Leachate Collection and Disposal System
Hardee County Regional Sanitary Landfill
Hardee County, Florida

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Briley, Wild & Associates, Inc.
1042 U.S. Highway 1, North
Ormond Beach, Florida 32074

Attention: Mr. John Cumming, P.E.

Subject: Leachate Collection and Disposal System, Hardee County Regional Sanitary Landfill, Hardee County, Florida

Gentlemen:

As requested and authorized by Mr. Cumming, we have completed our geotechnical study and evaluation for the proposed leachate collection and disposal system at the Hardee County Regional Landfill site. This report presents the results of our field exploration and laboratory testing program, results of our analyses and design recommendations.

This report has been prepared for the exclusive use of Briley, Wild & Associates, Inc. and Hardee County for specific application to the subject project in accordance with generally accepted geotechnical engineering practice. No other warranty, expressed or implied, is made.

SITE CONDITIONS

The subject landfill is located within Section 35, Township 33 South, Range 25 East in Hardee County, Florida, as shown in Figure 1. Specifically, the site is situated northeast of the City of Wauchula, and approximately one mile east of the Peace River. The existing landfill encompasses approximately 11 acres and is subdivided into separate cells. Figure 2 illustrates the general configuration of the subject landfill.

The landfill currently has high density polyethylene (HDPE) sidewall liners tied to a natural clay bottom liner on the west, north and east sides with a dewatering ditch on the south side. According to Mr. J. R. Prestridge of Hardee County, all the cells except Cells 6, 7 and 8 have been filled with refuse to less than 1 foot above the surrounding natural ground elevations. Cell 1 currently has refuse to 1 to 3 feet above ground. Natural ground surface elevation on the site range from a high of 87 feet (NGVD) in the northwest corner to a low of 76 feet (NGVD) in the ditch passing through the southwest corner of the site. The site generally slopes toward the bay head in the east-central portion. In wet weather, this bay head drains through a ditch to the southwest corner of the property toward the Peace River.

Figure 3 illustrates the undisturbed natural ground surface soil associations on the site as mapped by the Soil Conservation Service (Envisors, Inc., 1982). The surface soils at the site consists of poorly drained (under natural condition), nearly level sandy soils found in the flatwood areas of the coastal plains. A description of the major soil associations which existed on the site prior to disturbance is presented in Table 1.

The high water table for the soil series at the site under natural conditions, as reported by the SCS, is generally within 10 inches below ground for Pomona fine sand and Oldsmar fine sand. During the wet season, groundwater rises to the surface in the areas with Immokalee fine sand, Florida mucky fine sand and Tomoka muck. The man-made ditch at the site has lowered the groundwater levels in the area south of the existing landfill significantly.

According to Wilson (1977), Hardee County falls within the mid-peninsular physiographic zone which includes the three subdivisions, the Polk Upland, DeSoto Plain, and Gulf Coastal Lowlands. These subdivisions correspond to several marine plains or terraces which were formed by invasions of the sea during the Pleistocene Epoch. The site lies within the Polk Upland which is a broad, slightly dissected upland in northern Hardee County.

The climate of the area is warm and moist during summers and mild and relatively dry during winters. Annual rainfall is 53 inches per year on average as documented by readily available records from the Wauchula, Florida weather station.

About 60 percent of the annual total falls during four summer months, June through September. Most of the summer rainfall is derived from local showers and thunderstorms. The average monthly distribution of rainfall at Wauchula is presented below:

RAINFALL RECORDS

Month	Rainfall* (inches)
January	2.40
February	3.01
March	3.02
April	2.46
May	4.94
June	8.33
July	8.50
August	6.87
September	7.03
October	2.88
November	1.76
December	1.89
	53.09"

*1951 - 1980 data

According to the Florida Bureau of Geology Map Series No. 32, annual rainfall exceeds lake evaporation by 5 inches.

GEOHYDROLOGY

According to the U.S. Geological Survey, Report of Investigation No. 83, the groundwater system in the study area consists of two aquifers, the surficial aquifer and the Floridan aquifer, which are separated from each other by a confining bed. The surficial unconfined aquifer consists of unconsolidated deposits of Pleistocene sand, clay, and phosphorite with minor thin-bedded limestone. Based upon the available site boring data, the surficial Pleistocene sand unit is underlain by interbedded layers of gray to grayish green clayey sand and sandy clay grading to a phosphatic calcareous and non-calcareous sandy clay at a depth between 12.5 feet and 19.0 feet below ground surface. This clayey stratum appears to constitute a continuous confining bed which separates the unconfined surficial aquifer from the top of the upper Floridan aquifer. The phosphatic sandy clay corresponds geologically to the Hawthorn Formation of the Miocene age. According to Envisor, Inc. (1982), at the site, the upper confining clay layer, which is underlain by calcareous sandy clay and limestone, varies in thickness between 14 feet and 35 feet with an average thickness of about 25 feet. Wilson (1977) considers the top of the upper Floridan aquifer to be the top of the uppermost limestone of the Hawthorn Formation. The calcareous sandy clay and limestone unit corresponds to the upper limits of the Tampa Formation of early Miocene age. In the site vicinity, the combined thickness of the Hawthorn and Tampa formations is approximately 400 feet.

The Tampa Limestone Formation is underlain by a series of limestone formations which comprise the lower unit of the Floridan aquifer. The lower unit of the Floridan aquifer consists of the limestone and dolomite beds of the Suwannee Limestone of Oligocene age, the Ocala Group, and Avon Park Limestone of Eocene age. Envisor, Inc. (1982) reports the average thickness of the Suwannee Limestone to be about 200 feet. The Ocala Group consists of the Crystal River, Williston, and Inglis formations which range in thickness from 250 feet to 400 feet. The Avon Park Limestone ranges in thickness from 200 feet to 470 feet.

In 1980, the U.S. Geological Survey documented the potentiometric surface of the Floridan aquifer at 55.0+ feet (NGVD). The 1980 Floridan aquifer mapping indicated the direction of groundwater flow in the Floridan aquifer in the site vicinity to be toward the southwest.

FIELD EXPLORATION

The field exploration consisted of performing four (4) Standard Penetration Test (SPT) borings and installing three (3) piezometers at the locations shown in Figure 2. Two SPT borings were drilled within the landfill site. One SPT boring was performed south of the existing dewatering ditch. The remaining one boring was performed outside the landfill boundary (i.e., outside the HDPE side liner) on the east side. Hardee County ran vertical control to the land surface elevations at each boring and piezometer locations. The borings were staked in the field by measurement from known landmarks. The locations shown should be considered accurate only to the degree implied by the method used.

The borings were advanced to depths varying from 10.5 to 16.5 feet with continuous sampling within the upper 10 feet and at 5-foot intervals thereafter. These samples were recovered from each of the test holes and visually classified in the field. The SPT borings were performed according to ASTM D-1586 methodology as summarized in Appendix 1.

Representative soil samples were transported to our laboratory in air-tight sample jars for further classification and laboratory testing. In addition, three "undisturbed" Shelby tube samples were retrieved during our field exploration for the determination of the engineering properties of the existing site soils. A description of the undisturbed sampling procedures is included in Appendix 2.

Typed copies of the soil boring logs are provided in Appendix 3. The results of our field exploration are also presented in the form of generalized soil profiles in Figure 4. Soil stratification is based upon examination of recovered soil samples and interpretation of field boring logs. The stratification lines represent the approximate boundary between soil types and the actual transition may be gradual. In some cases, variations in properties not considered pertinent to our engineering evaluations have been omitted for clarity.

The soil profile is variable, as shown in Figure 4, a subsurface profile across the site from south to north. In general, the upper 12 feet to 14.5 feet of the existing landfill site consists of brown to gray and reddish brown fine sand to silty fine sand, with occasional slightly clayey fine sand layers (Stratum 4) and traces of cemented sand (Stratum 2). Test hole 3 (TH-3) encountered a thin layer of clayey fine sand (Stratum 5) at a depth of 8.5 feet below ground surface. All of our test holes except TH-3 were terminated in a stratum consisting of gray to grayish brown clayey sand to sandy clay with traces of phosphates which was encountered at a depth between 12 and 14.5 feet below ground surface. These results are in general agreement with the site soil conditions reported by Envisors, Inc. (1982). The phosphatic clayey stratum corresponds geologically to the Hawthorn Formation of Miocene age. According to Envisor, Inc. (1982), this cohesive clayey layer, which is underlain by calcareous sandy clay and limestone, varies in thickness between 14 and 35 feet with an average thickness of about 25 feet. The calcareous sandy clay and limestone unit corresponds to the upper limits of the Tampa Formation of early Miocene age.

Three piezometers were installed at the subject site to monitor the groundwater level at each of the test hole locations. All three piezometers were installed above the confining clay layer (Stratum 6). Groundwater level observations were made during our field exploration on December 29, 1986. The groundwater levels measured on these dates are also shown in Figure 4. Groundwater levels noted on the boring profiles represent instantaneous readings and are not necessarily representative of conditions expected on a long-term basis such as minimum, average, or maximum.

The 2-inch diameter piezometers were installed by advancing a 6-inch hole to the final piezometer depth, inserting a length of 2-inch diameter No. 10 slotted PVC pipe connected to a 2-inch diameter schedule 40 PVC riser, backfilling the annular space with 20-30 silica sand to above the screen, installing a 12-inch tamped bentonite seal above the collection zone and backfilling with a bentonite/cement grout to land surface. The piezometer installation details are presented in Appendix 4.

An in situ permeability test was performed in piezometer P-1 adjacent to TH-1A. The measured coefficient of permeability of the surficial aquifer was 2.6×10^{-4} cm/sec (0.74 feet/day). Permeability tests could not be performed in the remaining piezometers because of relatively deep water tables encountered at the time of our field exploration. Envisors, Inc. (1982) reported permeabilities for the surficial aquifer in the range of 5.5×10^{-5} cm/sec to 3.3×10^{-3} cm/sec with an average of 4.9×10^{-4} cm/sec.

LABORATORY TESTING PROGRAM

All split-spoon samples taken during the field exploration program were classified in the laboratory using the procedures outlined by the Unified Soil Classification System. The results of the laboratory tests, which include percent fines and natural moisture determination and grain size distribution, were used to aid in classification and in defining the stratification of the subsurface soils. All of the tests, where applicable, were performed in accordance with ASTM standards. The laboratory test results are shown beside the location of each tested sample on the soil boring logs in Appendix 3. The complete grain size curves are presented in Appendix 5.

In-place dry densities were determined for all the "undisturbed" Shelby tube samples obtained. The in situ dry density of the surficial aquifer soils ranged from 85.6 to 106.8 pounds per cubic foot.

One constant head and two falling head permeability tests were performed on the relatively undisturbed surficial aquifer soils to determine the relation between the horizontal coefficient of permeability, soil density, and soil type. The samples were prepared in a manner allowing flow parallel to the field horizontal direction.

The constant head permeability test was performed in a specially manufactured triaxial-type permeameter with the test specimens encased in latex membrane. The falling head permeabilities were tested in stainless steel molds. The head difference across the constant head sample was monitored with an electric pore pressure transducer and manually recorded from a digital voltmeter. Water was used as the permeant, and the quantity of flow occurring through the specimens was monitored with time in 20 cc-burettes. Sufficient quantities of flow were allowed to pass through the specimens until constant values of the coefficient of permeability were obtained.

The results of horizontal permeability tests (laboratory) are also presented in Appendix 3 adjacent to the location of the soils tested. The measured coefficients of horizontal permeability were 5.1×10^{-4}, 4.3×10^{-3} and 1×10^{-5} cm/sec for the three tested samples with the percent passing the U.S. No. 200 sieve of 17, 12 and 26 percents, respectively. The initial dry densities of the tested samples were 106.8, 93.5 and 88.0 pcf, respectively.

ANALYSES AND RECOMMENDATIONS

For the purpose of analyses, the subject site was considered underlain by an average 12-foot thick surficial aquifer overlying a continuous confining layer with an average thickness of about 25 feet. Based upon the results of our field and laboratory programs and that presented by Envisors, Inc. (1982), a surficial aquifer permeability of 1.4 feet/day was used in the analyses. A confining bed permeability of 2.83×10^{-4} feet/day ($=10^{-7}$ cm/sec) was conservatively used in the analyses. Envisors, Inc. (1982) reported an average permeability of 5.8×10^{-8} cm/sec for this confining clay layer.

Water Balance

Water balance analyses were performed for the existing landfill site to estimate leachate quantities generated from the site. Analyses were also performed for the proposed sprayfield area south of the dewatering ditch to estimate the lateral seepage from this area to the dewatering ditch. This seepage water comes in contact with the leachate water in the dewatering ditch and, therefore, needs to be disposed of in a manner similar to disposal of leachate.

Water balance analyses were performed utilizing the "Hydrologic Evaluation of Landfill Performance (HELP)" computer model developed by the U.S. Army Engineer Waterways Experiment Station in Vicksburg, Mississippi. This program models on a daily basis the effects of all of the hydrologic processes, including precipitation, surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage, that enter the water balance equation. Daily rainfall and temperature data from 1974 to 1978 for West Palm Beach, Florida (default data in the model) were used in the analyses. These data appeared to be closer to reported average values at the site than the 1974-78 data for Tampa. It is our opinion that the West Palm Beach data are sufficiently representative of site conditions to be used in the water balance calculations required for this project. The conceptual hydrologic cycle in the landfill area is illustrated in Figure 5.

Two scenarios were considered for water balance analyses of the existing landfill. The first scenario which represents the worst case in generating leachate, assumes that the landfill site is completely filled with refuse to the original ground surface elevation and has a 12-inch thick intermediate cover without any surface vegetation. This scenario approximates the existing conditions at the landfill except that cells 6 and 7 (Figure 2) are still virgin natural ground. The vertical coefficient of permeability of the intermediate cover used in the analyses is 1.4 feet/day.

The second scenario represents the conditions of a "closed" landfill. A 24-inch thick compacted final cover having a good grass cover and with a vertical coefficient of permeability of 0.3 feet/day was used in the analyses. In both the scenarios, a 4-foot deep perimeter underdrain system on the west, north and east sides of the landfill was incorporated in the analyses.

Natural ground condition in the proposed sprayfield area south of the dewatering ditch was simulated using the coefficient of permeability for the surficial aquifer of 1.4 feet/day and a poor grass cover.

Table 2 presents summary results of water balance analyses for the various design conditions. As can be seen, the maximum amount of leachate will be generated when the refuse is at the original ground surface elevation with 12 inches of intermediate cover. For the purpose of disposal area design, we recommend a leachate generation rate of 11.9 inches per year. For an 11-acre landfill, this rate corresponds to 0.03 acre-feet per day.

Land Application System (LAS)

The hydraulic capacity of a site for a LAS depends on such site specific variables as aquifer permeability, thickness of aquifer, height between bottom of aquifer and design water level at LAS, height between aquifer and water level in adjacent areas out of the zone of influence of the LAS, existing maximum high water level at the LAS site, and recharge to the first artesian aquifer.

The LAS can be a slow rate, rapid rate or flood irrigation system. At the subject site, only a slow rate system was considered.

Water budget analyses indicate that average annual rainfall is approximately 53 inches, average annual runoff is approximately 13 inches, and percolation to "deep" aquifers is less than 1.6 inches per year. Net rainfall (e.g. rainfall minus runoff) is water available for plant evapotranspiration and is equal to approximately 38 inches at the site.

Gross irrigation requirement is equal to the maximum plant evapotranspiration rate less net rainfall divided by irrigation efficiency. McCloud, 1970, reports that the maximum annual evapotranspiration rate for grasses in central Florida is 64.4 inches. Using an irrigation efficiency for a spray irrigation system of approximately 85 percent, the annual gross irrigation requirement for a sprayfield system at the subject site is approximately 31 inches per year, which compares well with the gross irrigation rate of 31.8 inches per year (for pasture grass) as recommended by the Soil Conservation Service for the Tampa area.

Using a gross irrigation rate of 31.8 inches per year, the area required for irrigation is calculated to be about 5.4 acres. Based upon a percolation rate of 3.9 inches per year (Table 2), approximately 10 acres of land south of the dewatering ditch is estimated to contribute lateral seepage to the dewatering ditch (i.e., approximately 10 acres of land immediately south of the dewatering ditch is suitable for spray irrigation of leachate).

The estimated monthly gross irrigation requirement is as follows:

ESTIMATED GROSS IRRIGATION REQUIREMENT

Month	Inches
January	1.04
February	0.73
March	1.71
April	3.61
May	5.85
June	3.55
July	3.37
August	3.01
September	2.11
October	3.01
November	2.63
December	1.23
	31.80

These values represent the average monthly irrigation quantities that the cover crop will accept during irrigation periods. Irrigation can occur whenever there is no surface water runoff. During drought periods gross irrigation requirements will be greater than these average values. Likewise, during extreme wet weather periods the gross irrigation requirements will be less than the average values.

The irrigation system should be designed to handle less than 1 to more than 6 inches per month based on the average monthly gross irrigation requirements. Considering the infiltration/percolation rates for the soils, the fact that irrigation cannot occur during surface water runoff periods, and the fact that close to 6 inches per month of irrigation may be deemed prudent during some months, the following design criteria for the irrigation system are provided:

- Maximum application rate is 0.1 inch per hour
- Maximum liquid loading is 1 to 2 inches per week
- Effluent is applied once every 7 days
- In the winter months, application rate may be as low as 0.2 inch/week
- In the summer months, application rate may be over 1 inch/week
- The average application rate should not exceed 0.61 inches per week on an average annual basis.

At the site, the lateral seepage from the irrigated area is expected to be toward the dewatering ditch south of the landfill. We recommend, however, that monitoring wells be installed south of the irrigated area to monitor flows potentially leaving the site in this direction.

The irrigation site should have a cover crop the entire year. Hay, coastal bermuda grass and winter rye grass are the anticipated cover crop. The rye grass needs to cover the land by mid November such that the cover crop will be functioning at the time of the first hard freeze in the fall. Young, healthy crops are optimum for nutrient and transpiration of water uptake.

The design loading rate for this site must also consider the nutrient uptake of the cover crop. The nitrogen uptake of a coastal bermuda-rye grass combination, based on the Tallahassee experience as referenced in U.S. EPA 1976 (a), is approximately 600 lbs/acre/year assuming a crop yield for coastal bermuda of 10 ton/acre/year and for rye grass of 3 tons/acre/year. The design loading rate of an LAS site with a coastal bermuda-rye grass combination for an effluent with a total nitrogen concentration of 25 mg/1, then, would be limited to 2 inches per week. If the nitrogen concentration in the effluent is 12.5 mg/1, the design loading rate, under similar cover conditions, could be increased to 4 inches per week. Under these conditions, the nitrogen content of the percolate would be essentially zero.

Leachate Storage Area

The existing 700-foot long dewatering ditch has top and bottom widths of 100 feet and 50 feet, respectively. The average depth to the ditch bottom is approximately 11.4 feet. The maximum storage available in the ditch is 14 acre-feet.

The storage requirement for the irrigation system can be calculated using monthly water balance data. Based on the analysis of the average gross monthly irrigation requirements and the average monthly distribution of leachate production calculated by the HELP model, the maximum storage required is approximately 3.1 acre-feet, which corresponds to 3.2 feet of leachate in the ditch. This value represents an estimate of average condition requirements. The maximum storage is expected to occur in the month of March. The monthly water balance calculations are provided in Table 3.

Side Liner

As discussed previously, approximately 10 acres of land south of the dewatering ditch contribute lateral seepage to the ditch. No seepage is anticipated to leave the dewatering ditch. A side liner is therefore not required on the fourth (i.e., the south) side of the landfill site.

It was shown above that 5.4 acres of sprayfield is required to dispose of the leachate generated from the landfill. Using a rectangular spray irrigation plot (adjacent to the dewatering ditch) with a length of 700 feet parallel to the ditch, a 335-foot extension of the side liner is recommended to force all seepage toward the dewatering ditch. We recommend extending the east and west wall side liners to a minimum distance of 400 feet south from the south edge of the ditch.

The side liner should consist of a minimum 60 mil high density polyethylene (HDPE) liner keyed at least 18 inches into the continuous confining clay layer (Stratum 6) underlying the site. The new HDPE side liner should be field welded to the existing HDPE liner using a "Fusion Welding" technique. The specifications for the new HDPE side liner are provided in Appendix 6.

Leachate Collection System

A leachate collection system is required at the site to collect and convey the leachate to the dewatering ditch and to prevent leachate from building up within the landfill and from exiting the above ground landfill side walls in the future. In addition, the leachate collection system will lower the hydraulic head necessary for recharge into the underlying aquifer.

We recommend a peripheral leachate collection underdrain on the west, north and east sides of the landfill. The underdrains should be a minimum of 4 feet below natural ground and should slope toward the dewatering ditch. Figure 6 illustrates two alternative leachate collection underdrain design concepts.

The first alternative consists of a minimum 14-inch wide trench and an 8-inch diameter corrugated, slotted HDPE pipe completely surrounded by at least 3 inches of clean filter aggregates. Though the anticipated steady-state leachate flow of approximately 0.004 gpm per lineal feet of pipe can be handled by a 6-inch diameter pipe, we recommend using a minimum 8-inch inside diameter underdrain pipe for clean out purposes.

The second alternative consists of a minimum 24-inch wide trench and an 8-inch diameter corrugated slotted HDPE pipe completely surrounded by at least 3 inches of locally available coarse concrete aggregates which in turn is completely wrapped in a filter fabric as shown in Figure 6.

The underdrain pipe should meet ASTM F-667 specifications for corrugated heavy duty polyethylene tubing and fittings.

The filter aggregate or concrete aggregate that surrounds the slotted pipe should be clean, non-calcareous, and should not be susceptible to attack from acids and alkalies with a pH of 3 to 11 and must be sized to prevent the backfill above the filter aggregate from entering the filter system and to prevent the filter aggregate or concrete aggregate from entering the slotted pipe.

The specifications for the leachate collection system are provided in Appendix 7.

Monitoring Program

A monitoring program is proposed for the LAS. The following monitoring program will serve to aid in operation of the system:

- Flow meter to monitor leachate generation
- Raingage at spray irrigation site
- Water table monitoring wells
- Staff gage in holding pond (i.e., dewatering ditch)
- Flow meter on irrigated water

The flow into the dewatering ditch will be documented by the raingage and the flow meter. The change in storage level in the ditch will be documented by the staff gage in the pond. The flow meter on the irrigated water and site raingage

staff gauge
in dewatering
ditch

will document the water applied to the irrigated land. The groundwater monitoring wells will aid in managing the water table so the root zone is not saturated for too long a period.

The analysis and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated. This report does not reflect any variations which may occur at other locations where borings are not available. The nature and extent of variations between the borings may not become evident until during the course of construction. If variations then appear evident, it may be necessary for a reevaluation of the recommendations to be made after performing on-site observations during the construction period and noting the characteristics of any variations.

In the event any changes occur in the size, shape, location or loading conditions of the LAS site and ditch system, we should review the applicability of conclusions and recommendations in this report. We also recommend a general review of final design and specifications by our office to check that our recommendations have been properly interpreted and implemented in the design specifications.

It has been a pleasure to assist you on this phase of the project. If you have any questions concerning the contents of this report, please do not hesitate to contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

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Table 1

DESCRIPTION OF MAJOR SOIL ASSOCIATIONS
(Source: Envisors, Inc., 1982)

Classification Number	Soil Type	Description
10	Pomona Fine Sand	The Pomona Series consists of poorly drained, nearly level soils of the Flatwoods in the hyperthermic region of the coastal plains. Typically, these soils have a very dark gray sand surface horizon underlain to a depth of about 26 inches by layers of gray or light gray sand. Below this to 36 inches are layers of very dark gray sand that are weakly cemented. Between depths of 36 to 51 inches are layers of brownish sand. Below 51 inches to 72 inches or deeper are layers of gray sandy clay loam or light sandy clay.
13	Floridana Mucky Fine Sand Depressional	These are very poorly drained soils that occur on broad low flats. A representative profile has a black sand surface soil about 12 inches thick and a grayish brown sand subsurface layer over a dark gray sandy clay loam subsoil that begins within a depth of 20 to 40 inches below the soil surface. These soils were formed in sandy and loamy marine sediments.
15	Immokalee Fine Sand	The Immokalee Series consists of poorly drained sandy soils with a weakly cemented BH horizon below a depth of 30 inches. They occur on the lower atlantic and gulf coastal Flatwoods and formed in sandy marine sediments. In a representative profile, the surface layer is very dark gray fine sand 6 inches thick. Next is 6 inches of light gray fine sand and then 23 inches of white fine sand. Between 35 and 54 inches is weakly cemented black and dark reddish brown fine sand, brown fine sand extended to below 80 inches.

Table 1
(continued)

DESCRIPTION OF MAJOR SOIL ASSOCIATIONS

Classification Number	Soil Type	Description
35	Oldsmar Fine Sand	The Oldsmar Series consists of nearly level, poorly drained soils in Flatwoods areas in central and southern Florida. In a representative profile, the surface layer is black fine sand about 5 inches thick. The subsurface layer is gray and light gray fine sand that extends to about 34 inches deep. Next is about 10 inches of black and dark reddish brown fine sand that is coated with organic matter. Mottled fine sandy loam is next and extends to below a depth of 65 inches.
36	Tomoka Muck	The Tomoka Series consists of very poorly drained, nearly level soils that occur in south and central Florida. In a representative profile, the soil is muck to a depth of 27 inches. The upper 5 inches is very dark brown. The next 6 inches is dark reddish brown and between depths of 13 to 27 inches it is black. Below this is a layer of very dark gray sand about 4 inches thick, and then a layer of gray sand about 4 inches thick. Between depths of 35 to 46 inches is dark gray sandy clay loam underlain by gray sandy loam.

Table 2

SUMMARY OF WATER BALANCE ANALYSES

	Thickness of Cover (inches)	Permeability of Cover (feet/day)	Surface Condition	SCS Curve No. Used	Annual Rainfall (inches)	Annual Runoff (inches)	Annual ET (inches)	Annual Percolation (inches)	Annual Recharge (inches)
Worst Case: Landfill refuse at original ground surface elevation	12	1.4	Bare	80 (85.6)*	56.9 56.9	5.3 (8.4)	32.4 (32.0)	11.9 (9.7)	1.6 (1.6)
Final Cover Scenario	24	0.3	Good Grass	74*	56.9	4.3	37.5	8.3	1.6
Proposed sprayfield area south of dewatering ditch	Natural Ground	1.4	Poor Grass	85	56.9	11.8	33.4	3.9	1.6

NOTES

- ET Evapotranspiration
- * Curve number generated by the HELP model
- The analyses for the landfill consider a peripheral leachate collection underdrain around landfill boundary.

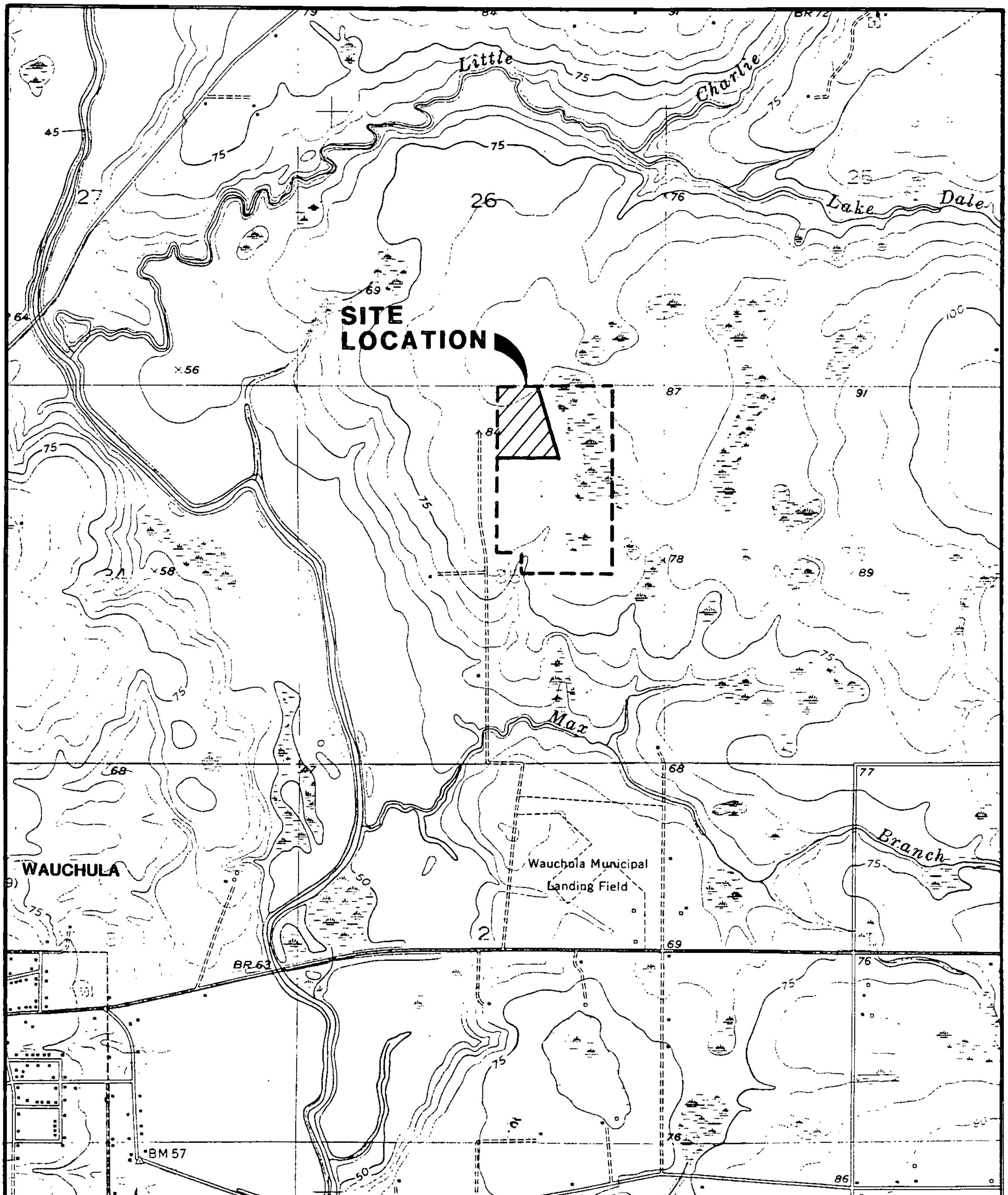
Table 3

MAXIMUM STORAGE REQUIREMENT

Month	Wauchula PPT	West Palm Beach PPT (in)	(1) Leachate (in)	(2) Leachate Volume (acre-in) (1)x11 ac.	(3) Spray Irrigation (in) (USDA)	(4) Volume Irrigation (acre-in) (3)x5.5 ac.	(5) Drainage to Ditch (in)	(6) Volume Drain (acre-in) (5)x10 ac.	(7) Change in Storage (acre-in) (2)+(6)-(4)	Cumulative Storage (acre-in)
Jan	2.40	3.33	0.922	10.142	1.04	5.72	.295	2.95	7.37	27.46
Feb	3.01	1.81	0.769	8.459	0.73	4.02	.265	2.65	7.09	34.55
Mar	3.02	1.70	0.820	9.020	1.71	9.41	.290	2.90	2.51	37.06
Apr	2.46	1.16	0.723	7.953	3.61	19.86	.269	2.69	-9.22	27.84
May	4.94	8.66	0.765	8.415	5.85	32.18	.297	2.97	-20.80	7.04
Jun	8.33	6.28	0.928	10.208	3.55	19.53	.305	3.05	-6.27	0.77
Jul	8.50	5.22	0.997	10.967	3.37	18.54	.330	3.30	-4.27	0
Aug	6.87	5.13	0.972	10.692	3.01	16.56	.333	3.33	-2.54	0
Sep	7.03	8.73	1.084	11.924	2.11	11.61	.339	3.39	3.70	3.70
Oct	2.88	5.69	1.248	13.728	3.01	16.56	.386	3.86	1.03	4.73
Nov	1.76	5.31	1.275	14.025	2.63	14.47	.378	3.78	3.34	8.07
Dec	1.89	3.90	1.355	14.905	1.23	6.77	.388	3.88	12.02	20.09
Total	53.09	56.92	11.858		31.8		3.874			

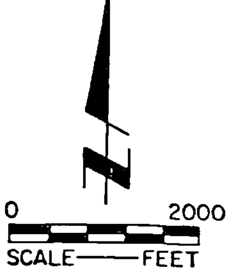
NOTES

- PPT (precipitation) used are for W. Palm Beach
- Leachate quantities are 5-yr. average values 74-78
- Naturally drainage to dewatering ditch occurs from approximately 10 acres.
- Spray Area = (Area LF x 11.857 + 10 x 3.874)/31.8 = 5.32 ac, say 5.5 acres.



SITE LOCATION MAP

SECTION 35
RANGE 25 EAST
TOWNSHIP 33 SOUTH



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Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HARDEE COUNTY REGIONAL
SANITARY LANDFILL
HARDEE COUNTY, FLORIDA

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SOURCE: U.S.G.S. WAUCHULA QUADRANGLE, 1955

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FIGURE 1

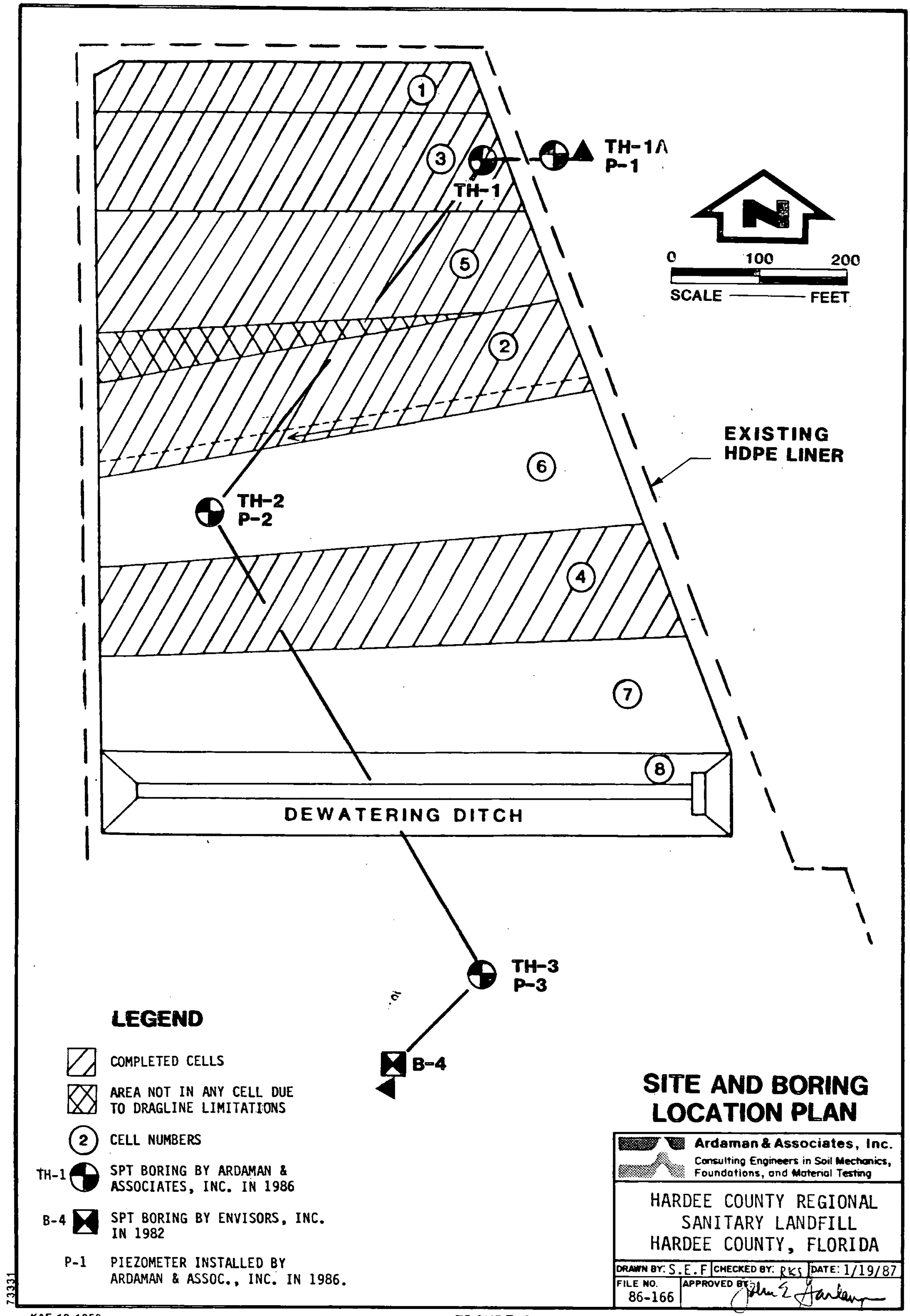

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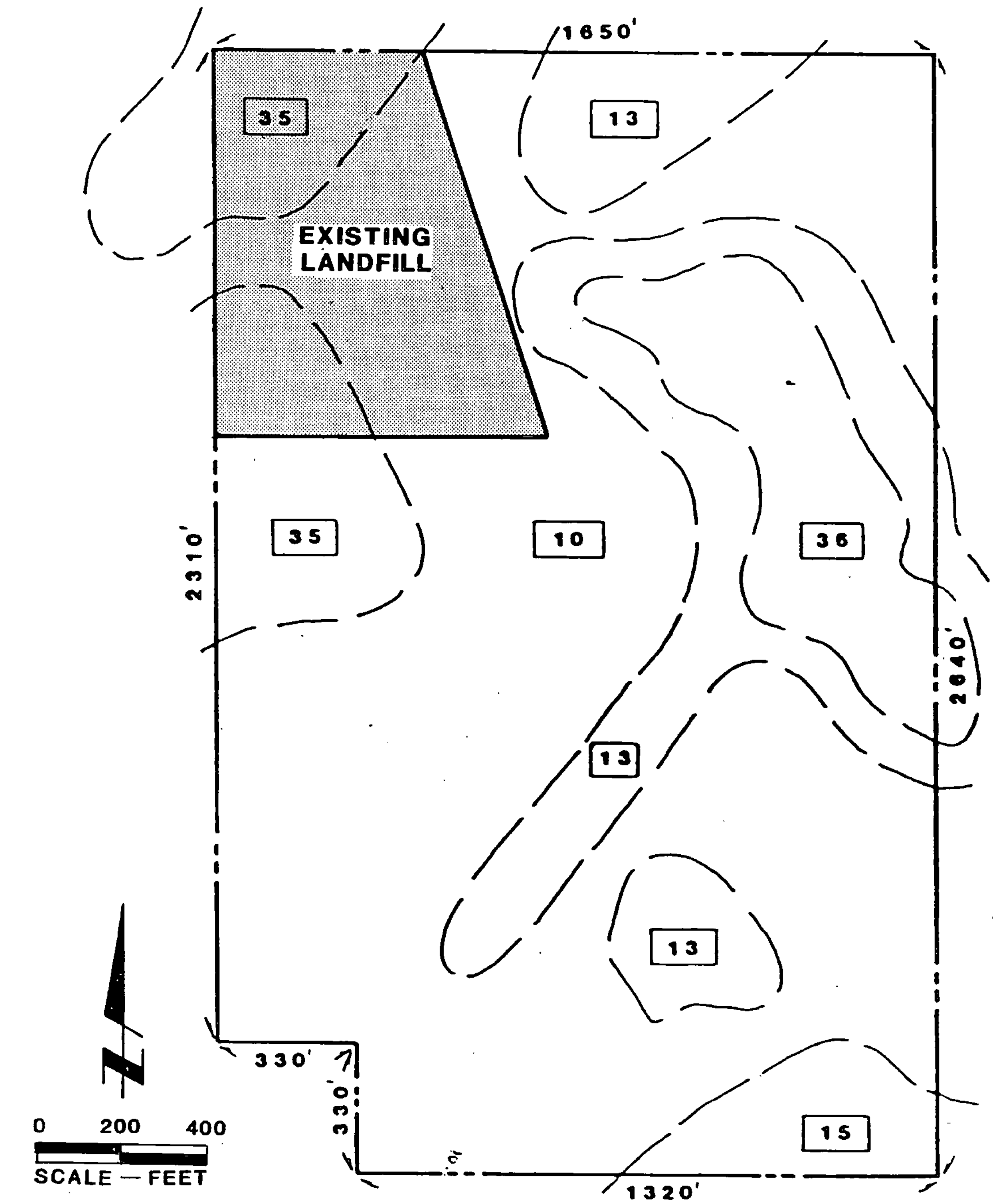
FIGURE 2

SURFACE SOILS ASSOCIATIONS

HARDEE COUNTY SANITARY LANDFILL SITE



LEGEND

- 10 POMONA FINE SAND
- 13 FLORIDANA MUCKY FINE SAND, DEPRESSIONAL
- 15 IMMOKALEE FINE SAND
- 35 OLDSMAR FINE SAND
- 36 TOMOKA MUCK
- SITE BOUNDARY
- ---- LIMITS OF SPECIFIC SOILS ASSOCIATION

Source: Envisors, Inc. (1982)
Reference: Interim Soil Survey Report, Maps and Interpretations by U.S.D.A., Soil Conservation Service.

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HARDEE COUNTY REGIONAL SANITARY LANDFILL HARDEE COUNTY, FLORIDA

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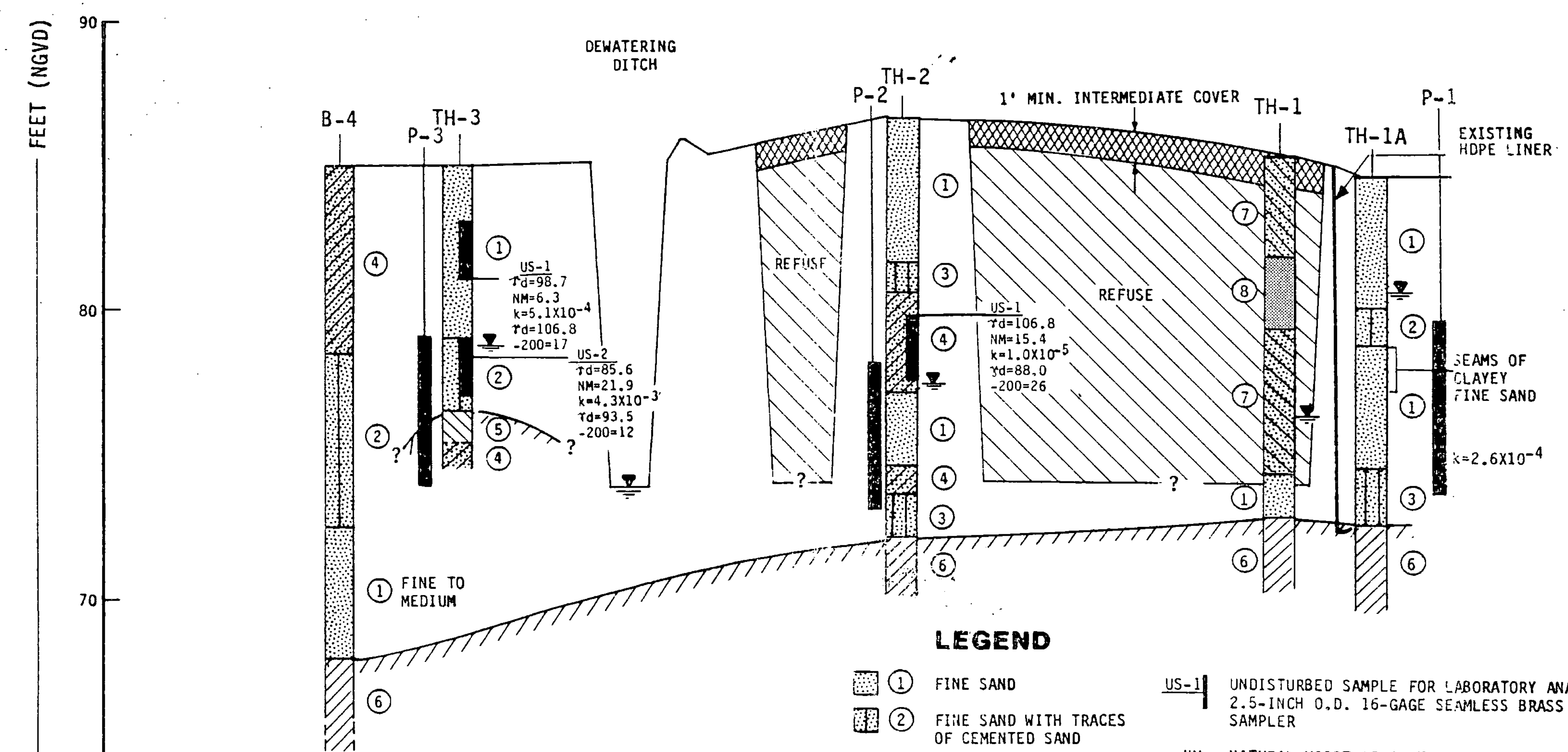
FIGURE 3



LEGEND

①	FINE SAND
②	FINE SAND WITH TRACES OF CEMENTED SAND
③	SLIGHTLY SILTY TO SILTY FINE SAND
④	SLIGHTLY CLAYEY FINE SAND
⑤	CLAYEY FINE SAND
⑥	CLAYEY SAND TO SANDY CLAY WITH TRACES OF PHOSPHATES
⑦	FINE SAND OCCASIONALLY MIXED WITH CLAYEY SAND (FILL)
⑧	REFUSE
TH-1	ARDAMAN TESTHOLE
B-4	ENVISOR, INC. TESTHOLE
▽	WATER TABLE ON 12/29/1986
US-1	UNDISTURBED SAMPLE FOR LABORATORY ANALYSIS FROM 2.5-INCH O.D. 16-GAGE SEAMLESS BRASS SHELBY TUBE SAMPLER
NM	NATURAL MOISTURE CONTENT IN PERCENT
-200	PERCENT PASSING THE U.S. NO. 200 SIEVE
γd	IN-PLACE DRY DENSITY IN POUNDS PER CUBIC FOOT (PCF)
k	COEFFICIENT OF PERMEABILITY IN CM/SEC
	PIEZOMETER COLLECTION ZONE

NOTE: SEE FIGURE 2 FOR CROSS-SECTION LOCATION

NORTH-SOUTH CROSS SECTION

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HARDEE COUNTY, FLORIDA

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FIGURE 4

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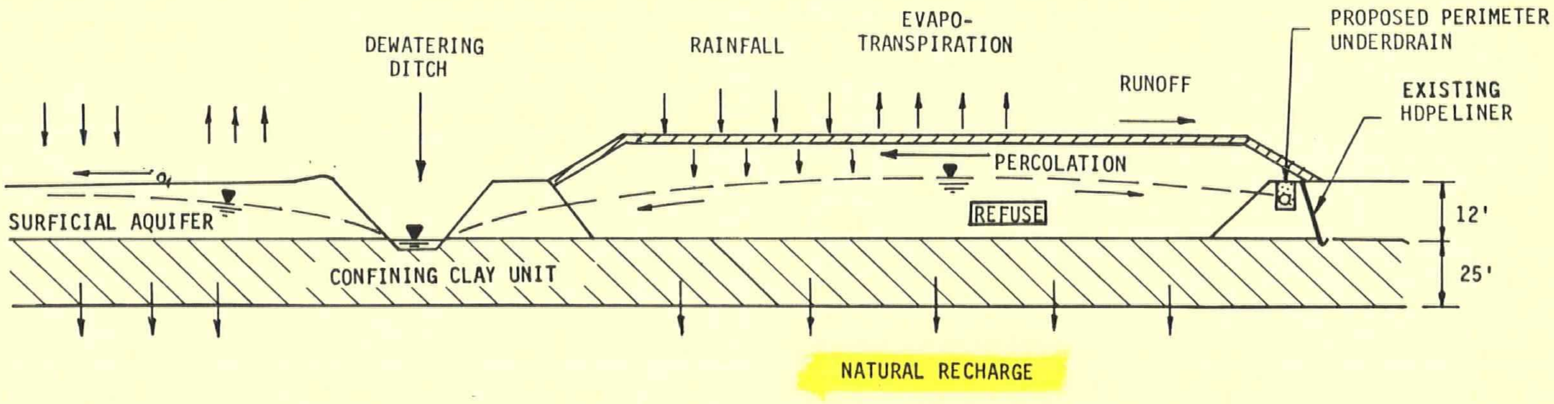
FIGURE 5



CONCEPTUAL HYDROLOGIC CYCLE

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HARDEE COUNTY, FLORIDA

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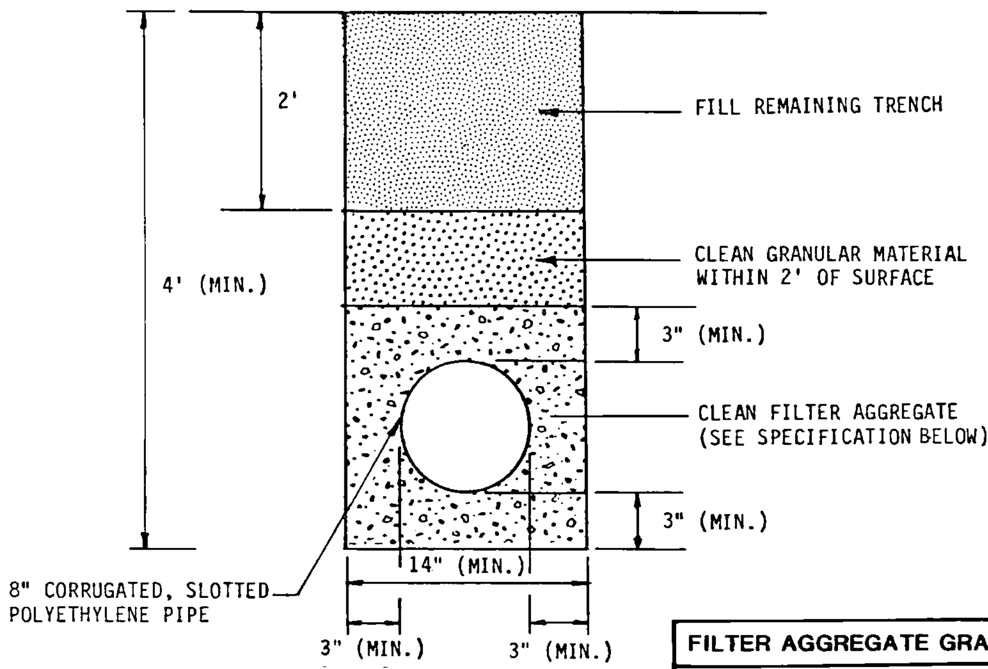
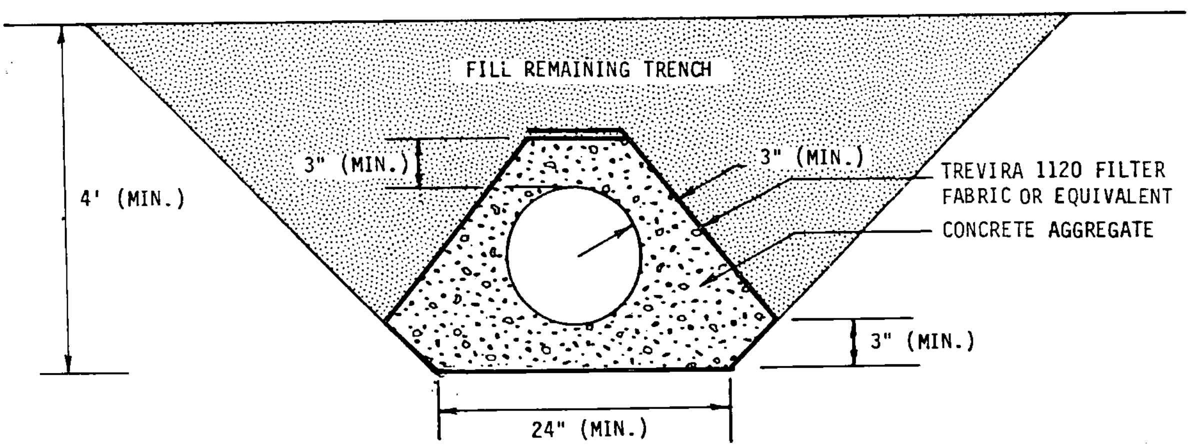
ALTERNATIVE 1



FILTER AGGREGATE GRADATION

U.S. SIEVE	PERCENT PASSING
1"	MAX. SIZE
3/8"	80-100
NO.4	60-90
NO.10	30-70
NO.20	0-40
NO.40	0-15

ALTERNATIVE 2



LEACHATE COLLECTION SYSTEM

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SANITARY LANDFILL
HARDEE COUNTY, FLORIDA

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FIGURE 6

Appendix 1

STANDARD PENETRATION TEST PROCEDURES

STANDARD PENETRATION TEST

The standard penetration test is a widely accepted method of *in situ* testing of foundation soils (ASTM D-1586). A 2-foot long, 2-inch O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 30 inches. The number of blows needed for each 6 inches of penetration is recorded. The sum of the blows required for penetration of the second and third 6-inch increments of penetration constitutes the test result or N-value. After the test, the sampler is extracted from the ground and opened to allow visual examination and classification of the retained soil sample. The N-value has been empirically correlated with various soil properties allowing a conservative estimate of the behavior of soils under load.

The tests are usually performed at 5-foot intervals. However, more frequent or continuous testing is done by our firm through depths where a more accurate definition of the soils is required. The test holes are advanced to the test elevations by rotary drilling with a cutting bit, using circulating fluid to remove the cuttings and hold the fine grains in suspension. The circulating fluid, which is a bentonitic drilling mud, is also used to keep the hole open below the water table by maintaining an excess hydrostatic pressure inside the hole. In some soil deposits, particularly highly pervious ones, NX-size flush-coupled casing must be driven to just above the testing depth to keep the hole open and/or to prevent the loss of circulating fluid.

Representative split-spoon samples from soils at every 5 feet of drilled depth and from every different stratum are brought to our laboratory in air-tight jars for further evaluation and testing, if necessary. Samples not used in testing are stored for at least six months prior to being discarded. After completion of a test boring, the hole is kept open until a steady state groundwater level is recorded. The hole is then sealed, if necessary, and backfilled.

Appendix 2

UNDISTURBED SAMPLING PROCEDURES

UNDISTURBED SAMPLING

Undisturbed sampling implies the recovery of soil samples in a state as close to their natural condition as possible. Complete preservation of in situ conditions cannot be realized; however, with careful handling and proper sampling techniques, disturbance during sampling can be minimized for most geotechnical engineering purposes. Examination and testing of undisturbed samples gives a more accurate estimate of in situ soil behavior than is possible with disturbed samples.

Normally, we obtain undisturbed samples by pushing a 2.875-inch I.D., thin wall seamless steel tube, 24 inches into the soil with a single stroke of a hydraulic ram. The sampler, which is a Shelby tube, is 30 inches long. After the sampler is retrieved, the ends are sealed in the field and it is transported to our laboratory for further examination and testing, as needed.

In some instances, when even less disturbed samples are required, a fixed-piston sampling device is used. The fixed-piston sampler is a 2.875-inch I.D. Shelby tube with a piston inside it. While the sampler is lowered into the bore hole, the piston is located at the lower end of the sampling tube. The piston is then placed at the bottom of the hole on top of the soil to be sampled, and is held stationary while the tube is smoothly pushed past the piston 24 inches into the soil. The sample is sheared from the parent soil by rotating the sampling device. After the sampler is brought out of the hole, the ends of the tube are sealed and the sample is brought back to our laboratory.

Four major improvements over our conventional undisturbed sampling procedures are achieved with the piston sampler; a larger sample is obtained; no soil enters the tube as the sampler is lowered to the sampling depth; excess soil does not enter the tube during the sampling operation; and a vacuum is generated between the piston and the sample as the sampler is being retrieved, thus helping to retain the sample in the tube.

Appendix 3

BORING LOGS

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO. TH-1
TOTAL DEPTH 15.0 ft
SHEET 1 OF 1

PROJECT Hardee County Regional Sanitary Landfill FILE NO. 86-166
CLIENT Hardee County
BORING LOCATION See Location Plan
COUNTY Hardee STATE Florida ELEVATION ±85' (NGVD) - Estimated
DATE STARTED 12/22/86 DATE COMPLETED 12/22/86 BORING TYPE SPT
DRILLER/RIG A. Gavin/CME-45 LENGTH/TYPE CASING
WATER TABLE DEPTH: 1st 9.0 ft DATE 12/22/86 TIME
2nd DATE TIME
REMARKS

Depth (Meters)	Depth (Feet)	Standard Penetration Test ASTM D-1586 Blows/6"	N Value	Sample No.	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Soil Description and Remarks (Unified Classification)	Undisturbed Samples
		6-8-9	17	1					Brown sand with traces of trash (fill)	
1		11-9-6	15	2					Brown sand with clayey sand (fill)	
	5	9-21-55	76	3					Refuse	
		21-9-5	14	4					Water loss	
2		4-5-7	12	5					Gray and yellowish brown clayey sand (fill)	
		10-9-10	19	6					Gray slightly clayey sand with 2" to 3" layers of gray sand (fill)	
3	10	11-13-17	30	7					Brown sand with 1" to 1½" layers of brown clayey sand (fill)	
		14-19-20	39	8					Grayish brown sand	
4									Gray clayey sand with phosphate	
	15	13-9-7	16	9/10					Layer of brown sand	
5									Boring terminated at 15.0 feet	
6	20									
7										
	25									
8										
9	30									
10										
	35									
11										
12	40									

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO. TH-1A
TOTAL DEPTH 15.0 ft
SHEET 1 OF 1

PROJECT Hardee County Regional Sanitary Landfill — FILE NO. 86-166
CLIENT Hardee County
BORING LOCATION See Location Plan
COUNTY Hardee — STATE Florida — ELEVATION 84.87 feet (NGVD)
DATE STARTED 12/24/86 — DATE COMPLETED 12/24/86 — BORING TYPE SPT
DRILLER/RIG A. Gavin/CME-45 — LENGTH/TYPE CASING
WATER TABLE DEPTH: 1st 4.5 ft — DATE 12/24/86 — TIME
2nd 4.0 ft — DATE 12/29/86 — TIME
REMARKS A 2-inch diameter piezometer (P-1) was installed at this location.

Depth (Meters)	Depth (Feet)	Standard Penetration Test ASTM D-1586: Blows/6"	N Value	Sample No.	Lab Data: NM (%)	-200 (%)	LL (%)	PI (%)	Soil Description and Remarks (Unified Classification)	Undisturbed Samples
		1-3-5	8	1					Dark brown sand with roots	
									Brown sand with roots and traces of clayey sand (fill)	
1		6-7-6	13	2					Light brown sand	
	5	6-6-5	11	3	16.6	9			Brown and dark brown sand with roots and traces of cemented sand	
2		3-2-3	5	4						
		3-6-6	12	5	17.4	17			Brown sand with seams of clayey sand	
3	10	2-4-6	10	6					Brown sand	
		7-8-8	16	7					Light brown slightly silty sand	
4	15	7-9-7	16	8					Grayish brown clayey sand (sand is medium to coarse)	
5									Boring terminated at 15.0 feet	
6	20									
7	25									
8										
9	30									
10										
11	35									
12	40									

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO. TH-2
TOTAL DEPTH 16.5 ft
SHEET 1 OF 1

PROJECT Hardee County Regional Sanitary Landfill — FILE NO. 86-166
CLIENT Hardee County
BORING LOCATION See Location Plan
COUNTY Hardee — STATE Florida — ELEVATION 86.87 feet (NGVD)
DATE STARTED 12/22/86 — DATE COMPLETED 12/22/86 — BORING TYPE SPT
DRILLER/RIG A. Gavin/CME-45 — LENGTH/TYPE CASING
WATER TABLE DEPTH: 1st 9 ft 3 in — DATE 12/22/86 — TIME
2nd 9 ft 3 in — DATE 12/29/86 — TIME
REMARKS A 2-inch diameter piezometer (P-2) was installed at this location.

Depth Meters	Depth Feet	Standard Penetration Test ASTM D-1586 Blows/6"	N Value	Sample No.	Lab Data NM (%)	-200 (%)	LL (%)	PI (%)	Soil Description and Remarks (Unified Classification)	Undisturbed Samples
		1-2-4	6	1					Yellowish brown sand with roots (fill) Brown sand with roots (fill)	
1		6-8-7	15	2					Very light brown sand	
		7-7-7	14	3					Dark reddish brown sand	
	5								Reddish brown sand	
2		6-6-4	10	4					Brown slightly silty to silty sand	
		3-3-4	7	5					Brown silty to very slightly clayey sand	US-1 NM=15.4% γ_d=106.8 pcf k=1.0x10^{-5} cm/sec (γ_d=88.0 pcf -200=26%)
		4-2-4	6	6						
3	10	6-5-7	12	7						
									Dark reddish brown sand	
		7-11-14	25	8					Grayish brown slightly clayey sand	
4		5-7-9	16	9						
									Brown slightly silty sand	
	15									
5		10-7-5	12	10					Gray clayey sand with 1" to 2" layers of gray sandy clay with traces of phosphates	
									Boring terminated at 16.5 feet	
6	20									
7										
8	25									
9	30									
10										
	35									
11										
12	40									

BORING LOG

ARDAMAN & ASSOCIATES, INC.

BORING NO. TH-3
TOTAL DEPTH 10.5 ft
SHEET 1 OF 1

PROJECT Hardee County Regional Sanitary Landfill
FILE NO. 86-166
CLIENT Hardee County
BORING LOCATION See Location Plan
COUNTY Hardee
STATE Florida
ELEVATION 85.06 feet (NGVD)
DATE STARTED 12/22/86
DATE COMPLETED 12/22/86
BORING TYPE SPT
DRILLER/RIG A. Gavin/CME-45
LENGTH/TYPE CASING
WATER TABLE DEPTH: 1st 8.0 ft DATE 12/22/86 TIME
2nd 6.0 ft 3 in DATE 12/29/86 TIME
REMARKS A 2-inch diameter piezometer (P-3) was installed at this location.

Depth (Meters)	Depth (Feet)	Standard Penetration Test ASTM D-1586: Blows/6"	N Value	Sample No.	Lab Data: NM (%)	-200 (%)	LL (%)	PI (%)	Soil Description and Remarks (Unified Classification)	Undisturbed Samples
		1-2-3	5	1					Gray sand with roots	
									Brown sand with roots	
1		3-3-4	7	2					Light yellowish brown sand with roots	US-1 NM=6.3%
	5	4-4-4	8	3					Light brown sand	γ_d=98.7 pcf, k=5.1x10$^{-[illegible]}$ cm/sec (γ_d=106.8 pcf, -200=17%)
2		3-3-5	8	4	12.8	13			Brown slightly silty sand with roots	
		4-4-5	9	5					Reddish brown sand with traces of silt and cemented sand	US-2 NM=21.9%
		4-4-5	9	6	14.7	27			Gray clayey sand with seams of brown sand	γ_d=85.6 pcf, k=4.3x10^{-3} cm/sec (γ_d=93.5 pcf, -200=12%)
3	10	5-9-20	29	7					Grayish brown slightly clayey sand with traces of silt	
									Boring terminated at 10.5 feet	

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Appendix 4

PIEZOMETER INSTALLATION RECORDS

WELL INSTALLATION RECORD

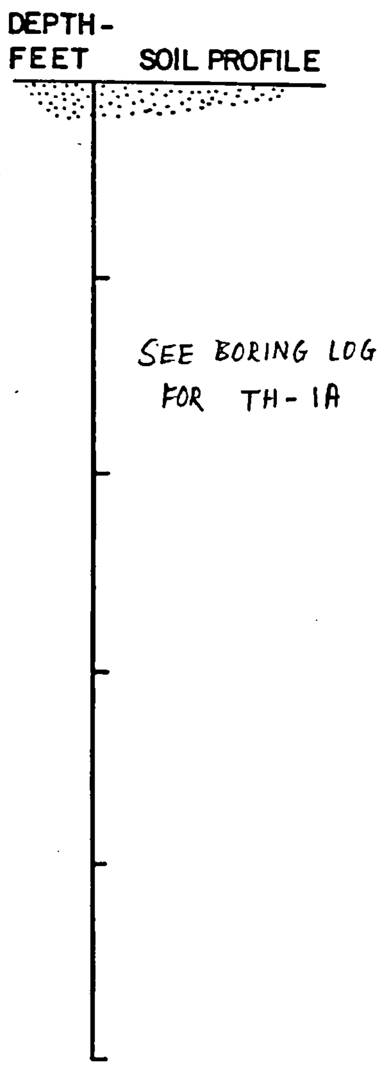
CLIENT: HARDEE COUNTY PROJECT: HARDEE CO. SANITARY LANDFILL FILE NO: 86-166

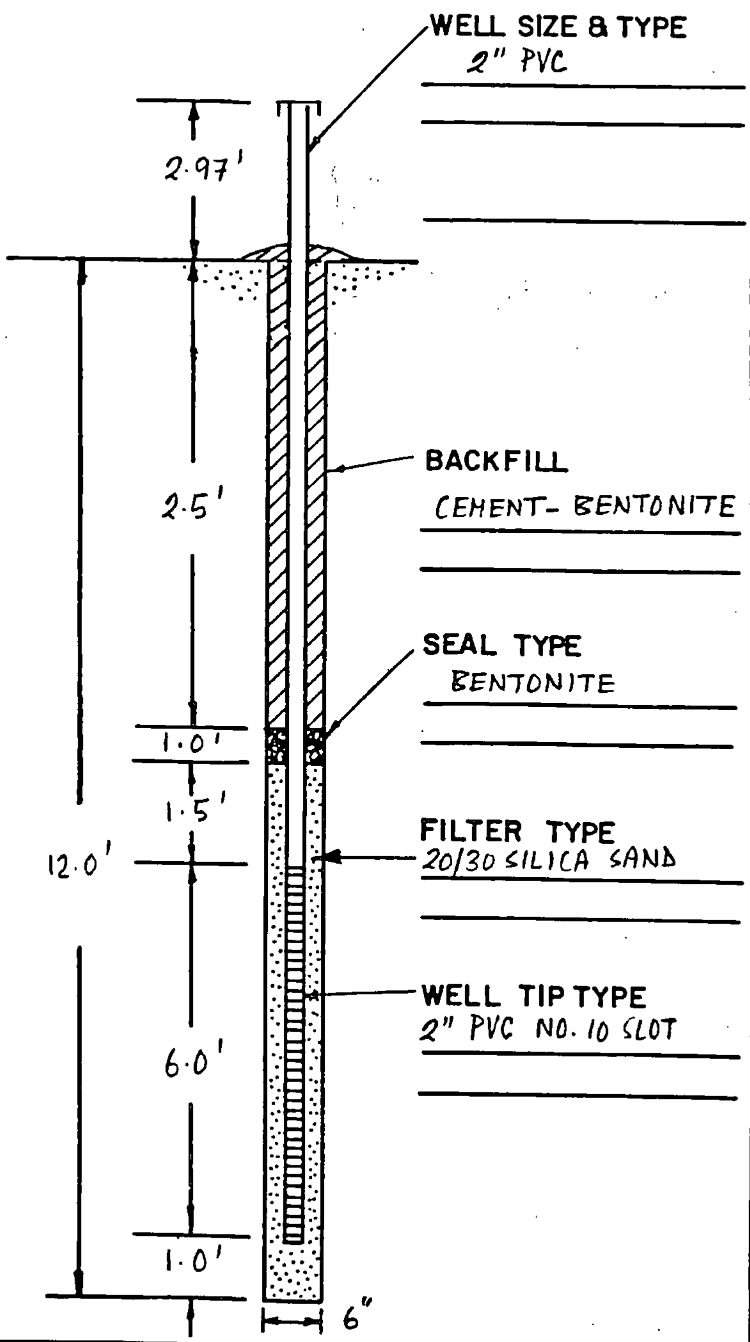
STATION NO: – WELL NO. P-1

CREW SUPERVISOR: A. GAVIN DATE INSTALLED: 12/24/1986

WELL LOCATION: SEE MAP

GROUND ELEV: 84.87' (NGVD) WELL TOP ELEV: 87.84' (NGVD)





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WELL INSTALLATION RECORD

CLIENT: Hardee County PROJECT: Hardee Co. Sanitary Landfill FILE NO: 86-166

STATION NO: – WELL NO. P-2

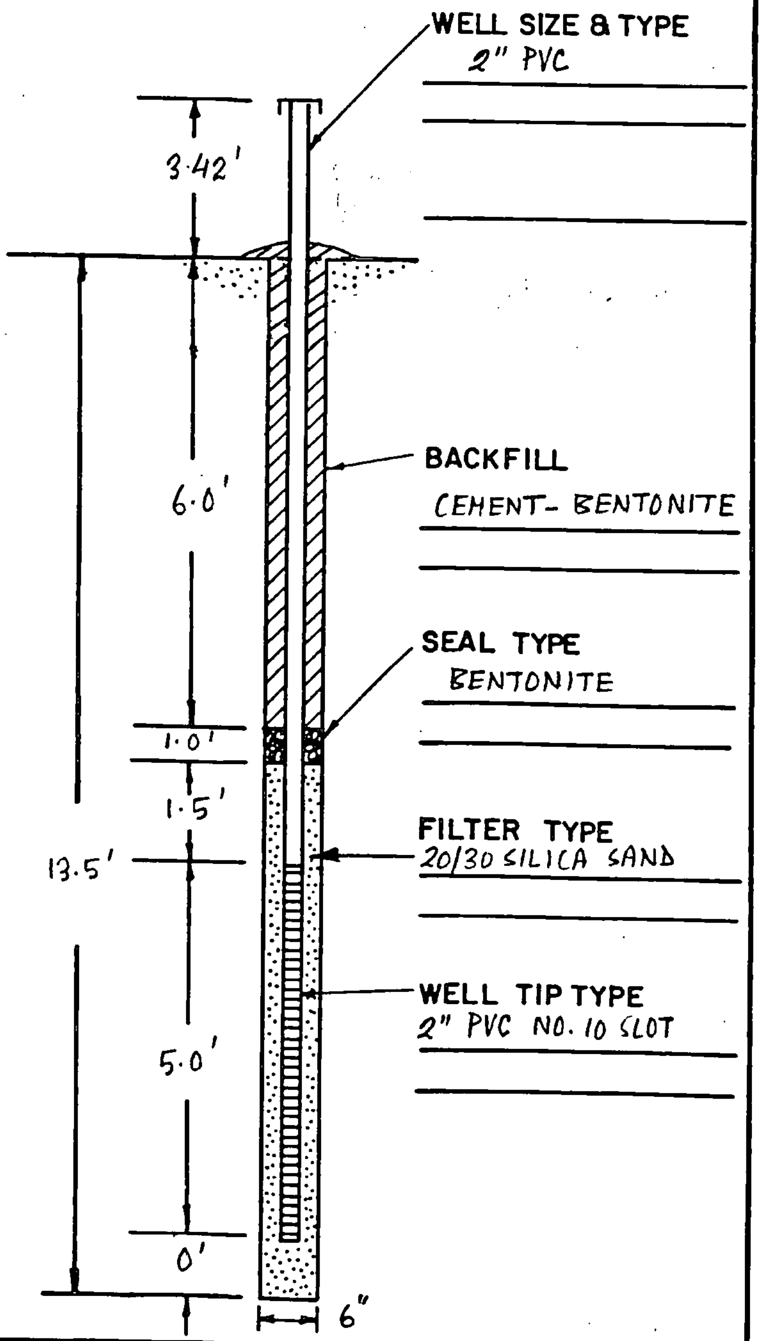
CREW SUPERVISOR: A. Gavin DATE INSTALLED: 12/24/1986

WELL LOCATION: See map

GROUND ELEV: 86.86' (NGVD) WELL TOP ELEV: 90.28' (NGVD)

DEPTH-FEET | SOIL PROFILE

See boring log for TH-2



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WELL INSTALLATION RECORD

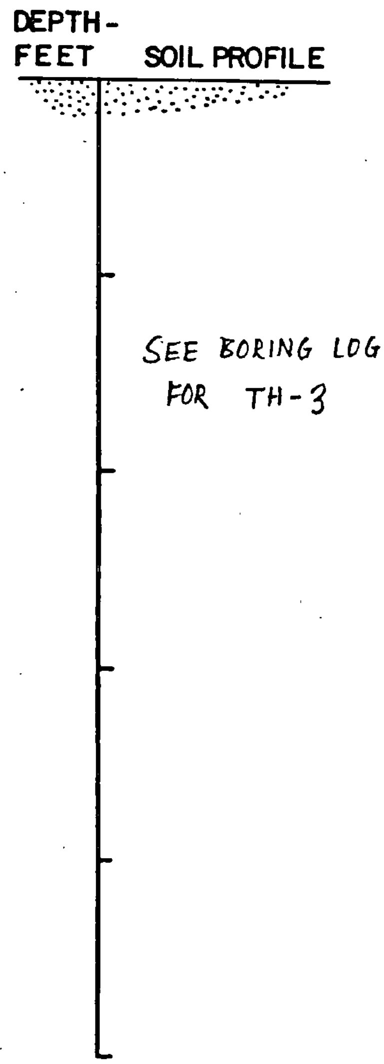
CLIENT: HARDEE COUNTY PROJECT: HARDEE CO. SANITARY LANDFILL FILE NO: 86-166

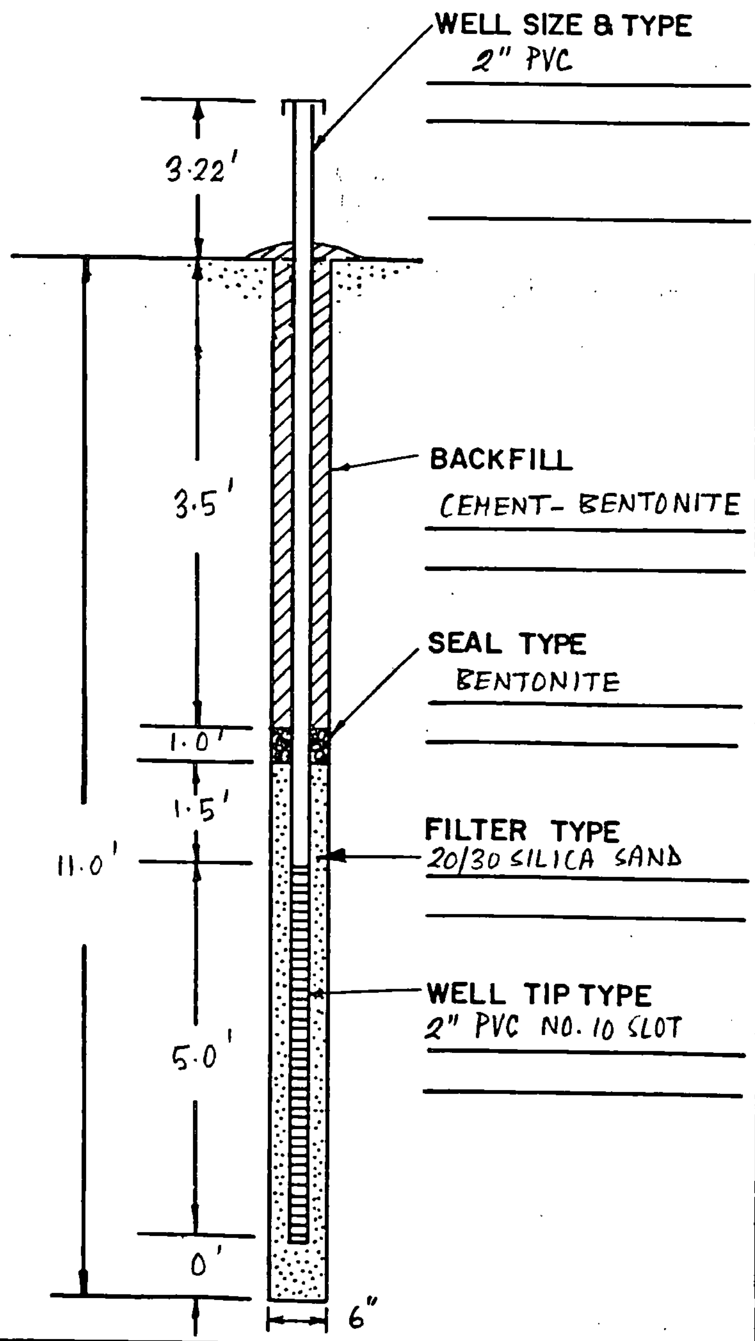
STATION NO: - WELL NO. P-3

CREW SUPERVISOR: A. GAVIN DATE INSTALLED: 12/24/1986

WELL LOCATION: SEE MAP

GROUND ELEV: 85.06'(NGVD) WELL TOP ELEV: 88.28'(NGVD)





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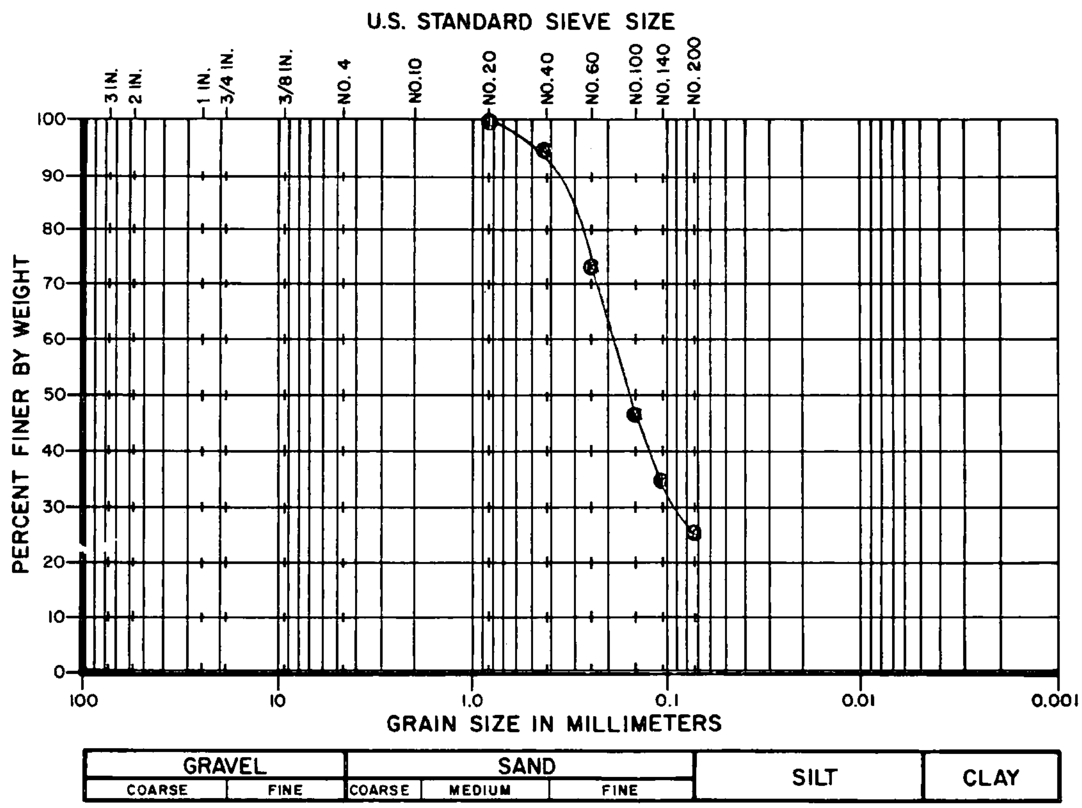
Appendix 5

GRAIN SIZE CURVES



TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
TH-2	US-1	7.0'-9.0'	●	GRAYISH BROWN CLAYEY FINE SAND	SC
				(PERMEABILITY SAMPLE)	

GRAIN SIZE DISTRIBUTION

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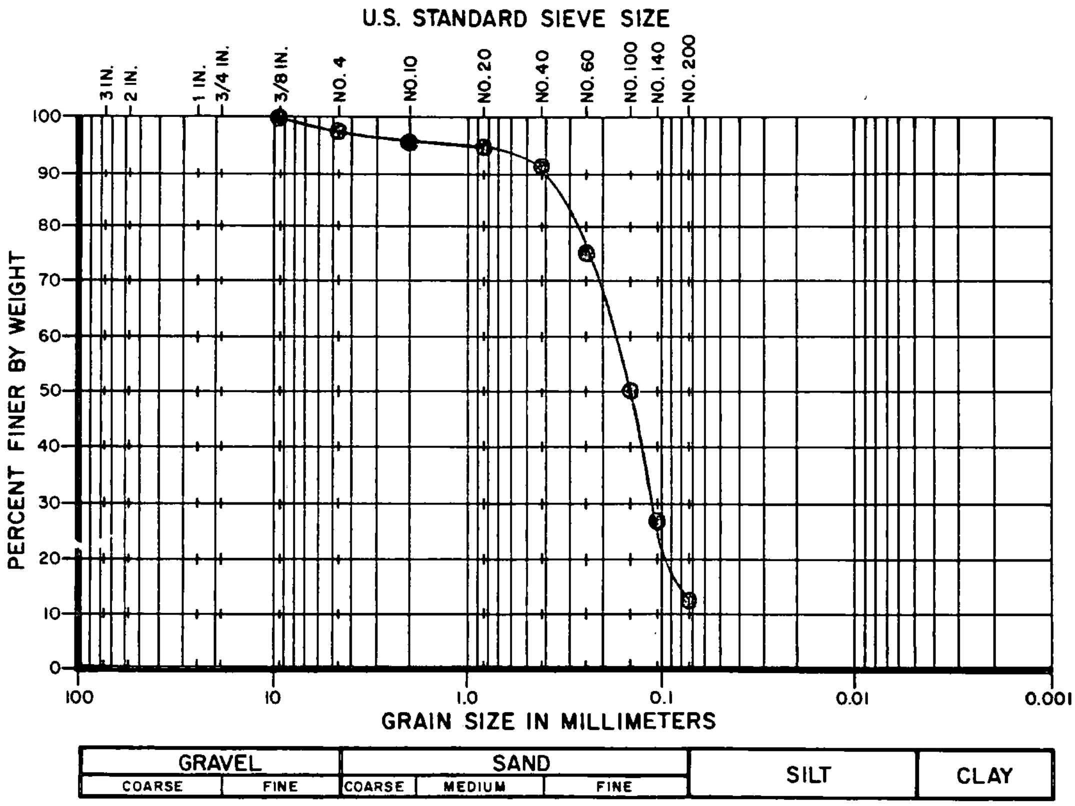
FILE NO. 86-166 | APPROVED BY: [signature]

FORM NO. 1509 7/80



TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
TH-3	US-2	6.0'- 8.0'	●	REDDISH BROWN SLIGHTLY SILTY FINE SAND	SP-SM
				WITH TRACES OF CEMENTED SAND	
				(PERMEABILITY SAMPLE)	

GRAIN SIZE DISTRIBUTION

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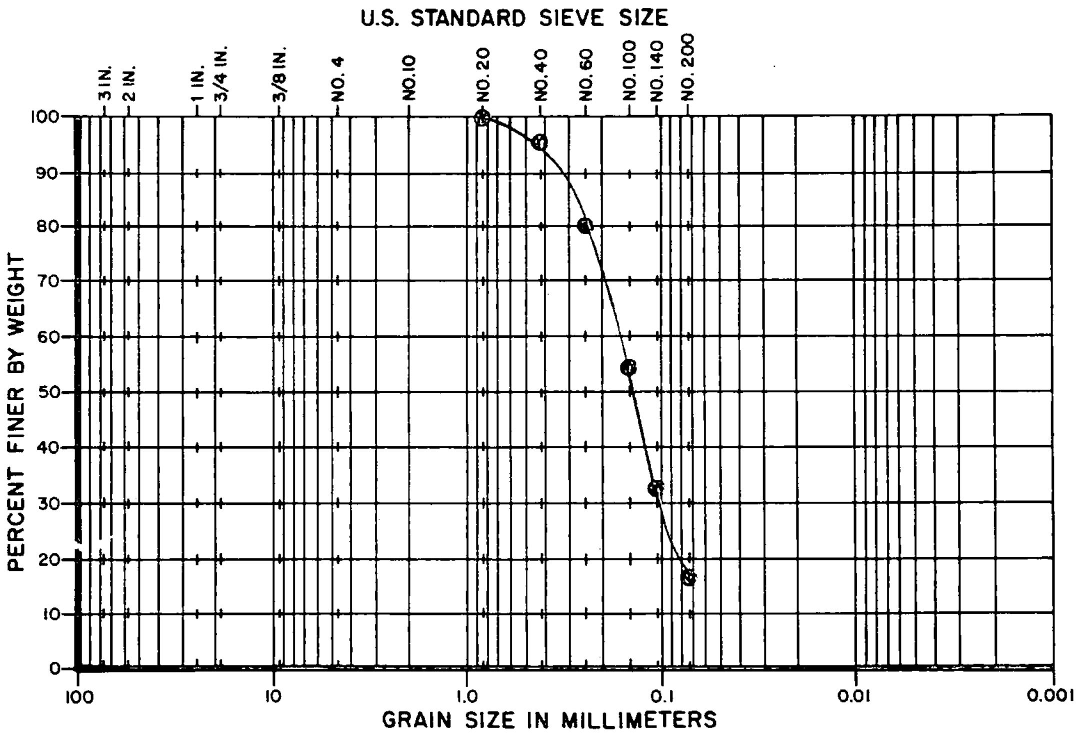
FORM NO. 1509 7/80



GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
TH-3	US-1	2.0'- 4.0'	●	LIGHT BROWN SILTY FINE SAND	SM
				(PERMEABILITY SAMPLE)	

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FORM NO. 1509 7/80

Appendix 6

SPECIFICATIONS FOR HDPE SIDE LINER

The specifications for the synthetic side liner should contain the following language.

Material Specifications

The liner material base resin shall be unreinforced High Density Polyethylene (HDPE) with properties equivalent to ASTM D-1248 Classification P23 or P34. The resin shall be Chevron 9642 or Phillips TR400, or approved equivalent. The resin must contain not less than 2 percent carbon black as defined in ASTM D-1248, Section 3.1.2.3, Class C. The liner shall further meet the following criteria:

Item	Specification	Criteria
Nominal Thickness, mil	ASTM D-374, Method C	60
Puncture Resistance, lbs.	FTMS 101B Method 2031	$\geq$270
Tensile Yield Strength, lb/in^2	ASTM D-638	$\geq$140
Elongation at Break, %	ASTM D-638	$\geq$700
Tear Resistance, lbs.	ASTM D1004, Die C	$\geq$45

The liner must also have good appearance qualities. It shall have a smooth uniform surface with no visible defects and shall be free of holes, blisters, gels, undispersed ingredients and any contamination or defect that may affect its serviceability. The liner must be uniform in thickness with a maximum 10 percent deviation from the nominal thickness. The edges shall be straight and free of nicks and cuts. Inspection of pinholes shall be made prior to shipment to the field. An acceptable method of testing for pinholes and a method for removing or patching pinholes and defective areas must be submitted by the Contractor for approval by the Owner.

The manufacturer/installer shall provide a written warranty stating that for a minimum duration of 20 years the liner materials and workmanship specifically provided or performed under this project shall be free from any significant defects. Said warranty shall apply to normal use and service by the Owner and specifically excludes mechanical abuse or puncture by machinery, equipment or people, or natural catastrophies. Defects or non-conformance shall be repaired or replaced within a reasonable period of time at no cost to the Owner provided that portion of the area in question has been made available to the manufacturer/installer and that such areas have been cleared of all liquids, sludges, dirt, sand or gravel.

A complete description of the liner material proposed for use by the Contractor that meets or exceeds the requirements specified herein must be submitted with the Contractor's proposal to the Owner for approval.

Installation Procedures

The liner shall be installed at the locations and along the lines and grades shown on the plans and drawings. Laying of the liner must comply with the specified standards and guidelines. These standards must be fully defined in the Contractor's proposal for approval by the Owner. The Contractor shall also propose standards for welded joints, embedment, anchoring, and water proof pipe penetration connections subject to approval by the Owner.

All factory seaming must be done on level, firm and clean surfaces. All seams must be uniform and provide a bond strong enough so that the parent material will fail prior to the bond under all test conditions.

Field seaming must be conducted in the dry and in such a manner as to prevent dust, dirt, or other foreign material from being included in the seam. Preconstruction samples of field seams made using field construction techniques must be tested and submitted by the Contractor for approval by the Owner prior to the initiation of the liner installation. All sample field seams submitted by the Contractor will be considered by the Owner to be the minimum field seam quality expected in terms of seam width, strength, and chemical resistance. All seams must be stronger than the parent material. The seams must be uniform in width and properties.

Prior to welding the new side liner with the existing side liner, the existing side liner shall be cleaned thoroughly to prevent dust, dirt or other foreign material from being included in the seam.

Appendix 7

SPECIFICATIONS FOR LEACHATE COLLECTION SYSTEM

The specifications for the leachate collection system should contain the following language:

Materials

- Pipe and Fittings

The pipe used shall meet ASTM F-667 specifications for corrugated heavy duty polyethylene tubing and fittings. The resin used in the pipes and fittings shall be High Density Polyethylene (HDPE) with properties equivalent to ASTM D-1248 Classification P34. The resin must not contain less than 2 percent carbon black as specified in ASTM D-1248, Section 3.1.2.3, Class C, to impart maximum weather resistance. The corrugated underdrain pipes should have an inside diameter of 8 inches. The pipes shall have slots not exceeding 2.5 mm in width evenly cut and spaced in the valley of the corrugation around the circumference with a total slotted area no less than 2.6 square inches per foot of pipe. The wall thickness and stiffness of the drain pipes shall be sufficiently adequate to withstand the overburden pressure. All fittings shall be of the same materials as the pipes unless otherwise approved by the Owner.

- Filter Aggregate

The filter aggregate that surround the slotted pipe in Alternative 1 shall be clean, non-calcareous, washed gravelly sand that is non-susceptible to clogging from acids and alkalies within a pH of 3 to 11. The filter aggregate shall conform to the following requirements.

U.S. Standard Sieve Size	Percent Fines by Weight Passing
1 inch	Max. Size
3/8 inch	80 to 100
No. 4	60 to 90
No. 10	30 to 70
No. 20	0 to 40
No. 40	0 to 15

- Concrete Aggregate

The concrete aggregate that surround the slotted pipe in Alternative 2 shall be clean, non-calcareous, gravel that is non-susceptible to clogging from acids and alkalies within a pH of 3 to 11. The concrete aggregate shall not contain any particles finer than the U.S. No. 8 sieve size. The maximum size of the aggregate shall be 1½ inches.

- Filter Fabric

  The filter fabric used to wrap the concrete aggregate in Alternative 2 shall be a spunbonded polyester material equivalent to Trevira S1120, or approved equivalent. The filter fabric shall also exhibit the following physical properties.

Property	Specification	Criteria
- Physical Characteristics		
Fabric Weight (oz/yd^2)	ASTM D-1117	≥ 6
Thickness (mils)	ASTM D-1777	≥ 100
E.O.S. (U.S. Std. Sieve Size)*	COE CW-02215	≥ 70
- Strength Characteristics		
Grab Tensile Strength (lbs)	ASTM D-1682	≥ 175
Grab Elongation (%)	ASTM D-1682	≥ 85
Puncture Resistance (lbs)**	ASTM D-751	≥ 90
Mullen Burst Strength (lb/in^2)	ASTM D-751	≥ 300

* Equivalent Opening Size (U.S. Standard Sieve Size Number)
** Determined according to ASTM D-751 modified by using a ring clamp and replacing the spherical ball with a 5/16-inch diameter solid steel cylinder with a hemispherical tip centered within the ring.

Leachate Collection System Installation

- The leachate collection system shall be installed at the locations and along the lines and grades shown on the plans and drawings. The gravel filter material (if Alternative 1 is adopted) should be carefully placed around the pipe. Clean granular materials shall be placed over the gravel filter to the depth and grades shown on the drawings.

- The filter fabric used in the drainage trench (if Alternative 2 is adopted) shall remain wrapped and protected from moisture and ultraviolet light until the time of installation. Storage at the site shall be in a suitable area protected from sunlight and exposure to moisture.

- During installation, the filter fabric shall be loosely laid (not stretched) with the full length direction along the alignment of the trench over a prepared surface which is free from any debris or projection which could damage the filter material. Where field joints are necessary, the adjacent panels of filter fabric shall be lapped a minimum of 18 inches with the field seam as recommended by the manufacturer and approved by the Owner. If sewn field joints are used, the thread shall be of the same material as the filter fabric. After installation, no portion of the filter fabric shall be left exposed for more than 7 days before being covered with cover material. If the filter fabric is projected to be exposed to sunlight for a period in excess of 7 days, then the fabric shall be protected from the ultraviolet rays of the sun by a thin plastic sheet no less than 2 mil (0.05 mm) in thickness, and made of low density polyethylene film, containing no less than 3 percent carbon black. The plastic film shall completely cover the filter fabric and shall be properly anchored to prevent it from being blown by the wind. Stabilizers in the trench will be needed if the filter fabric is projected to be exposed to sunlight for more than 4 months. The filter fabric shall be adequately anchored or held down so as to protect it from being displaced by wind storms.

- A 3-inch thick layer of gravel material shall be placed in the trench prior to the installation of drain pipe. After the pipe is in place, more gravel shall be placed over the pipe for a minimum thickness of 3 inches prior to wrapping with the filter fabric.

- The trench for the leachate collection pipe shall be excavated along the specified alignment, and to the required elevation and width shown on the plans and drawings. Trench excavation shall proceed ahead of pipe installation only as far as necessary to allow efficient pipe installation. The width of the trench shall be as specified on the drawings.

  Extreme care shall be exercised while excavating the trench to avoid damaging the existing HDPE side liner.

  When the subgrade is found to consist of refuse, organic material, or any other unsuitable material, such material shall be removed to a minimum depth of at least 6 inches into the underlying natural sand, or to the depth specified by the Owner and replaced under the direction of the Owner with clean, suitable backfill material without additional compensation. The bedding shall then be compacted and leveled so that the drain may be installed as specified.

- Proper tools and facilities shall be provided and used for the safe and efficient performance of the work.

  Extreme care shall be exercised in handling and installing the drain pipe to avoid damaging the slots of the pipe. Under no circumstances shall pipeline materials be dropped or dumped into the trench. The trench shall be dewatered where necessary prior to installation of the pipe. The construction method must be approved in advance by the Owner.

  All pipe, fittings, and other appurtenances shall be examined carefully for damage and other defects prior to installation. Defective materials shall be rejected and replaced.

As each section of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.

At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Owner.

To prevent crushing of the pipe, sufficient backfill shall be placed above the pipes according to manufacturer's specifications and subsequent to performance of actual field trial tests to confirm that the cover is adequate before equipment is allowed to pass over the pipes. Any pipe which is broken, cracked, or otherwise unsuitable, as determined by the Owner, shall be removed and replaced by the Contractor at his own expense.

- Field pipe joints and connections to manholes shall be made using the manufacturer's recommendations subject to approval by the Owner.

- Cutting pipe for the insertion of fittings or closure pieces shall be done in a neat, workmanlike manner without causing damage to the pipe. Ends shall be cut square and perpendicular to the pipe axis. Burrs shall be removed and ends shall be smoothly beveled. Field cut ends shall be marked for proper depth of joint assembly.