect area and repair as described herein.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL

AFTER 5 MINUTES – LLDPE

MATERIAL (MIL)	PRESSURE DIFFF.
40	4 psi
60	3 psi

5) At the conclusion of all pressure test, the end of the air-channel opposite the pressure gauge is cut. A decrease in gauge pressure must be observed or the air channel will be considered "blocked" and the test will have to be repeated from the point of blockage. If the point of blockage cannot be found, cut the air channel in the middle of the seam and treat each half as a separate test.

6) Remove the pressure feed needle and seal the resulting hole by extrusion welding.

b. In the event of a non-complying air pressure test, the following procedure shall be followed:

1) Check seam end seals and retest seams.

2) If a seam will not maintain the specified pressure, the seam should be visually inspected to localize the flaw. If this method is unsuccessful, cut one-inch (1") samples from each end of the seam.

3) Perform destructive peel test on the samples using a field tensiometer.

4) If all samples pass destructive testing, remove the overlap left by the wedge welder and vacuum test the entire length of the seam as described herein.

a) If a leak is located by the vacuum test, repair by extrusion filet welding. Test the repair by vacuum testing.

b) If no leak is discovered by vacuum testing, the seam will be considered to have passed non-destructive testing.

5) If one or more peel specimens are in non-compliance, additional samples will be taken as described herein.

a) When two (2) passing samples are located, the length of seam bounded by the two (2) passing test locations will be considered non-complying. The overlap left by the wedge welder will be heat tacked in place along the entire length of seam and non-complying portion of seam will be extrusion fillet welded.

b) Test the entire length of the repaired seam by vacuum testing as described herein.

c. General air testing procedures shall be as follows:

1) The opposite end of the air channel will in all cases be pierced to assure that no blockages of the air channel have occurred.

2) Whenever possible, seams should be air tested prior to completing butt seams to avoid having to cut into liner. All

cuts through the liner as a result of testing will be repaired by extrusion welding.

3) All needle holes remaining in air channels after testing will be circled by testing crew and will be repaired with an extrusion bead.

d. Air pressure testing documentation-All information regarding air-pressure testing (date, initial time and pressure, final time and pressure, pass/fail designation, and technician's initials) will be written at both ends of the seam, or portion of seam, tested. All of the above information will also be logged by the QC Coordinator on an appropriate form.

5. Vacuum Testing

a. This test is to be used on extrusion welds, or when the geometry of a fusion weld makes air pressure testing impossible or impractical, or when attempting to locate the precise location of a defect believed to exist after air pressure testing.

1) Equipment for vacuum testing

a) Vacuum box assembly consisting of a rigid housing with a soft neoprene gasket attached to the bottom, a transparent viewing window, port hole or valve assembly, and a vacuum gauge.

b) Vacuum pump assembly equipped with a pressure controller and pipe connection.

c) A bucket and means to apply a soapy solution.

d) A soapy solution.

2) Procedure for vacuum testing

a) Trim excess overlap from the seam, if any.

b) Turn on the vacuum pump to reduce the vacuum box to approximately 10 inches of mercury, i.e., 5 psi gauge.

c) Apply a generous amount of a strong solution of liquid detergent and water to the area to be tested.

d) Place the vacuum box over the area to be tested and apply sufficient downward pressure to "Seat" the seal strip against the liner.

e) Close the bleed valve and open the vacuum valve.

f) Apply a minimum of 5 psi vacuum to the area as indicated by the gauge on the vacuum box.

g) Ensure that a leak-tight seal is created.

h) For a period of approximately 10 to 15 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

i) If no bubbles after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum three-inch (3") overlap, and repeat the process.

3) Procedure for Non-Complying Test

a) Mark all areas where soap bubbles appear and repair the marked areas as described herein.

b) Retest repaired areas.

4) General Vacuum Testing Documentation

a) Vacuum box testing will be performed by qualified construction personnel with frequent supervision by the QC Coordinator.

b) Overlap must be trimmed prior to vacuum boxing all seams.

c) Special attention shall be exercised when vacuum testing "T" seams or patch intersections with seams.

5) Vacuum Testing Documentation

a) Vacuum testing crew will use permanent markers to write on liner, indicating tester's initials, date, and pass/fail designation on all areas tested.

b) Records of vacuum testing will be maintained by the QC Coordinator or testing crew on the appropriate form.

6. Destructive Testing

a. Destructive testing will be held to a minimum to reduce number of repairs to the membrane.

b. Procedure for Destructive Testing

1) Destructive test samples shall be marked and cut out randomly at a minimum average frequency of one (1) test location every 500 feet of seam length.

2) Location of destructive samples will be selected by QC Coordinator (or Third Part QC Representative), with samples cut by Construction Personnel.

3) Destructive samples will be taken and tested as soon as possible after seams are welded (the same day) in order to receive test results in a timely manner.

4) QC Coordinator will observe all destructive testing and record date, time, seam number, location, and test results.

5) All destructive test locations with pass/fail designation will be marked on liner with permanent markers.

6) Sample Size

   a) The sample shall be twelve (12) inches wide with a seam sixteen (16) inches long centered lengthwise in the sample. The sample may be increased in size to accommodate independent laboratory testing by the manufacturer.

   b) A one-inch specimen shall be cut from each end of the test seam for field testing.

   c) The two (2) one-inch-wide specimens shall be tested on a field tensiometer for peel strength. If

either field specimen does not pass, it will be assumed the sample would also not pass laboratory destructive testing. The procedure outlined in Paragraph 3 shall be followed to locate passing samples to send to the laboratory.

c. Procedure for Non-Complying Destructive Tests

1) Cut additional field samples for peel testing. In the case of a field production seam, the samples must lie approximately ten (10) feet in each direction from the location of the initial non-complying sample. Perform a field test for peel strength. If these field samples pass, then laboratory samples can be cut and forwarded to the laboratory for full testing.

a) If the laboratory samples pass, then reconstruct the seam between the two (2) passing sample locations according to procedures detailed herein.

b) If either of the samples are still in non-compliance, then additional samples are taken in accordance with the above procedure until two (2) passing samples are found to establish the zone in which the seam should be constructed.

2) All passing seams must be bounded by two (2) locations from which samples passing laboratory destructive tests have been taken.

3) In cases of reconstructed seams exceed 150 feet, a sample must be taken from within the zone in which the seam has been constructed and must pass destructive testing.

4) All destructive seam samples shall be numbered and recorded.

7. Laboratory Testing Of Destructive Seam Samples

a. Seam destructive samples will be sent to manufacturer's laboratory or third party laboratory for destructive testing.

b. Acceptance Criteria – Destructive samples will be tested for "Shear Strength" and "Peel Adhesion" (ASTM D4437). Five (5) specimens shall be tested for each test method. Four (4) out of the five (5) specimens must exhibit FTB (as defined by NSF Standard Number 54-1991) for each round of peel and shear testing. In addition, four (4) of the five (5) individual specimens and the average of the five (5) peel and shear tests must or exceed the manufacturer's strength requirements.

8. Defects and Repairs

a. QC Coordinator and Project Superintendent shall conduct a detailed walk through and visually check all seams and non-seam

areas of the geomembrane for defects, holes, blisters, and signs of damage during installation.

b. All other installation personnel shall, at all times, be on the lookout for any damaged areas. Damaged areas shall be marked and repaired.

c. Repair procedures – Any portion of the goemembrane or geomembrane seam showing a flaw or having a destructive or non-destructive test shall be repaired. Several procedures exist for repair, and the decision as to the appropriate repair procedure shall be made by the project superintendent.

Procedure available for repair include the following:

1) Patching – used to repair large holes, tears and destructive sample locations. All patches shall extend at least three (3) inches beyond the edges of the defect and all corners of patches shall be rounded.

2) Grinding and Welding – used to repair sections of extruded fillet seams.

3) Spot welding or Seaming – used to repair small tears, pinholes, or other minor localized flaws.

4) Capping – used to repair lengths of extrusion or fusion welded seams.

5) Extruding the exposed overlap along the length of fusion welded seams.

6) Removal of a suspect seam and replacement with a strip of new material seamed into place.

d. Verification of Repairs – Every repair shall be non-destructive tested. Repairs which pass the non-destructive test shall be deamed acceptable. Repairs in excess of 150 feet require a destructive test. Non-destructive testing of repairs shall be documented. The repair location shall be recorded on the record drawing.

9. Geotextiles

a. Handling and Placement – All geotextiles shall be handled in a manner to ensure they are not damaged. The following special handling requirements shall be adhered to:

1) On slopes, the geotextiles shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geotextile sheet in sufficient tension to preclude folds and wrinkles.

2) In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent.

3) Geotextiles shall be cut using an approved cutter. If the material is being cut in place, special care must be taken to protect other geosynthetic materials from damage.

b. Seams and Overlaps – Geotextiles may be seamed by thermal bonding or by sewing. No horizontal seams shall be allowed on side slopes.

1) On slopes steeper than tem (10) horizontal to one (1) vertical, it is recommended that geotextiles be continuously sewn along the entire length of the seam. Geotextiles shall be overlapped a minimum of four (4) inches prior to sewing.

2) On bottoms and slopes shallower than ten (10) horizontal to one (1) vertical, it is recommended that geotextiles be continuously sewn as indicated above or thermally bonded. If thermally bonded, the geotextiles shall be overlapped a minimum of four (4) inches prior to seaming.

c. Repairs – Any holes or tears in the geotextiles shall be repaired as follows:

1) On slopes – A patch made from the same geotextile shall be seamed into place. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.

2) Horizontal Areas – A patch made from the same geotextile shall be spot-seamed in place with a minimum of twelve (12) inches in all directions.

10. Geonets

a. Handling and Placement – The geonets shall be handled in such a manner as to ensure that the geonets are not damaged in any way.

1) Onslopes, the geonets shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet shall be positioned by hand after being unrolled to minimize wrinkles.

2) Geonets shall not be welded to geomembranes with extrusion welders. Geonets shall be cut using approved cutters, i.e., hood blade, scissors, etc. Care should be taken to prevent damage to underlying layers.

3) Care must be taken not to entrap dirt in the geonet that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane.

b. Layering and Tying of Geonet-When several layers of geonet are installed, care will be taken to prevent the strands of one layer from penetrating the channels of the next layer, thereby significantly reducing the transmissivity. Layered geonets will be placed in the same direction and never laid perpendicular to the underlying geonet. Adjacent geonet shall be joined according to the following requirements:

1) Adjacent rolls shall be overlapped by at least four (4) inches and securely tied.

2) Tying can be achieved by plastic fasteners. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.

3) Tying shall be every five (5) feet along the slope, two (2) feet across the slope, and six (6) inches in the anchor trench.

4) In the corners of the side slopes where overlaps between perpendicular geonet trips are required, an extra layer of geonet shall be unrolled along the slope, on the top of the previously installed geonets, from the top to bottom of the slope.

5) When more than one layer of geonet is installed, overlaps must be staggered and layers tied together.

c. Repairs – Any holes or tears in the geonet shall be repaired by placing a patch extending two (2) feet beyond the edges of the hole or tear. The patch shall be secured to the original geonet by tying every six (6) inches. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area shall be cut out and the two (2) portions of the geonet shall be joined.

CITY OF BOLIVAR, TENNESSEE
SANITARY LANDFILL

OPERATIONS MANUAL & CALCULATIONS

October 1987

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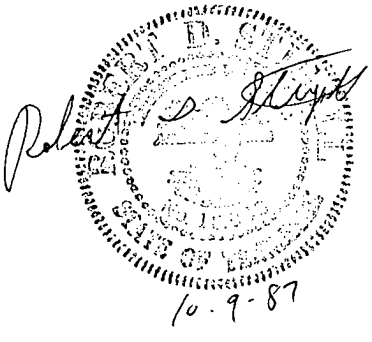

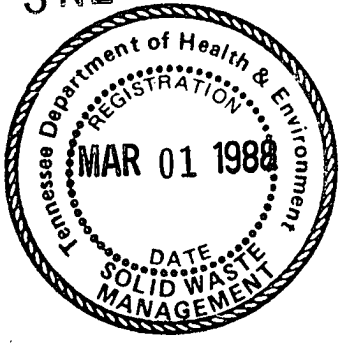

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CITY OF BOLIVAR, TENNESSEE
SANITARY LANDFILL
OPERATIONS MANUAL & CALCULATIONS

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CITY OF BOLIVAR, TENNESSEE
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CITY OF BOLIVAR, TENNESSEE
SANITARY LANDFILL

OPERATIONS MANUAL & CALCULATIONS

A. GENERAL/PURPOSE

The City of Bolivar presently operates a sanitary landfill which is projected to be exhausted in early 1988. As such, the residents and commercial/industrial establishments of Bolivar and Hardeman County require that an approved disposal method of solid waste be implemented as soon as possible.

Severe environmental and potential legal problems would arise if the City's existing landfill's capacity is reached without the development of a suitable means of disposal of solid waste.

In August, 1987, a solid waste feasibility report was performed and approved by the Tennessee Division of Solid Waste Management. The feasibility report considered various methods of solid waste disposal and recommended utilizing a new sanitary landfill. This operation report will address various aspects associated with operating the proposed Bolivar landfill.

B. DESCRIPTION OF OPERATION

Two concurrent methods of operation will be used to develop the Bolivar Sanitary Landfill. Initially, the area will be developed by cutting trenches not to exceed eight feet deep. Solid waste is compacted below the existing grade and cover is added until the original grades are restored.

Upon completion of the trench, the area fill process will begin by compacting solid waste against a berm over the top of the completed trench.

This concurrent process of trenching and area filling will continue until the site is completely developed.

C. ACCESS ROADS

The proposed Bolivar Sanitary Landfill site is readily accessible by automobile or truck. The site is just west of the Bolivar City

Limits, approximately 2,500 feet north of U.S. Highway 64 off Walton Lane. An access road is to be constructed from Walton Lane into the landfill site as shown on the plans.

D. ACCESS TO SITE

Use of the Bolivar Landfill site will be restricted to the residents and commercial/industrial establishments of Bolivar and Hardeman County. The landfill supervisor or his representative will be at the landfill site during all hours of operation. At the end of the day, the gate on the access road will be closed and locked in an effort to prevent unauthorized dumping of waste material. The operating hours every day will be from 7:00 a.m. to 5:30 p.m.

E. UNLOADING OF WASTES

Most of the solid waste to be disposed of at the proposed Bolivar Sanitary Landfill will be unloaded by the use of dump trucks. During the progressive trench phase of development, trucks will back down a slope to a point near the working face of the landfill. Here the waste will be dumped below existing grade to facilitate compaction and to prevent scattering and blowing of the solid waste.

In order to arrive at the site, trucks will travel the permanent access road until the temporary roads on site are reached. From this point, trucks will turn to the right (north) to the working face of the site.

During the area fill phase of the Site, the waste is to be dumped near the working face of the landfill. However, this will be above existing grade and may require prompt attention to prevent blowing of the solid waste.

F. BLOWING LITTER

As mentioned in E. above, the chances of having blowing litter will be reduced by having the waste unloaded as near the working face as possible and by compacting and covering the waste immediately on days when the wind is relatively strong.

G. SPREADING AND COMPACTING OF WASTE

Spreading and compacting of solid waste at the Bolivar Sanitary Landfill will be accomplished by two dozers and a compactor which will

be assigned to the site. The solid waste will be unloading within fifty feet of the working face of the facility where it will be spread and compacted against the face of the landfill. The waste should be compacted in layers not to exceed two feet thick to facilitate proper compaction.

H. DAILY COVER

Daily cover material will be placed and compacted over all solid waste to a depth of six inches. This "daily cover" is subject to inspection and approval by the Tennessee Division of Solid Waste Management.

I. INTERMEDIATE COVER

In all but the final lift of the sanitary landfill, twelve inches of compacted cover material shall be placed on all surfaces of the landfill which contain waste and will be exposed for a period of over one month.

J. FINAL COVER

A depth of twenty-four inches of compacted cover material shall be placed on the site above waste not later than one week after the final lift is completed. In order to help prevent erosion and surface deterioration, the final cover shall be immediately stabilized to the satisfaction of the Tennessee Division of Solid Waste Management.

K. SILT CONTROL

The drainage area is limited to the approximately size of the area requested to be permitted. There will be a minimal disturbance with the natural drainage areas. Diversion ditches will be constructed to divert surface runoff from the disturbed areas where practical. As a final control, a silt pond will be constructed. The calculations for the pond are provided later in this manual.

L. SEEDING AND REVEGETATION

Seeding shall consist of placing grass seed, fertilizer, mulch, straw and other such material as needed to promote a stand of grass on the target areas. Seeding should be performed as soon as possible once final grades are completed. No seeding shall be done during periods of high wind.

M. SITE DRAINAGE AND GRADING

The proposed Bolivar Landfill site is to be operated in a manner which will provide adequate drainage during all phases of development. Berms and diversion ditches are to be constructed to prevent surface water from flowing into the areas which are being trenched.

The proposed final grading of the site will divert surface water around areas which contain waste. The top of the landfill site will maintain a sufficient slope to insure proper drainage of water which falls directly on the site. The proposed final contours of the site are shown on the plans.

N. OPEN BURNING

Presently no open burning is proposed at the Bolivar Sanitary Landfill site. However, any burning of waste on the site must have prior approval from the Tennessee Division of Solid Waste Management and the Division of Air Pollution Control.

O. FIRE PROTECTION

If proper daily cover is maintained at the landfill site, the chance of a fire occurring is remote. However, the site is readily accessible by the Hardeman County Fire Department if needed.

The City of Bolivar presently has a 6-inch water line on Walton Lane. The City will extend water service to the landfill site from this line as shown on the Drawings. While this line may not be able to fight a major fire, having water at the site for maintenance of the grounds may prevent a fire.

A fire extinguisher is to be kept on the equipment and one is to be kept in the equipment building.

P. SIGNS

A sign will be erected on the gate across the access road which shall read:

Bolivar Sanitary Landfill
Hours of Operation:
7:00 A.M. - 5:30 P.M.
Contact: Fred F. Kessler
(901)658-2020
Permit Number:

Q. SALVAGE OPERATIONS

No salvage operations will be permitted at the proposed Bolivar Sanitary Landfill.

R. SPECIAL WASTES HANDLING

No hazardous, dangerous, or difficult to manage waste will be allowed to be dumped at the landfill site. The landfill operator will refuse to accept any difficult to handle or suspected hazardous waste.

S. DOMESTIC ANIMALS

No domestic animals will be allowed to linger at the Bolivar Sanitary Landfill site. This situation is not anticipated to be a problem. However if domestic animals persist in coming to the site, appropriate preventive or deterrent action will be taken.

T. VECTOR CONTROL

Unfavorable conditions for the breeding of insects, rodents, and other vectors are best maintained by performing routine operations of the landfill in a prompt, efficient manner. If this practice does not prove effective in controlling vectors, supplemental vector control measures will be incorporated as necessary.

U. DUST CONTROL

Adequate dust control may be achieved at the proposed Bolivar Sanitary Landfill site by dampening disturbed areas during extended period of

dry weather. This can easily be accomplished as a water line is to be constructed to serve the site.

V. CONTAMINATION CONTROL

The threat of contamination is best minimized by constructing the landfill in accordance with the restrictions stated by the Tennessee Division of Solid Waste Management. The restrictions which will be followed in an effort to avoid contamination are as follows:

1. In order to maintain a sufficient base of clayey material, no excavation should be made more than eight feet below the surface.

2. No waste should be placed directly on sand unless it is well mixed with clay to a compacted thickness of five feet. No sandy material should be used for cover unless it is well mixed with clay.

3. A distance of 200 feet must be maintained between the streams and the placement of waste.

4. The ponds on site should be closed prior to filling of areas within 200 feet upgradient of the ponds.

In addition, if leachate should develop at the Bolivar Landfill site, abatement actions will be performed to the satisfaction of the Division of Solid Waste Management.

W. SUPERVISION OF OPERATIONS

The City of Bolivar will be responsible for the operation of the proposed sanitary landfill. Mr. DeWayne Lax will be the supervisor of operations for the site. Mr. Lax has over fifteen years of experience in sanitary landfill operations.

X. ACCIDENT PREVENTION AND SAFETY

A safe working environment is to be maintained at the proposed Bolivar Sanitary Landfill. All TOSHA Requirements are to be fully complied with. First aid equipment will be available at the Bolivar Landfill site (Maintenance Building).

Y. ON-SITE STRUCTURE

A maintenance building is to be constructed at the proposed Bolivar Sanitary Landfill site. This building will house maintenance equipment and provide shelter from inclement weather. Also, sanitary sewer facilities will be provided for the site.

Z. RECORDS AND REPORTS

Accurate records and reports concerning the activities of the Bolivar Sanitary Landfill will be kept current and in accordance with all requirements of the Tennessee Division of Solid Waste Management.

AA. COMPLETION OF THE SANITARY LANDFILL

Upon completion of final grading and seeding, the Bolivar Sanitary Landfill will be inspected by the Tennessee Division of Solid Waste Management for final approval. Upon approval, the landfill site will be recorded with the County as a former landfill site. The City of Bolivar is to maintain the integrity of the site for a period of one year after approved closure of the site.

AB. EQUIPMENT

The City of Bolivar will use a Kamatsu Tractor/Shovel and an International Loader to develop the proposed landfill. In addition, the City intends to purchase a compactor upon approval of the proposed site. This addition will greatly increase the efficiency of the landfill operations. (The calculations which are shown later in this manual were generated assuming a compactor will be used.)

If the City of Bolivar's equipment is unable to perform for any reason, appropriate equipment will be leased to do the job until the City's equipment is repaired or replaced. Under no circumstances will the proper operation of the landfill be hindered as a result equipment failure.

AC. GROUNDWATER MONITORING

One upgradient and three or four downgradient monitoring wells will be installed in locations determined by the Division of Solid Waste Management. The well construction and testing parameter will also be established by the Division of Solid Waste Management.

C A L C U L A T I O N S

BOLIVAR SANITARY LANDFILL

PHASE I - TRENCHING OPERATION

A. The Bolivar Landfill will dispose of 25,000 cubic yards of solid waste each year.

B. On an average day, the landfill will accept approximately 70 cubic yards of solid waste (25,000/365).

C. As shown on Sheet 3 of the plans, an area of 628,000 square feet will be utilized for trenching operations.

D. As shown in Sketch #1, the dimensions of a typical daily cell (excluding cover) are 20 feet wide by 13.5 feet long by 7 feet high (70 cubic yards).

E. Also, as shown in Sketch #1, the daily requirement for cover is 19.85e cubic yards.

F. Each day, 70 cubic yards of solid waste are disposed of and 19.85 cubic yards of earth are used for cover. Therefore, the site will be 77.9% compacted solid waste (70/89.85) and 22.1% earth.

G. From C. above, an area of 628,000 square feet is to be utilized for trenching. Using a depth of cut = 8 feet, the total available volume of the trenching phase = 5,024,000 cubic feet = 186,070 cubic yards.

H. From F. above, 22.1% of the volume is required for cover (daily & intermediate), therefore 41,120 cubic yards of earth are dedicated for cover.

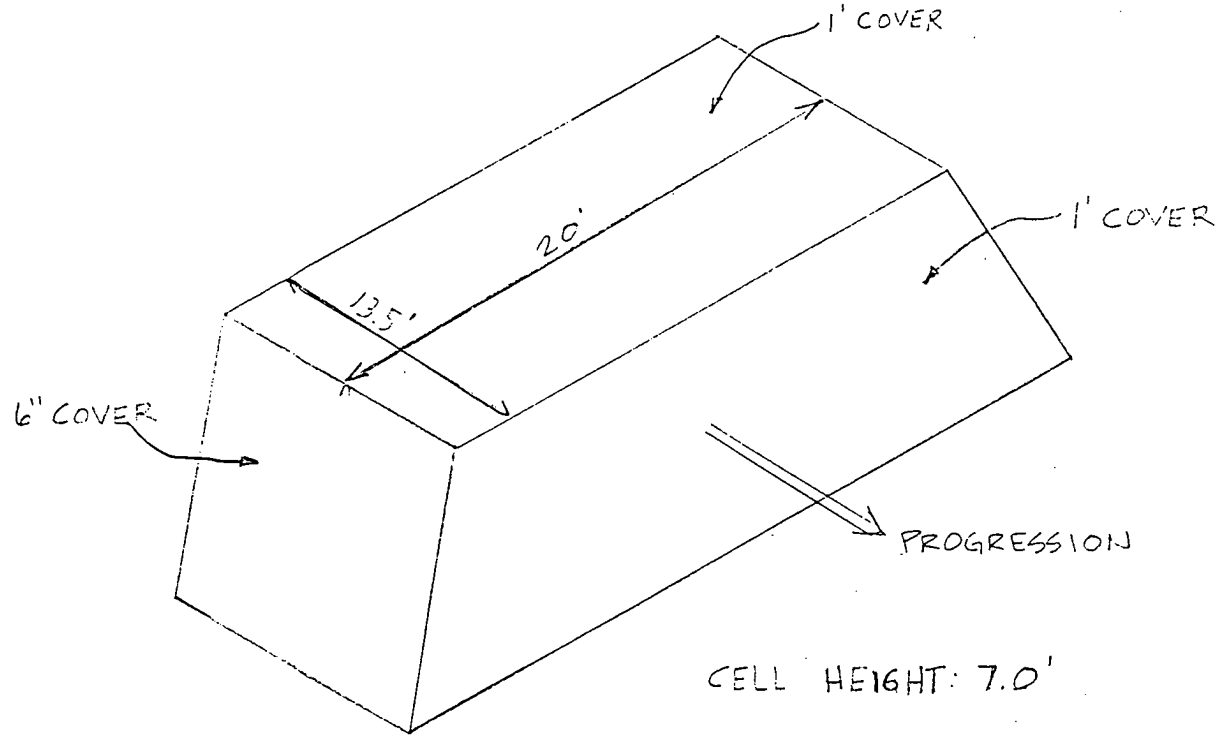
I. The total volume which can be utilized to dispose of solid waste is 144,950 cubic yards.

J. From A. above, the landfill will accept 25,000 cubic yards of solid waste each year. Therefore, the total life of the trenching phase should be approximately 5.80 years (144,950/25,000).

K. The trenching operation as described should require approximately 2.5 acres per year.

L. It will require approximately 3,500 cubic yards of earth to build the silt pond and to fill the pond which is presently in the area to be trenched.

M. It is estimated that 108,710 cubic yards of earth will be stockpiled upon completion of the trenching phase (75% of theoretical).



DAILY TYPICAL CELL
TRENCHING OPERATION

SKETCH #1

PHASE II - AREA FILL OPERATION

A. The Bolivar Landfill will dispose of 25,000 cubic yards of solid waste each year.

B. On an average day, the landfill will accept approximately 70 cubic yards of solid waste (25,000/365).

C. As shown on Sheet 6 of the plans, an area of 360,000 square feet (excluding side slopes) will be utilized for the area fill operation.

D. As shown in Sketch #2, the dimensions of a typical daily cell (excluding cover) are 20 feet wide by 12.0 feet long by 8 feet high (70 cubic yards.

E. Also, as shown in Sketch #2, the daily requirement for cover is 29.6 cubic yards.

F. Each day, 70 cubic yards of solid waste are disposed of an 29.6 cubic yards of earth are used for cover. Therefore, the site will be 70.3% compacted solid waste (70/99.6) and 29.7% earth. (Use 70% - 30%).

G. From C. above, an area of 360,000 square feet is to be utilized for the area fill operation. Using the average height of fill = 11.33 feet, the total available volume of the area fill phase = 4,080,000 cubic feet = 151,110 cubic yards.

H. From F. above, 30.0% of the volume is required for cover (daily, intermediate, and final), therefore 45,330 cubic yards of earth are dedicated for cover.

I. The total volume which can be utilized to dispose of solid waste is 105,780 cubic yards.

J. From A. above, the landfill will accept 25,000 cubic yards of solid waste each year. Therefore, the total life of the area fill phase should be approximately 4.23 years (105,780/25,000).

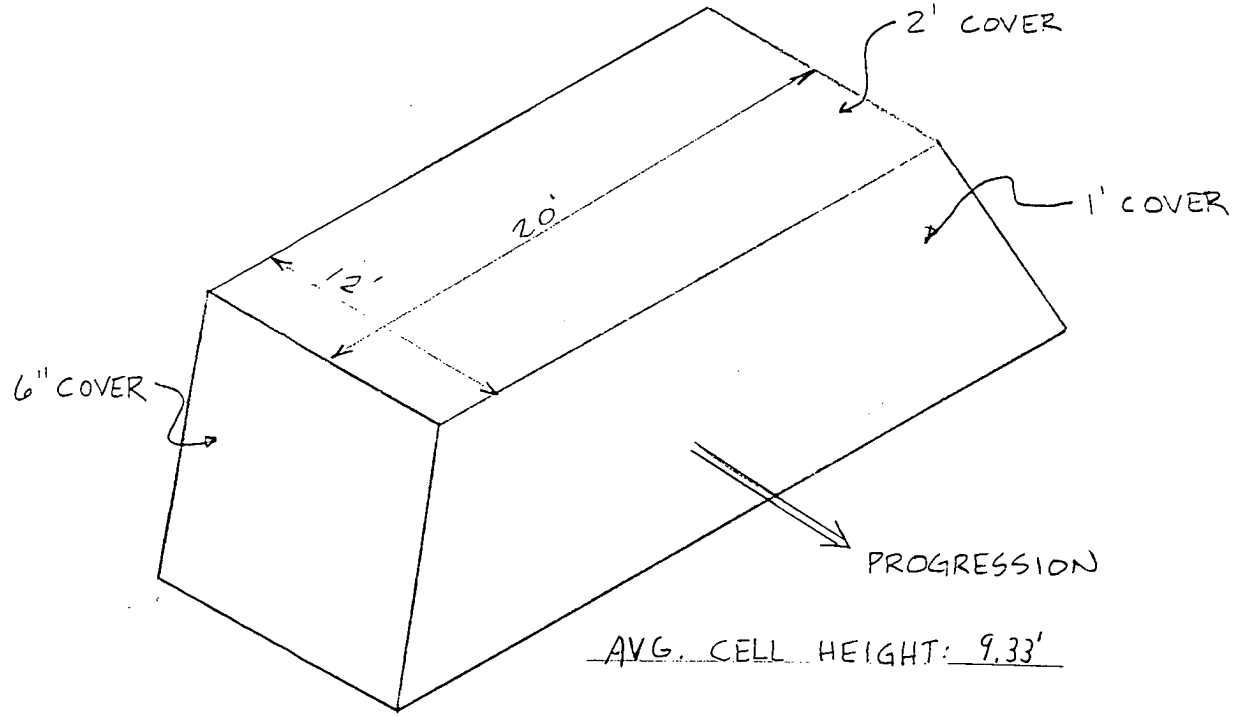
K. The area fill operation as described should require approximately 1.95 acres per year (excluding side slopes).

L. The earth required to build the slopes for the area fill phase is approximately 10.5 cubic yards per linear foot of slope. Therefore, it will require approximately 27,300 cubic yards to build the slopes as the perimeter of the area fill operation is approximately 2,600 feet.

M. Upon completion of the area fill phase, approximately 190,000 square feet of area will require an additional foot of dirt for final cover. This is the area which was trenched, but not filled. Approximately 7,040 cubic yards of earth will be required to provide adequate final cover over these areas.

N. From the information above, it will require a total of approximately 79,670 cubic yards of earth to perform all phases of the area fill operation. the fill operation should have started with in excess of 100,000 yards of earth. Thus, sufficient earth should be available to perform all operations of the landfill. If significant earth remains upon completion of the area fill phase, the City should consider adding another lift to the landfill site as the quantity of earth allows.

O. The total life of the site is calculated to be approximately 10 years.



AVG. CELL HEIGHT: 9.33'

DAILY TYPICAL CELL

FILL OPERATION

SKETCH #2

III. DRAINAGE CALCULATIONS

A. The drainage area of the site is approximately 16 acres.

B. Figure I shows the 25-year, 24-hour rainfall to be approximately 6.3 inches for the Bolivar Area (Hardeman County).

C. Figure II shows the peak discharge for 16 acres having a 24-hour rainfall of 6.3 inches to be 47 cfs.

D. Both ditches will be designed to carry the peak runoff rate of 47 cfs.

E. Ditch #1 will have a minimum slope of 1% and Ditch #2 will have a minimum slope of 2.5%. Ditch #1 is to be grassed and a manning number of 0.027 will be used for flow calculations. Ditch #2 is to be rip-rapped and a manning number of 0.016 will be used in calculations.

F. The calculations for Ditch #1 using the manning equation are as follows:

Find velocity and flow of Ditch #1 when the depth of flow = 1.2 feet.

V = (1.49/0.027)(0.76)^0.666(0.01)^0.5
V = (55.19)(0.83)(0.1)
V = 4.58 feet/second

Flow = Area x Velocity
Flow = 10.56 square feet x 4.58 feet/second = 48.4 cfs
(Ditch is O.K.)

G. The calculations for Ditch #2 using the Manning equation are as follows:

Find velocity and flow of Ditch #2 when the depth of flow = 0.85 feet.

V = (1.49/0.016)(0.56)^0.666(0.025)^0.5
V = (93.12)(0.68)(0.16)
V = 10.13 feet/second

Flow = Area x Velocity
Flow = 4.72 square feet x 10.13 feet/second = 47.8 cfs
(Ditch is O.K.)

FIGURE I

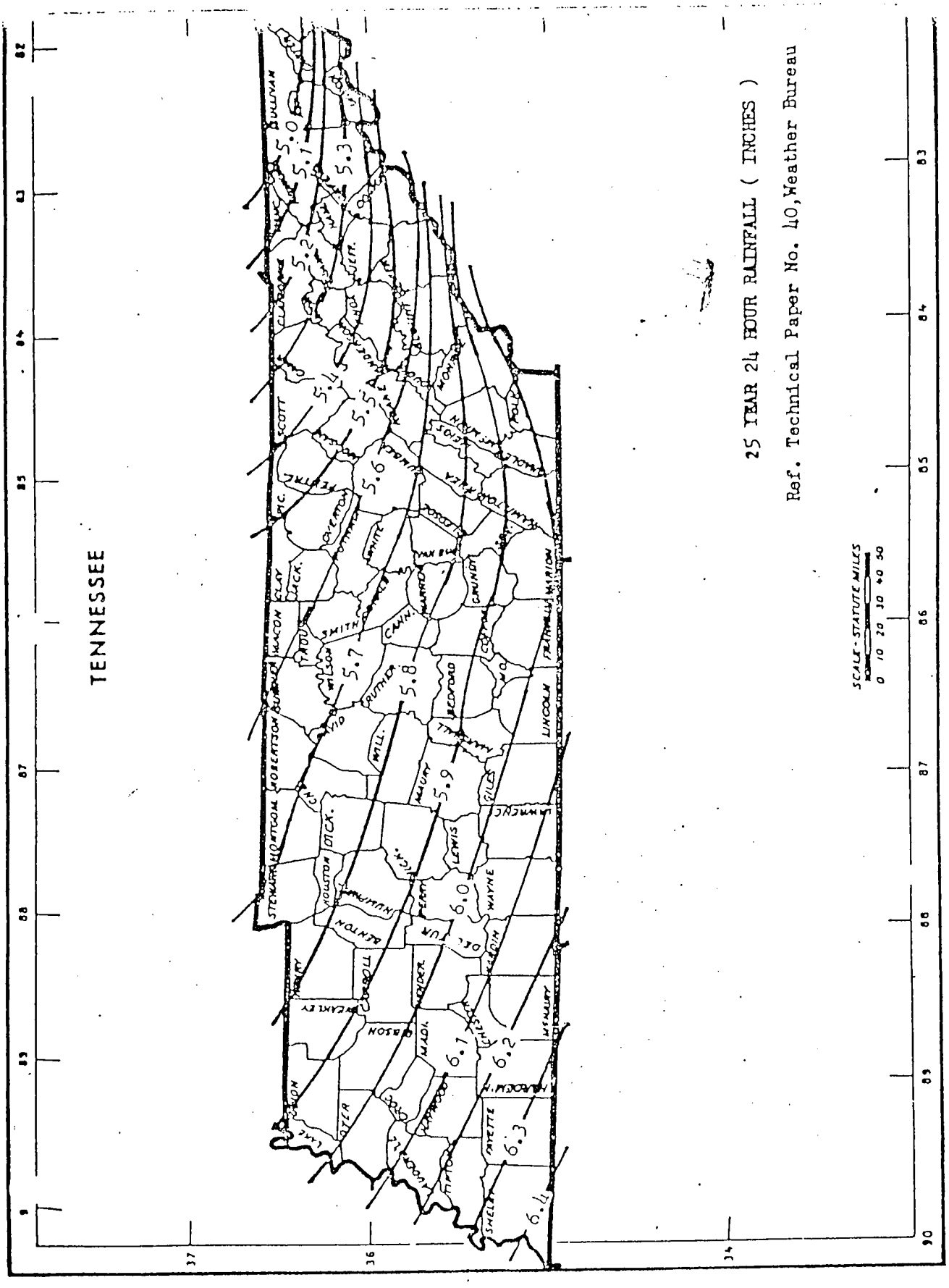
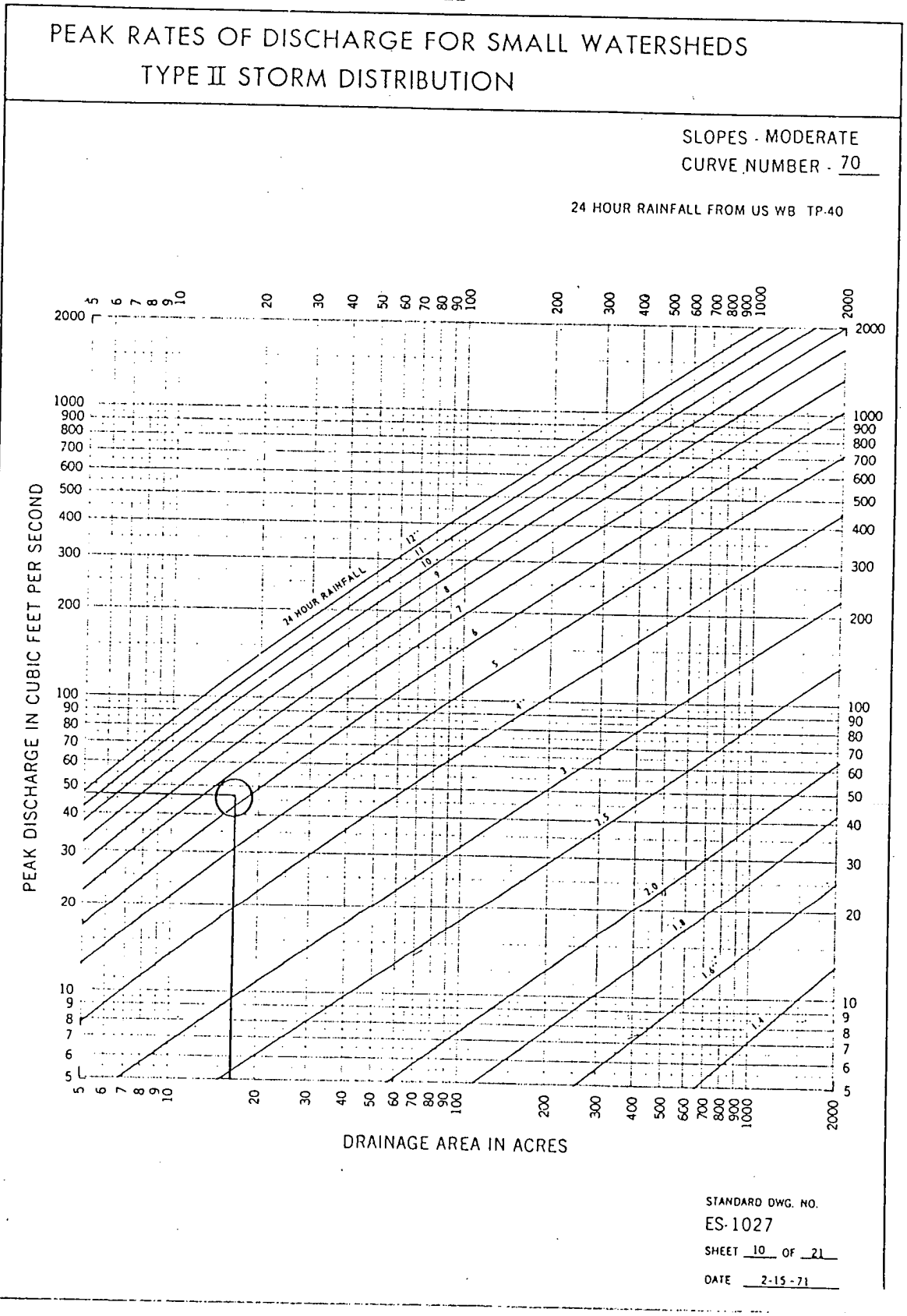

TENNESSEE
25 YEAR 24 HOUR RAINFALL (INCHES)
Ref. Technical Paper No. 40, Weather Bureau
SCALE - STATUTE MILES
0 10 20 30 40 50
5.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
6.0
6.1
6.2
6.3
6.4

FIGURE II


PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE II STORM DISTRIBUTION
SLOPES - MODERATE
CURVE NUMBER - 70
24 HOUR RAINFALL FROM US WB TP-40
PEAK DISCHARGE IN CUBIC FEET PER SECOND
DRAINAGE AREA IN ACRES
24 HOUR RAINFALL
STANDARD DWG. NO.
ES-1027
SHEET 10 OF 21
DATE 2-15-71

IV. POND CALCULATIONS

A. Assume sediment loss will be 1.0 inch over the site (16 acres).

B. Volume of sediment will be 58,080 cubic feet.

C. The normal water elevation of the silt pond is to be 427.00.

D. The bottom area of the pond (elevation 420.00) has an area of approximately 12,000 square feet. The water/sediment depth is 7 feet which equals a volume of 84,000 cubic feet. Sediment should be removed if or when it reaches 60% of the pond capacity (elevation 424.00).

V. OUTLET PIPE DESIGN

A. As shown in the drainage calculations, the peak runoff for the site should be 47 cfs.

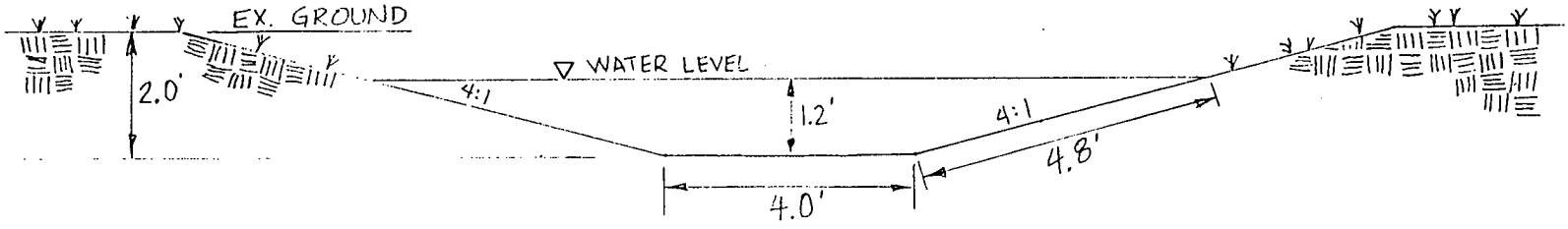
B. To prevent the pond from overflowing, two (2) 24-inch diameter outlet pipes will be utilized.

C. The outlet pipes will be laid on a 4% grade, as such the following calculations apply for the pipes flowing full:

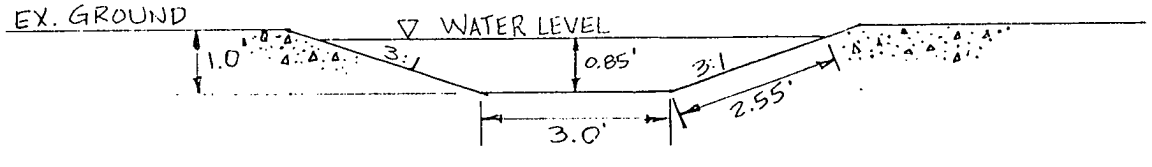
V = (1.49/n)(R)^ 0.666(S)^0.5 where
V = velocity (feet/second)
n = Manning number
R = Hydraulic radius (flow area/wetted perimeter)
S = Slope (feet/feet)

V = (1.49/0.013)(0.5)^0.666(0.04)^0.5
V = (114.6)(0.63)(0.2)
V = 14.44 feet/second
Flow = Area X Velocity
Flow = 3.14 square feet x 14.44 feet/second =
45.3 cfs per pipe, total flow capability = 90.6 cfs

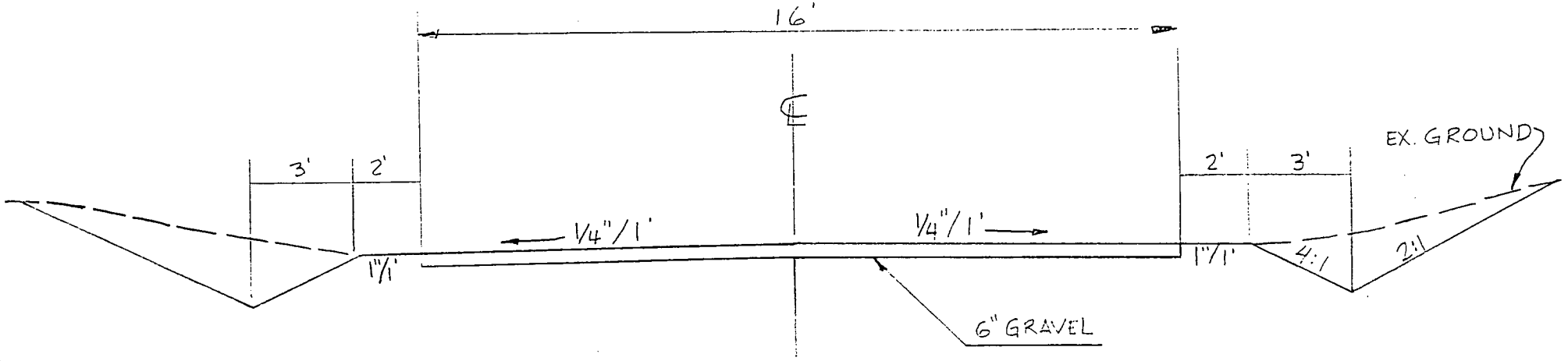
Outlet pipes can handle a 9-inch rain in a 24-hour period.



DITCH #1



DITCH #2



TYPICAL SECTION – ACCESS ROAD

N.T.S.

5,000 cu ft
12.54

****
****

HARDEMAN COUNTY LANDFILL
BOLIVAR, TENNESSEE
APRIL 27, 1992

****
****

5000 @ 9 1/2 $

40,000 gal

Storage

POOR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.3325 VOL/VOL
FIELD CAPACITY	=	0.2173 VOL/VOL
WILTING POINT	=	0.1361 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2173 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000010799999 CM/SEC

LAYER 2

BARRIER SOIL LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4224 VOL/VOL
FIELD CAPACITY	=	0.3495 VOL/VOL
WILTING POINT	=	0.2648 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3495 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000850000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	1000.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2766 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 5

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0624 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.005799999926 CM/SEC
SLOPE	=	1.00 PERCENT
DRAINAGE LENGTH	=	600.0 FEET

LAYER 6

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	60.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC
LINER LEAKAGE FRACTION	=	0.00010000

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	89.91
TOTAL AREA OF COVER	=	900000. SQ FT
EVAPORATIVE ZONE DEPTH	=	15.00 INCHES
UPPER LIMIT VEG. STORAGE	=	3.9900 INCHES
INITIAL VEG. STORAGE	=	3.9853 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	320.2322 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR NASHVILLE TENNESSEE

MAXIMUM LEAF AREA INDEX = 1.00
START OF GROWING SEASON (JULIAN DATE) = 97
END OF GROWING SEASON (JULIAN DATE) = 305

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
37.10	40.40	49.00	59.60	68.10	75.80
79.40	78.40	72.30	60.20	48.60	40.90

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MONTHLY TOTALS FOR YEAR 74

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	9.45	3.01	5.25	3.97	5.04	6.80
	2.10	4.13	10.44	1.47	6.23	2.81
RUNOFF (INCHES)	8.189	1.186	2.198	1.053	2.441	4.356
	0.627	0.623	5.788	0.752	2.751	0.838
EVAPOTRANSPIRATION	1.339	1.921	3.260	4.153	2.516	2.666
(INCHES)	1.408	3.284	4.601	1.012	1.849	1.217
PERCOLATION FROM	0.1556	0.1339	0.1441	0.1102	0.0000	0.0000
LAYER 2 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.1284
LATERAL DRAINAGE FROM	0.0234	0.0222	0.0256	0.0259	0.0278	0.0279
LAYER 5 (INCHES)	0.0299	0.0309	0.0309	0.0329	0.0328	0.0348
PERCOLATION FROM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS

AVG. DAILY HEAD ON	11.38	9.71	8.76	5.03	0.00	0.00
LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	5.64
STD. DEV. OF DAILY HEAD	0.55	1.48	1.12	2.98	0.00	0.00
ON LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	3.22
AVG. DAILY HEAD ON	2.40	2.56	2.72	2.88	3.03	3.19
LAYER 6 (INCHES)	3.34	3.48	3.63	3.77	3.91	4.04
STD. DEV. OF DAILY HEAD	0.05	0.04	0.05	0.05	0.05	0.04
ON LAYER 6 (INCHES)	0.04	0.04	0.04	0.04	0.04	0.04

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ANNUAL TOTALS FOR YEAR 74

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	60.70	4552498.	100.00
RUNOFF	30.802	2310126.	50.74
EVAPOTRANSPIRATION	29.226	2191953.	48.15
PERCOLATION FROM LAYER 2	0.6723	50421.	1.11
LATERAL DRAINAGE FROM LAYER 5	0.3452	25888.	0.57
PERCOLATION FROM LAYER 6	0.0001	10.	0.00
CHANGE IN WATER STORAGE	0.327	24525.	0.54
SOIL WATER AT START OF YEAR	322.08	24156178.	
SOIL WATER AT END OF YEAR	322.41	24180702.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	-3.	0.00

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MONTHLY TOTALS FOR YEAR 75

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	4.67	5.22	12.35	3.55	6.52	2.22
	2.96	4.69	5.42	5.86	3.00	4.12
RUNOFF (INCHES)	3.544	3.526	8.933	1.335	3.339	0.688
	1.840	2.627	2.090	3.537	0.546	2.354
EVAPOTRANSPIRATION	1.145	1.966	3.037	3.143	3.746	1.919
(INCHES)	0.989	2.080	2.891	2.591	2.003	1.139
PERCOLATION FROM	0.1539	0.1366	0.1459	0.1204	0.0146	0.0000
LAYER 2 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE FROM	0.0358	0.0331	0.0375	0.0371	0.0392	0.0388
LAYER 5 (INCHES)	0.0409	0.0418	0.0412	0.0434	0.0427	0.0449
PERCOLATION FROM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS

AVG. DAILY HEAD ON	10.99	10.39	9.20	4.20	0.21	0.00
LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	0.00
STD. DEV. OF DAILY HEAD	0.92	1.03	1.54	1.74	0.58	0.00
ON LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	0.00
AVG. DAILY HEAD ON	4.17	4.30	4.42	4.54	4.66	4.78
LAYER 6 (INCHES)	4.90	5.02	5.13	5.24	5.35	5.45
STD. DEV. OF DAILY HEAD	0.04	0.03	0.04	0.04	0.04	0.03
ON LAYER 6 (INCHES)	0.03	0.03	0.03	0.03	0.03	0.03

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ANNUAL TOTALS FOR YEAR 75

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	60.58	4543499.	100.00
RUNOFF	34.359	2576930.	56.72
EVAPOTRANSPIRATION	26.649	1998688.	43.99
PERCOLATION FROM LAYER 2	0.5714	42853.	0.94
LATERAL DRAINAGE FROM LAYER 5	0.4765	35736.	0.79
PERCOLATION FROM LAYER 6	0.0001	10.	0.00
CHANGE IN WATER STORAGE	-0.905	-67866.	-1.49
SOIL WATER AT START OF YEAR	322.41	24180702.	
SOIL WATER AT END OF YEAR	321.50	24112836.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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MONTHLY TOTALS FOR YEAR 76

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

PRECIPITATION (INCHES)	4.11	2.28	5.32	1.53	6.19	4.72
	4.01	8.05	5.08	5.17	1.30	1.81
RUNOFF (INCHES)	1.744	0.542	2.184	0.334	2.743	1.769
	1.502	5.916	2.585	2.126	0.242	0.051
EVAPOTRANSPIRATION	1.718	2.485	3.120	1.939	3.358	2.843
(INCHES)	2.260	2.772	1.992	2.616	1.263	1.430
PERCOLATION FROM	0.1173	0.1248	0.0970	0.0000	0.0000	0.0000
LAYER 2 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE FROM	0.0456	0.0434	0.0471	0.0462	0.0484	0.0475
LAYER 5 (INCHES)	0.0498	0.0504	0.0494	0.0516	0.0505	0.0528
PERCOLATION FROM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS

AVG. DAILY HEAD ON	6.52	6.28	1.90	0.00	0.00	0.00
LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	0.00
STD. DEV. OF DAILY HEAD	4.29	1.32	1.10	0.00	0.00	0.00
ON LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	0.00
AVG. DAILY HEAD ON	5.55	5.65	5.75	5.84	5.93	6.02
LAYER 6 (INCHES)	6.11	6.20	6.28	6.36	6.44	6.52
STD. DEV. OF DAILY HEAD	0.03	0.03	0.03	0.03	0.03	0.03
ON LAYER 6 (INCHES)	0.03	0.03	0.02	0.02	0.02	0.02

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ANNUAL TOTALS FOR YEAR 76

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	49.57	3717750.	100.00
RUNOFF	21.737	1630300.	43.85
EVAPOTRANSPIRATION	27.796	2084693.	56.07
PERCOLATION FROM LAYER 2	0.3391	25432.	0.68
LATERAL DRAINAGE FROM LAYER 5	0.5827	43703.	1.18
PERCOLATION FROM LAYER 6	0.0001	10.	0.00
CHANGE IN WATER STORAGE	-0.546	-40956.	-1.10
SOIL WATER AT START OF YEAR	321.50	24112836.	
SOIL WATER AT END OF YEAR	320.96	24071880.	
SNOW WATER AT START OF YEAR	0.00	0.	

SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	-2.	0.00

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MONTHLY TOTALS FOR YEAR 77

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	2.53	3.27	5.83	7.87	1.41	4.53
	1.15	4.65	5.04	4.22	5.64	4.57
RUNOFF (INCHES)	0.442	1.784	3.735	4.578	0.234	1.692
	0.168	1.657	1.905	2.749	2.578	2.522
EVAPOTRANSPIRATION	1.399	1.606	2.800	3.465	1.506	2.655
(INCHES)	0.869	3.333	2.843	1.761	1.640	1.420
PERCOLATION FROM	0.0727	0.1132	0.1184	0.0720	0.0000	0.0000
LAYER 2 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.1211
LATERAL DRAINAGE FROM	0.0534	0.0487	0.0544	0.0532	0.0554	0.0541
LAYER 5 (INCHES)	0.0564	0.0569	0.0555	0.0578	0.0564	0.0587
PERCOLATION FROM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 6 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS

AVG. DAILY HEAD ON	2.20	4.44	2.92	0.89	0.00	0.00
LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	8.17
STD. DEV. OF DAILY HEAD	3.41	1.33	0.56	0.74	0.00	0.00
ON LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	4.50
AVG. DAILY HEAD ON	6.60	6.67	6.74	6.80	6.87	6.94
LAYER 6 (INCHES)	7.00	7.07	7.13	7.18	7.24	7.30
STD. DEV. OF DAILY HEAD	0.02	0.02	0.02	0.02	0.02	0.02
ON LAYER 6 (INCHES)	0.02	0.02	0.02	0.02	0.02	0.02

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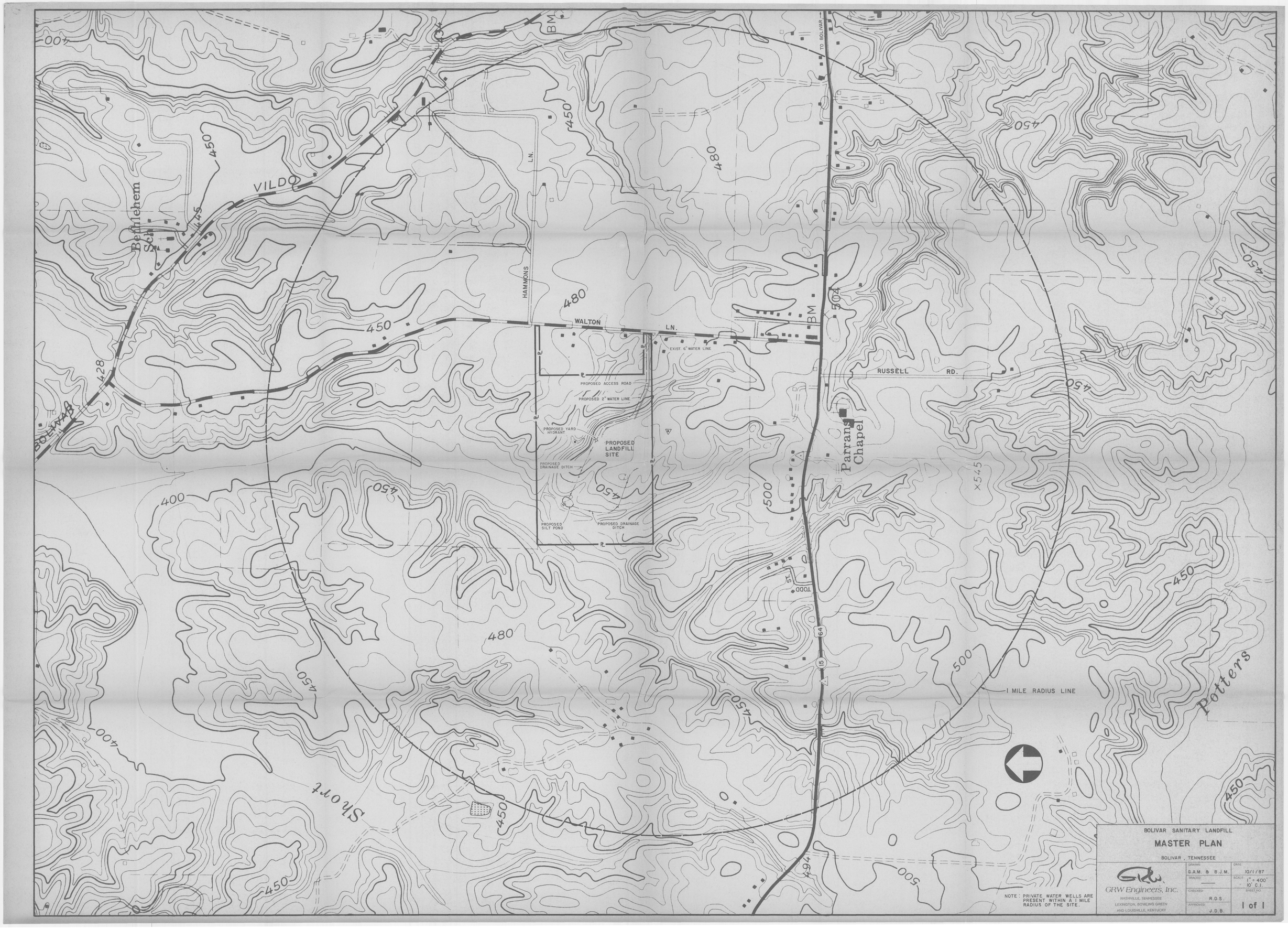
ANNUAL TOTALS FOR YEAR 77

	(INCHES)	(CU. FT.)	PERCENT



NOTE: PRIVATE WATER WELLS ARE PRESENT WITHIN A 1 MILE RADIUS OF THE SITE.

BOLIVAR SANITARY LANDFILL

MASTER PLAN

BOLIVAR, TENNESSEE

GRW Engineers, Inc.

NASHVILLE, TENNESSEE
LEXINGTON, BOWLING GREEN
AND LOUISVILLE, KENTUCKY

DRAWN: G.A.M. & B.J.M.		DATE: 10/1/87
TRACED: ——		SCALE: 1" = 400' 10' C.I.
CHECKED: R.D.S.		SHEET NO. 1 of 1
APPROVED: J.D.B.		

PRECIPITATION	50.71	3803249.	100.00
RUNOFF	24.043	1803225.	47.41
EVAPOTRANSPIRATION	25.298	1897331.	49.89
PERCOLATION FROM LAYER 2	0.4973	37301.	0.98
LATERAL DRAINAGE FROM LAYER 5	0.6610	49575.	1.30
PERCOLATION FROM LAYER 6	0.0001	10.	0.00
CHANGE IN WATER STORAGE	0.708	53107.	1.40
SOIL WATER AT START OF YEAR	320.96	24071880.	
SOIL WATER AT END OF YEAR	321.67	24124988.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	1.	0.00

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MONTHLY TOTALS FOR YEAR 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION (INCHES)	5.95	1.32	5.13	1.82	8.63	1.46
	4.03	3.79	0.57	3.10	4.01	12.45
RUNOFF (INCHES)	4.460	0.193	1.831	0.472	4.914	0.019
	1.727	1.063	0.019	1.431	1.445	9.803
EVAPOTRANSPIRATION (INCHES)	1.435	2.021	2.776	2.122	3.923	1.490
	2.316	2.372	0.906	1.520	1.500	1.557
PERCOLATION FROM LAYER 2 (INCHES)	0.1468	0.1201	0.1289	0.1111	0.0596	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0925
LATERAL DRAINAGE FROM LAYER 5 (INCHES)	0.0591	0.0537	0.0599	0.0583	0.0607	0.0591
	0.0614	0.0618	0.0601	0.0625	0.0608	0.0631
PERCOLATION FROM LAYER 6 (INCHES)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS

AVG. DAILY HEAD ON LAYER 2 (INCHES)	9.40	6.17	5.34	2.05	0.38	0.00
	0.00	0.00	0.00	0.00	0.00	4.73

STD. DEV. OF DAILY HEAD	1.26	1.25	1.90	1.06	0.37	0.00
ON LAYER 2 (INCHES)	0.00	0.00	0.00	0.00	0.00	3.45
AVG. DAILY HEAD ON	7.35	7.40	7.45	7.50	7.55	7.60
LAYER 6 (INCHES)	7.65	7.70	7.74	7.78	7.83	7.87
STD. DEV. OF DAILY HEAD	0.02	0.01	0.02	0.01	0.02	0.01
ON LAYER 6 (INCHES)	0.01	0.01	0.01	0.01	0.01	0.01

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ANNUAL TOTALS FOR YEAR 78

	(INCHES)	(CU. FT.)	PERCENT
PRECIPITATION	52.26	3919500.	100.00
RUNOFF	27.380	2053469.	52.39
EVAPOTRANSPIRATION	23.937	1795297.	45.80
PERCOLATION FROM LAYER 2	0.6589	49421.	1.26
LATERAL DRAINAGE FROM LAYER 5	0.7204	54031.	1.38
PERCOLATION FROM LAYER 6	0.0001	10.	0.00
CHANGE IN WATER STORAGE	0.223	16692.	0.43
SOIL WATER AT START OF YEAR	321.67	24124988.	
SOIL WATER AT END OF YEAR	321.89	24141680.	
SNOW WATER AT START OF YEAR	0.00	0.	
SNOW WATER AT END OF YEAR	0.00	0.	
ANNUAL WATER BUDGET BALANCE	0.00	0.	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	5.34	3.02	6.78	3.75	5.56	3.95
	2.85	5.06	5.31	3.96	4.04	5.15
STD. DEVIATIONS	2.60	1.44	3.13	2.54	2.66	2.14
	1.25	1.71	3.50	1.74	2.00	4.22
RUNOFF						

TOTALS	3.676	1.446	3.776	1.554	2.734	1.705
	1.173	2.377	2.478	2.119	1.512	3.114
STD. DEVIATIONS	2.966	1.313	2.975	1.739	1.692	1.651
	0.736	2.116	2.091	1.089	1.142	3.881

EVAPOTRANSPIRATION

TOTALS	1.407	2.000	2.999	2.964	3.010	2.315
	1.568	2.768	2.647	1.900	1.651	1.353
STD. DEVIATIONS	0.206	0.315	0.208	0.930	1.000	0.582
	0.687	0.551	1.358	0.697	0.290	0.171

PERCOLATION FROM LAYER 2

TOTALS	0.1292	0.1257	0.1269	0.0827	0.0148	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0684
STD. DEVIATIONS	0.0352	0.0097	0.0202	0.0498	0.0258	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0639

LATERAL DRAINAGE FROM LAYER 5

TOTALS	0.0435	0.0402	0.0449	0.0441	0.0463	0.0455
	0.0477	0.0484	0.0474	0.0496	0.0486	0.0509
STD. DEVIATIONS	0.0142	0.0127	0.0137	0.0129	0.0131	0.0124
	0.0126	0.0123	0.0116	0.0118	0.0111	0.0113

PERCOLATION FROM LAYER 6

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

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	54.76	(5.448)	4107299.	100.00
RUNOFF	27.664	(5.074)	2074810.	50.52
EVAPOTRANSPIRATION	26.581	(2.068)	1993592.	48.54
PERCOLATION FROM LAYER 2	0.5478	(0.1365)	41086.	1.00
LATERAL DRAINAGE FROM LAYER 5	0.5572	(0.1496)	41787.	1.02
PERCOLATION FROM LAYER 6	0.0001	(0.0000)	10.	0.00
CHANGE IN WATER STORAGE	-0.039	(0.665)	-2899.	-0.07

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	4.66	349500.0
RUNOFF	4.477	335740.9
PERCOLATION FROM LAYER 2	0.0051	382.8
HEAD ON LAYER 2	12.1	
LATERAL DRAINAGE FROM LAYER 5	0.0020	153.1
PERCOLATION FROM LAYER 6	0.0000	0.0
HEAD ON LAYER 6	7.9	
SNOW WATER	1.79	134548.5

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3325

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1313

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	3.84	0.3203
2	10.32	0.4300
3	4.52	0.3763
4	273.71	0.2737
5	3.70	0.3086
6	25.80	0.4300
SNOW WATER	0.00	

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