Compilation of Hydrogeological and Groundwater Data for Lena Road Landfill Stage II Area

Ardaman & Associates, Inc.

Compilation of Hydrogeological and Groundwater Data for Lena Road Landfill Stage II Area

Ardaman & Associates, Inc.

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Ardaman & Associates, Inc.

Consultants in Soils,Hydrogeology,
Foundations and Materials Testing

August 29, 1985
File Number 82-7047

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

Attention: Mr. John Cumming

Subject: Compilation of Hydrogeological and Groundwater Data for Lena Road Landfill - Stage II Area

Gentlemen:

As requested, we have prepared five copies each of the following hydrogeological data and interpretive reports for the Lena Road Stage II Landfill:

- Geotechnical and Hydrogeological Investigation at the Existing and Proposed Expansion for the Lena Road Landfill, Manatee County, Florida; March 3, 1983.

  This report is the original hydrogeological survey for the existing and Stage II landfill areas. Forty-two SPT borings were performed and 15 piezometers were installed for this project.

- Geotechnical/Groundwater Responses to letter dated April 18, 1983 from Mr. E. G. Snipes of FDER on Lena Road Landfill; May 27, 1983.

  This letter responds to questions on groundwater flow direction, well inventory, well sampling and analytical procedures, controlled irrigation program, groundwater flow calculations, bottom clay liner, clay mineralogy, groundwater monitoring, surface resistivity data, plume movement, and water table fluctuations. Completed FDER form 17-1.216(3) also was provided in this letter.

- Proposal for Additional Hydrogeological Investigation at the Lena Road Landfill; November 7, 1983.

  This letter outlines a two boring field program at a circular depression in the northwest corner of the landfill area to evaluate the integrity of the bottom clay liner in accordance with FDER suggestion dated September 2, 1983.

- Additional Hydrogeological Investigation at the Lena Road Landfill, Manatee County; February 24, 1984.

  This report responds to questions raised by FDER to Mr. Philip Davis on September 2, 1983 and was in accordance with our letter proposal dated

November 7, 1983 on the subject project. Four exhibits were presented in this report. Figure 1 shows the updated plot of permeability coefficient vs. percent fines including seven additional laboratory permeability test results. These additional permeability test results agree with previous data collected. In addition, all soils having greater than 20 percent passing No. 200 sieve have permeabilities between $2x10^{-7}$ and $2x10^{-8}$ cm/sec.

Figure 2 shows the boring profiles for the two holes placed within and adjacent to one topographic depression located at the northwest corner of the existing landfill. No sign of sinkhole activity was encountered to a depth of 54 feet within the depression. Both test holes documented approximately 41 feet of confining beds (i.e., strata 4, 5 and 7).

Figure 3 shows the boring profiles for the additional five SPT borings requested by Mr. Rick Hicks of FDER and Table 1 tabulates the thickness of the confining beds in the 44 borings. At least 2 feet of clayey soils were encountered in each hole. Based on our evaluation of the boring data at locations where the layer was completely penetrated, it appears that the minimum thickness of the uppermost confining layer is 7 feet. At most of the deeper boring locations, this layer was more than 20 feet thick.

- Stage II Lena Road Landfill Design Report; November, 1984.

  This engineering report was prepared for FDER and Manatee County by Briley, Wild & Associates, Inc. for subject project.

- April to November 1984 Manatee County Central Laboratory Analyses from Lena Road Landfill; December 10, 1984.

  This report was prepared by the Manatee County Public Utilities Department from water samples taken monthly at the landfill at MW-1, MW-3, MW-7, MW-8, CW-1, CW-2, CW-4, and CW-5. The analytical results are primarily for secondary drinking water and indicator parameters.

- Proposal for Additional Deep Monitor Wells at the Lena Road and Gun Club Landfill Sites; December 31, 1984.

  This letter proposal outlines the additional "deep" monitor wells required by FDER to prove that the existing landfills are not the source of contaminants alleged to be entering a private domestic well in the vicinity of the landfill. Four monitoring wells are part of this program. Monitor well SA-1 is between the Stage I and Stage II areas. Monitoring wells SA-2 and SA-3 are north of the Stage III area and monitoring well SA-4 is west of the Stage III area.

- Letter to FDER showing proposed locations for Intermediate Depth Monitor Wells; January 8, 1985.

  This letter provides FDER the proposed monitoring program as outlined in the December 31, 1984 proposal.

- Letter to Ardaman & Associates, Inc. from FDER on Intermediate Monitor Wells; January 30, 1985.

  This letter states that FDER approves the locations of the intermediate monitor wells.

- Seal Procedures for Intermediate Depth Monitor Wells; February 1, 1985.

  This letter documented to FDER the field procedures to seal intermediate depth monitor wells.

- Response to FDER Questions, Construction Permit Application, Lena Road Landfill, Stage II, Manatee County, Florida; May 8, 1985.

  This letter report outlines the groundwater monitoring plan for the Stage II area north of the existing landfill area. The report also referenced the project design report and project manual for more information on the technical specifications and quality control testing for the slurry wall.

- Geotechnical Related Responses to Contractor Questions Pertaining to Pre-Bid Meeting on Lena Road Landfill Slurry Wall; May 30, 1985.

  This letter presents boring and laboratory test data from the borings spaced on 350- to 400-foot centers around the existing landfill. The data documents the clay layer in every hole. In addition, the clarified technical specification for the bentonite-slurry mix was presented.

This document hopefully will serve your present needs as a compilation of groundwater and geotechnical elements of the project. If you need any further assistance, please contact the undersigned.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

Herbert G. Stangland

Herbert G. Stangland, Jr., P.E.
Senior Water Resources Engineer
Florida Registration No. 16713

John E. Garlanger

John E. Garlanger, Ph.D., P.E.
Principal

HGS:ed

Enclosures

GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION LENA ROAD LANDFILL

BRILEY, WILD & ASSOCIATES, INC.
MANATEE COUNTY, FLORIDA

Ardaman & Associates, Inc.

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Ardaman & Associates, Inc.

Consultants in Soils, Hydrogeology, Foundations and Materials Testing

March 3, 1983
File Number 82-7047

Briley, Wild and Associates, Inc.
5000 U.S. Highway 1, North
Ormond Beach, Florida 32074

Attention: Mr. John Cumming, P.E.

Subject: Geotechnical and Hydrogeological Investigation at the Existing and Proposed Expansion for the Lena Road Landfill, Manatee County, Florida

Gentlemen:

As requested by Mr. John Cumming and authorized by Manatee County, we are pleased to submit herein the geotechnical and hydrogeological investigation at the above mentioned site as per Florida Department of Environmental Regulation Guidelines. This report contains the results of our field investigation, laboratory testing, and engineering analyses and recommendations. We would appreciate the opportunity to discuss this report with your project team, including Mr. Rock Payne, at your earliest convenience once you have read the report.

We appreciate the opportunity to serve you on this project. Please do not hesitate to contact us if you have questions on the report or if we can be of further assistance to you on this project.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

Herbert G. Stangland, Jr., P.E.
Senior Water Resources Engineer

John E. Garlanger, Ph.D., P.E.
Principal
Florida Registration No. 19782

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Enclosures
cc: S. Davidson (w/encl.)

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Chapter 1

INTRODUCTION

The following report contains the results of our geotechnical and hydrogeologic field investigation, laboratory testing and engineering analyses/recommendations for the Lena Road landfill in Manatee County, Florida.

1.1 Location

The existing landfill is located in Section 6, Township 35 South, Range 19 East in Manatee County, Florida. The proposed 200-acre landfill expansion area is located north of and adjacent to the existing landfill in Section 6, T35S, R19E and Section 31, T34S, R19E. A location plan is presented in Figure 1.1.

1.2 Purpose and Scope

The purpose of the investigation was to:

- Document existing leachate plume, if any, adjacent to the existing landfill.
- Project leachate plume movement under various future landfill heights.
- Analyze potential leachate collection and/or leachate management systems at the existing landfill.
- Evaluate and analyze geotechnical elements of a golf course on the landfill. As a part of this element a plan is presented to install settlement platforms to quantitatively evaluate settlements in the existing landfill.
- Review published and unpublished reports, including those in our files, relating to the geology, hydrogeology and surficial soil conditions at the site.
- Collect and examine well logs drilled in the vicinity of the site to obtain a generalized profile of the stratigraphy.
- Plan a field program and visit the site to stake out boring locations and to record observations relating to surficial soil conditions, topographic features and surface drainage features.
- Conduct a field investigation program consisting of forty-two (42) Standard Penetration Test (SPT) borings carried at least into the uppermost confining layer, approximately 25.0 feet deep. Two (2) of the borings were carried to a depth of 60 feet and one (1) to a depth of 70 feet. Soil sampling was at 2.5 foot intervals for the first 10.0 feet, and at 5.0 foot intervals thereafter. All deep borings were grouted after completion.

- Install fourteen (14) shallow observation wells within the surficial aquifer to monitor water level, to use for water quality sampling, and to use for *in situ* permeability tests. Conductivity, chlorides, iron, chemical oxygen demand, nitrate, color, temperature, and pH values were determined from the groundwater taken from each observation well. Selected well waters also had analyses performed for arsenic, barium, cadmium, chromium, lead, mercury, and silver.

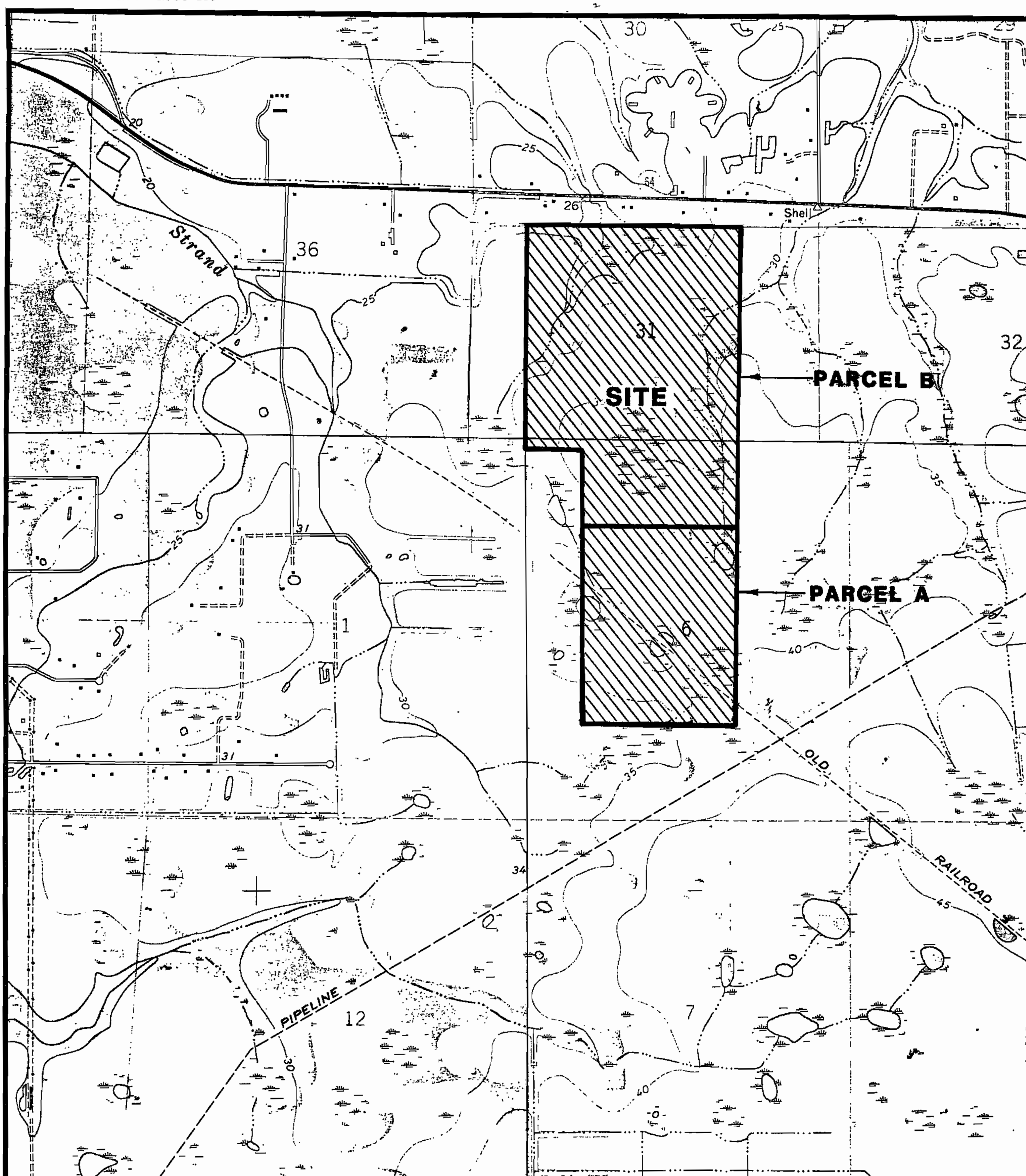
- Obtain nine (9) undisturbed samples of clay layers or other pertinent strata for permeability testing.

- Perform a laboratory testing program consisting of visual classification and index testing of the soil samples obtained from the test borings and permeability testing of samples of recompacted clayey borrow soils. These samples were tested at the *in situ* moisture content and compacted with the Standard Proctor compactive effort. One (1) of the clayey borrow soils was tested at varying moisture contents to determine the effect on density and permeability.

- Perform a well inventory for wells located within one quarter mile of the site. Inventory will rely on available data from the Southwest Florida Water Management District and from the Manatee County Health Department.

- Develop a fracture trace map and evaluate the potential for sinkhole development.

- Prepare this report documenting our field and laboratory testing and presenting the results of our hydrogeological investigation. The report discusses location, geology, hydrology, water supply, borrow material, design recommendations, and impact assessment analyses for the entire site as per Florida Department of Environmental Regulation guidelines.



0 2000
SCALE FEET

SITE LOCATION MAP

TOWNSHIP 35S, RANGE 19E
TOWNSHIP 34S, RANGE 19E

FROM USGS QUAD MAP: LORRAINE, 1944

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: H.A.D.	CHECKED BY: [illegible]	DATE: 12/21/82
FILE NO. 82-7047	APPROVED BY: H.G. Stangland	

FIGURE 1.1

Chapter 2

SITE CONDITIONS

2.1 Topography and Geology

The landfill site lies within the Terraced Coastal lowlands, a subdivision of the Coastal Plain Province. The topography is largely controlled by a series of marine terraces formed during Pleistocene time, when the sea stood above its present level. This rise and fall of sea level was attributed to the advance and retreat of the continental ice sheets. When the sea was relatively stationary for long periods, shorelines and marine terraces were developed. The site lies on the Talbot Terrace as indicated by Peek (1958). Elevations on this terrace range between 25 and 42 feet NGVD while "natural" elevations on site average 35 feet NGVD.

The Eocene age or younger deposits in descending order include: Pleistocene and recent deposits, Bone Valley Formation, Hawthorn Formation, Tampa Limestone, Suwannee Limestone, Ocala Group Limestones, and Avon Park Limestone.

Pleistocene and younger deposits range from 10 to 15 feet thick on-site. These deposits consist of gray and light brown fine sands and slightly silty to silty fine sands.

The Bone Valley and Hawthorn Formations underlie the Pleistocene and younger sediments. These deposits, as encountered in our borings, generally consist of coarse to medium sand and phosphate, gray and green clayey sand and clay with traces of phosphate, and gray silt. Our test borings did not encounter the bottom of these deposits. Scott, et al., 1981 report that the top of the Hawthorn Formation is 0 feet NGVD at the site. Scott et al., 1981 report a thickness of the Hawthorn at the site of about 300 feet.

Scott, et al., 1981 report that the top of the Tampa Limestone is 300 feet below sea level or approximately 335 feet below land surface. The Tampa Formation of Miocene Age is between 125 and 235 feet thick according to Peek (1958). The Tampa Limestone according to Scott, et al., 1981, is the first nonphosphatic (less than one percent phosphorus), light colored limestone. Quartz sand is common within these carbonates and clay seams are also present. In the study area, this Formation yields large quantities of water and its top is considered the top of the Floridan Aquifer.

The Oligocene (Suwannee Formation) and Eocene age limestones beneath the Tampa Formation have a total thickness of between 2,600 and 2,800 feet. The upper 1,000 feet of these limestones is the Floridan Aquifer (Peek, 1958). The upper part of the Suwannee is generally creamy-white to tan soft to hard granular porous limestone, with some crystalline and dolomitic limestone. Peek, 1958, reports that the top of the Suwannee Formation is 450 feet below sea level or almost 500 feet below land surface.

2.2 Soils

General site conditions before landfill operations began are shown in Figure 2.1 as per the 1952 aerial photographs for the Manatee County Soil Survey. The United States Department of Agriculture, Soil Conservation Service, Soil Survey of Manatee County, Florida (1958), indicates that the predominant surficial soil, excluding areas of shallow ponds, is Leon-Immokalee fine sands, nearly level phase. Surface drainage is classified as slow to very slow and internal drainage as very slow. Leon-Immokalee fine sands are clean sands with a hardpan layer.

2.3 Aquifer Systems

The surficial, secondary artesian, and Floridan aquifers are the aquifer systems in this area.

A surficial unconfined aquifer system is found in the beds of sand and slightly silty to silty sand found on site at depths between the surface and 10 to 15 feet. This zone is recharged directly by local rainfall. Water levels encountered in this system for the most part range between 2.5-4.0 feet below ground surface. These levels can fluctuate widely with variations in rainfall and evapotranspiration. Localized drawdown of the water table can be seen near the approximately 10-foot deep ditch located on the west side of the site. Movement of the shallow groundwater is very limited due to the lack of topographic relief but some radial movement away from the landfill occurs. Vertical movement of water downward is restricted due to the presence of clays and clayey sands found between depths of 10 to 15 feet. In fact, recharge through the confining beds to the Floridan Aquifer has been estimated at less than 2 inches/year by Stewart (1980). Wells for domestic supply are from the deeper artesian aquifers and not from this surficial aquifer.

At a depth of approximately 335 feet below land surface is found the Tampa Formation which is recognized as the top of the Floridan Aquifer. Probably most of the water in the Floridan in the area comes from rainfall that infiltrates into the aquifer in the recharge area of Polk County. The most used zones for wells in the area are in the Tampa and Oligocene age Suwannee Limestone although the deeper formations may yield large quantities of water; however, the concentrations of total dissolved solids increase with depth.

The Hawthorn Formation, beneath surficial sands and overlying the Tampa Limestone consists predominantly of clay and marl, which serves as a confining bed for the water in the Floridan Aquifer. Thin beds of sand, shell and limestone within the Formation, which are generally separated by relatively thick beds of clay, are the source of many domestic and small irrigation supplies. These thin pervious beds comprise the secondary aquifer. Seaburn and Robertson, 1980, report that the top of the first dolostone unit in the Hawthorn Formation is approximately 100 feet below mean sea level, several miles west of the landfill.

Data from a Southwest Florida Water Management District (SWFWMD) observation well near Verna, 11 miles southeast of the site, shows the potentiometric surface to range between a May low of 31.4 feet NGVD (average for the period of record) and a September high of 41.1 feet NGVD (average for the period of record). Coupled with an average water-table elevation of 37 feet NGVD at the site, head differences between the Surficial and Floridan aquifers can range between 5.6 feet downwards and 4.1 feet upwards. These data indicate that the potential exists for Floridan Aquifer waters to move upwards toward the surficial aquifer during the rainy season and to move downward toward the Floridan Aquifer during the dry season.

The direction of groundwater movement in the artesian aquifers is east to west. According to the SWFWMD potentiometric surface map of the Floridan Aquifer for May 1982 the surface was 6 feet NGVD and the hydraulic gradient flat. During September 1981 the surface was approximately 18 feet NGVD with hydraulic gradient of one foot per mile toward the west. During extremely low water level conditions the potentiometric surface probably will be below sea level with a hydraulic gradient to the north as evidenced by the May 1981 potentiometric surface map. Our experience in the area is that the secondary artesian aquifer direction of groundwater movement is the same as the direction of the groundwater movement in the Floridan Aquifer.

Peek (1958) conducted a pumping test at a Floridan Aquifer well located five miles east of Terra Ceia and approximately 10 miles northwest of the landfill. His calculations indicated a transmissivity of 100,000 gallons/day/foot and a storage coefficient of 0.00014 in the Floridan Aquifer.

2.4 Evaluation of Sinkhole Potential

While the mechanics of how cavities form and what causes a sinkhole are generally understood, the evaluation of a specific area for possible future sinkholes is not yet an exact science. Present tools utilized for such evaluations include local experience, review of geologic history, assessment of regional surficial and bedrock geology, review of hydrogeologic information, and the review of aerial photographs, topographic maps and infrared photographs.

The conditions which must be present for a sinkhole to occur are: (1) cavities or caverns in the limestone through which water is flowing; (2) a connection between these openings in the limestone and the overburden material through which the soil particles in the overburden can pass; and (3) water flowing down into the limestone from the overburden. The latter factor appears to be particularly important. Most sinkholes occur just after the dry season when the water level in the limestone aquifers reaches its low for the year especially where pumping from wells has further lowered the potentiometric surface and rainfall has begun to raise the groundwater level in the surficial aquifer.

The first step in evaluating the sinkhole potential of any area is the determination of past experience. Sinkhole prone areas can be readily identified and areas with the least potential will be conspicuous by the relative absence of sinkhole activity. The location of recent sinkholes which have occurred in Hillsborough, Polk, Manatee, and Hardee Counties are shown in Figure 2.2. The data presented has been collected from a variety of sources including Mr. William Casey of the Polk County Civil Defense Office, the Southwest Florida Water Management

District and previous investigations by Ardaman & Associates, Inc. It is significant to note that there are no reports of sinkholes in Manatee County, in extreme south Hillsborough County or in Hardee County, west of the Peace River.

Because solutioning is most active along fractures in the limestone, it is desirable when studying the sinkhole potential of a site to ascertain the location of these features. When the limestone surface is buried under overlying sediment, it is not possible to map these features. However, they can sometimes be inferred from linear surface features, e.g., stream segments, alignment of sinkholes, etc. These linear surface features are called lineaments. Figure 2.3 presents a lineament map of the study area discerned from aerial photographs and from U.S.G.S. quadrangle topographic maps.

The presence of linear surface features is only one of the factors which must be considered in determining the potential for sinkhole activity. Some other factors include thickness of clay beds above the limestone layers, relationship between elevations of water table and potentiometric surface in artesian aquifers, groundwater pumping, etc.

The downward recharge of groundwater, which is responsible for the erosion of overburden into the limestone cavities, cannot be significant in this area due to the relatively minor difference in water levels between the surficial aquifer and the artesian Floridan Aquifer. It should also be noted that the clayey and partially indurated soils within the Hawthorn Formation are relatively impervious, thick, consolidated sediments which are resistant to erosion.

The sinkhole classification of the region presented by the Florida Geological Survey as shown in Figure 2.4, suggests the site lies within an area of least probable sinkhole development.

In summary, the geologic, hydrologic and geotechnical evidence available to date suggests that the type of conditions favorable for the development of sinkhole formations does not exist in the vicinity of this site. Although cavernous limestone may be present, it is very deep and is overlain by thick deposits of relatively impermeable sediments. Furthermore, no evidence of sinkholes has been observed or recorded in the area of this investigation, nor do any of the aerial photographs indicate recent sinkhole activity. There is no potential for sinkhole development in this area.

2.5 Landfill

All of the existing landfill area has been filled, except for approximately 25-acres at the southwest portion of the site. The original cells are approximately 100 feet wide, 300 feet long and extend approximately 8 feet below the original surface elevation. Presently, filling operations are taking place along the northern part of the site. The surface of the landfill areas within this part of the site are presently approximately 14 feet above the original surface grade (approximately 50 feet NGVD).

A ditch with a 10-foot bottom width runs around most of the perimeter of the site. This ditch is not present for about 900 feet near the northwestern corner of the site. The perimeter ditch has no positive outlet. An earth plug separates the perimeter ditch and a drainage ditch on the west side of the site. This drainage ditch runs along the southern edge of a gun range, and into Cypress Strand, a tributary to the Manatee River.

As outlined by Briley, Wild & Associates, Inc., the proposed development approach being considered would require enlarging the existing landfill (Parcel A) to include that portion of the proposed expansion (Parcel B) within Section 6, T35S, R19E. The second stage of development would include the balance of Parcel B, which is within Section 31, T34S, R19E.

The general design approach to the first stage of the landfill (Parcel A) is to develop an elevated plateau over the existing fill area at elevations of 50 to 70 feet (NGVD) having a gentle downward slope of about 1% from east to west. The east, south and west edges of this plateau will have a more pronounced downward slope of 30% to leachate drainage ditches near these respective borders of the property. The northern face of the plateau will step down more gradually (approximate slope = 10%) to the natural existing grade and to drainage ponds which will result from excavation operations for needed cover material.

The plateau area of Parcel A will have a confining berm which in combination with the grading pattern will direct the surface storm drainage from this area to the mid-point of the western boundary of the existing landfill. An elevated water conveyance facility will be provided to direct the surface drainage, or stormwater runoff, over the leachate ditch, from the plateau level to the existing canal which runs westward from the existing landfill. In this way the surface runoff portion of stormwater falling on the landfill will be separated from the water which seeps into the landfill and becomes leachate. The leachate seepage will be collected by the leachate ditches and pumped to aeration ponds for treatment while the uncontaminated runoff will be directed to the natural water courses in its historic pattern.

The leachate ditches will be excavated to approximately one foot below the lowest anticipated groundwater level. Water levels in the leachate ditches will be maintained at a level below the natural, adjacent groundwater level. Therefore, seepage from both the landfill and from nearby adjacent lands will move into the leachate ditch to prevent migration of leachate offsite. The water level in the ditches will be controlled by monitoring the groundwater level on the side of the ditch opposite the landfill.

As mentioned earlier, the northern face of the Parcel A landfill plateau will slope gently down to the natural grade of the land. At the foot of this slope, about 300 feet north of the existing landfill, an impermeable, subsurface "slurry wall" will be built along an east-west line. The slurry wall will extend down to the clay layer to provide an effective seal against the northerly migration of leachate. A perforated drain pipe will be buried immediately south of the slurry wall to drain groundwater to the east and west leachate ditches. Thus, the landfill will be enclosed by leachate drainage ditches on three sides, east, south, and west, and by a slurry wall and buried drain on the north.

During most of the first stage (Parcel A) landfill operation, the leachate collected in the drainage ditches will be pumped to a reservoir in the unused portion in the southwest corner of the landfill. Sprays will be used to provide aeration treatment and to accelerate evaporation. As the first stage approaches final completion, the southwest reservoir area will be filled in and landfilled to the design elevation. The permanent drainage ponds to the north (in the southern portion of Parcel B) which were created to obtain cover material for the landfills will receive the leachate.

A second pond system just north of the "slurry wall" will be used to collect and store surface runoff in the immediate area and the water will provide irrigation water for the future golf course.

The design Stage II operations covering that portion of Parcel B within Section 31, Township 34 South, Range 19 East, is programmed to start upon completion of the Stage I operations.

During the Stage I operation, excess cover material will be stockpiled along a 200-foot buffer strip within the southern area of Parcel B.

During the Stage II operation (Parcel B), refuse will be deposited in the area north of this 200-foot buffer for a distance of approximately 2100 feet north to within 200 feet of the east and west boundaries. The main top surface area of the plateau resulting from this landfilling will slope downward to the north at approximately 1% grade. The east, south and west edges of the plateau will have more definite slopes of approximately 30%, while the north edge slope will average 10%.

Leachate ditches similar to those described in the Stage I design will be dug along the east and west borders of the Parcel B fill and across 800 feet of the western portion of the south border. Leachate which accumulates in those ditches will be pumped into the leachate pond in the northern part of the Stage I development. Surface drainage from the east, south and west edges of the landfill plateau will also be directed to the leachate pond either by way of the ditches and pumps, or directly from the fill slope in the case of the greater part of the southern edge. This pond will be surrounded with a slurry wall.

At the foot of the north slope from the landfill (Parcel B), a slurry wall of similar design to the one described for Stage I will be constructed. A submerged, perforated drain just south of the slurry wall will direct any leachate accumulation to the east and west leachate ditches.

A stormwater retention pond will be located between the slurry wall and the northern boundary of the property. This pond will have been excavated to develop the balance of the cover material needed for landfilling.

Water from this stormwater retention pond will be used to irrigate the future golf course. Overflow from the retention ponds will follow an existing water course to the north.

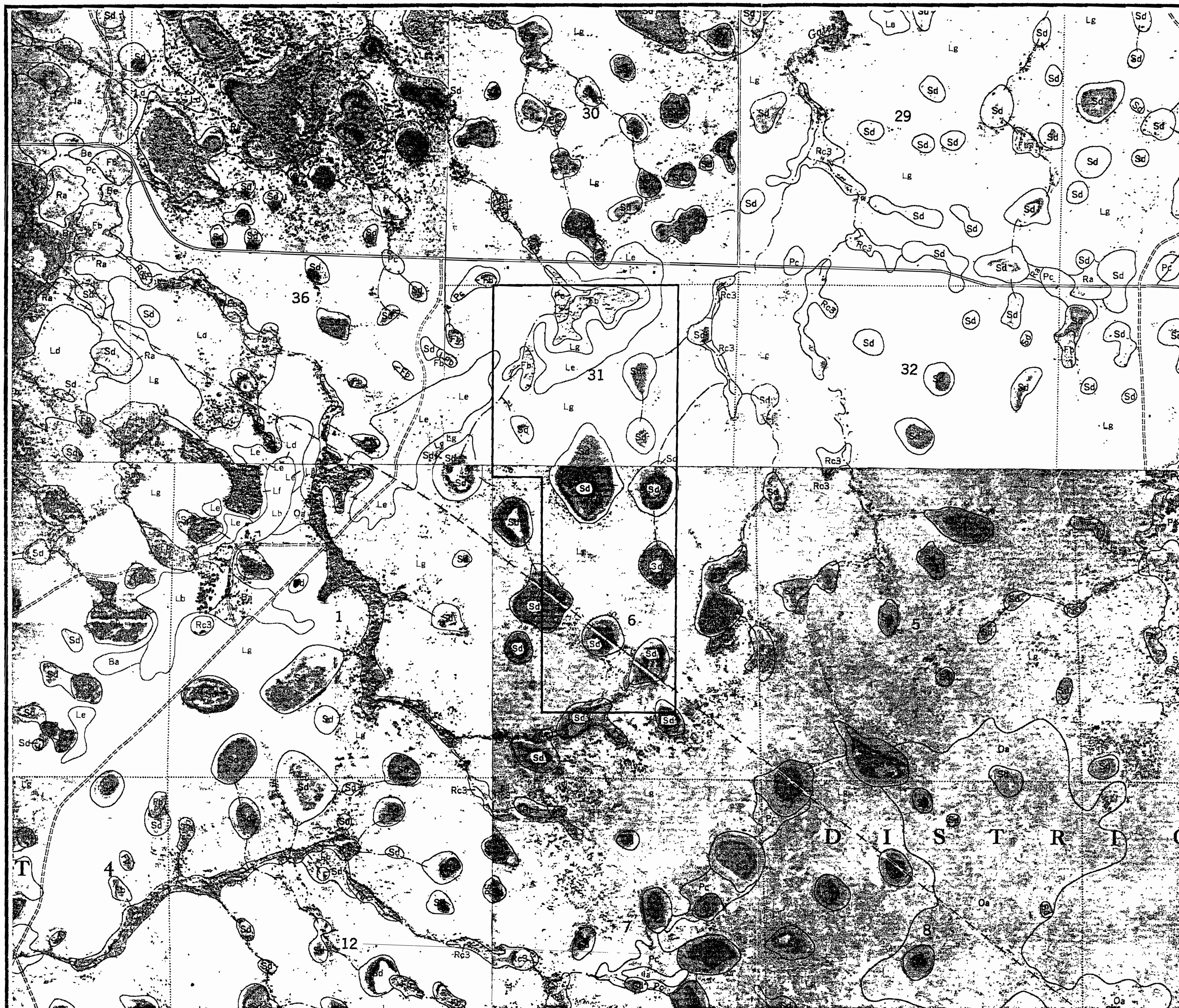


IMAGE IS OF POOR QUALITY

SOILS LEGEND

Be	Bradenton fine sand
Fa	Fresh water marsh (unclassified soils)
Fb	Fresh water swamp (unclassified soils)
Ia	Immokalee-Leon fine sands
Ld	Leon fine sand, heavy substratum phase
Le	Leon fine sand, light-colored surface phase
Lf	Leon-Immokalee fine sands, gently sloping phases
Lg	Leon-Immokalee fine sands, nearly level phases
Oa	Ona fine sand
Pa	Parkwood fine sand
Pc	Plummer fine sand
Ra	Ruskin fine sand
Rc	Rutlege fine sand, nearly level phase
Sd	Shallow ponds with grass

VEGETATION LEGEND

3	Prairie

SURFICIAL SOILS

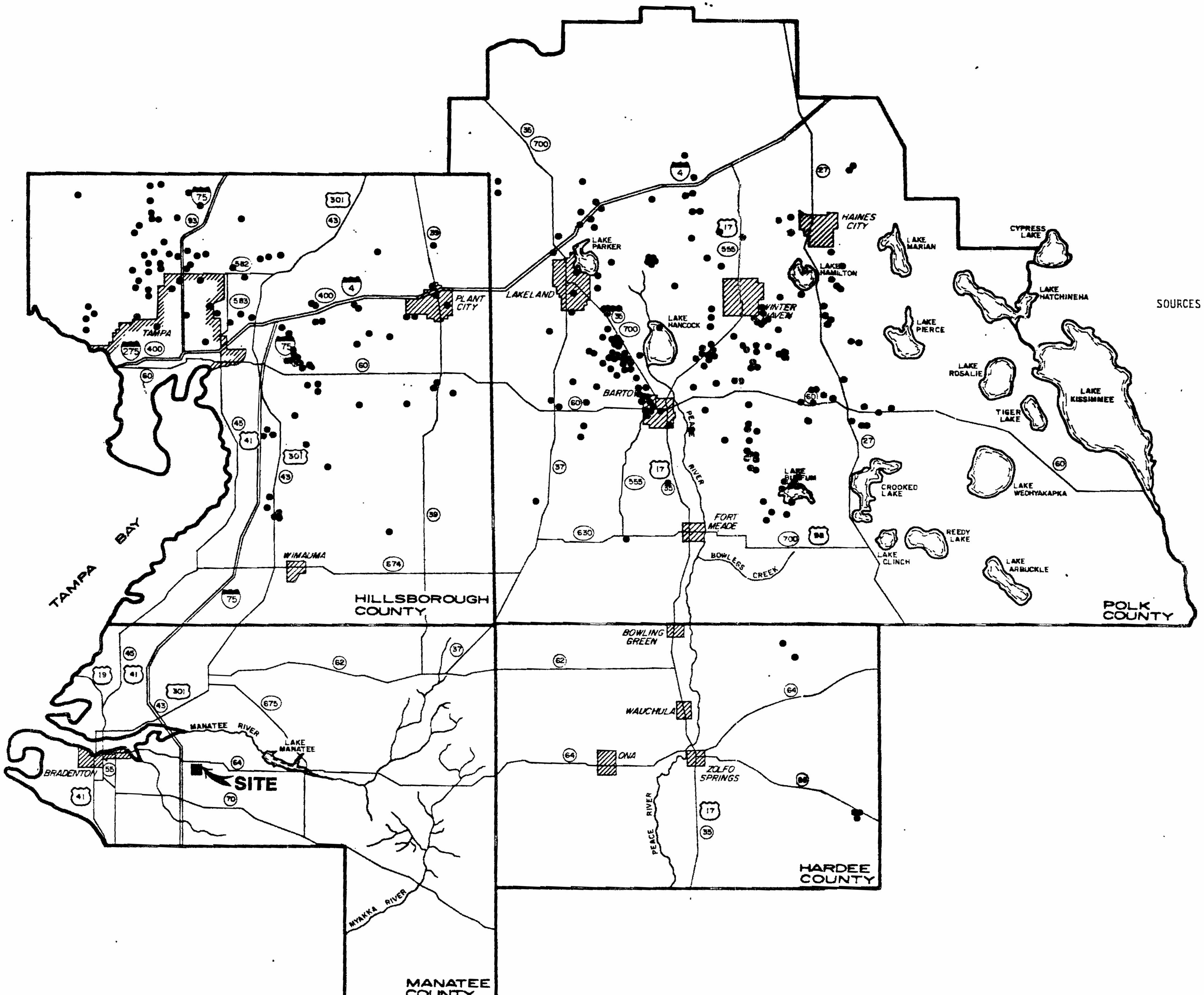
Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: R. J. F.	CHECKED BY: H.S.	DATE: 2/24/83
FILE NO. 82-7047	APPROVED BY: H.G. Staneland	

FIGURE 2.1

K&E 19 1133 12-81 MC3313e



REPORTED SINKHOLES AS OF MARCH 1982

SOURCES: (1) MR. WILLIAM CASEY, DEPUTY DIRECTOR OF PUBLIC SAFETY, CIVIL DEFENCE AGENCY, POLK COUNTY, FLORIDA

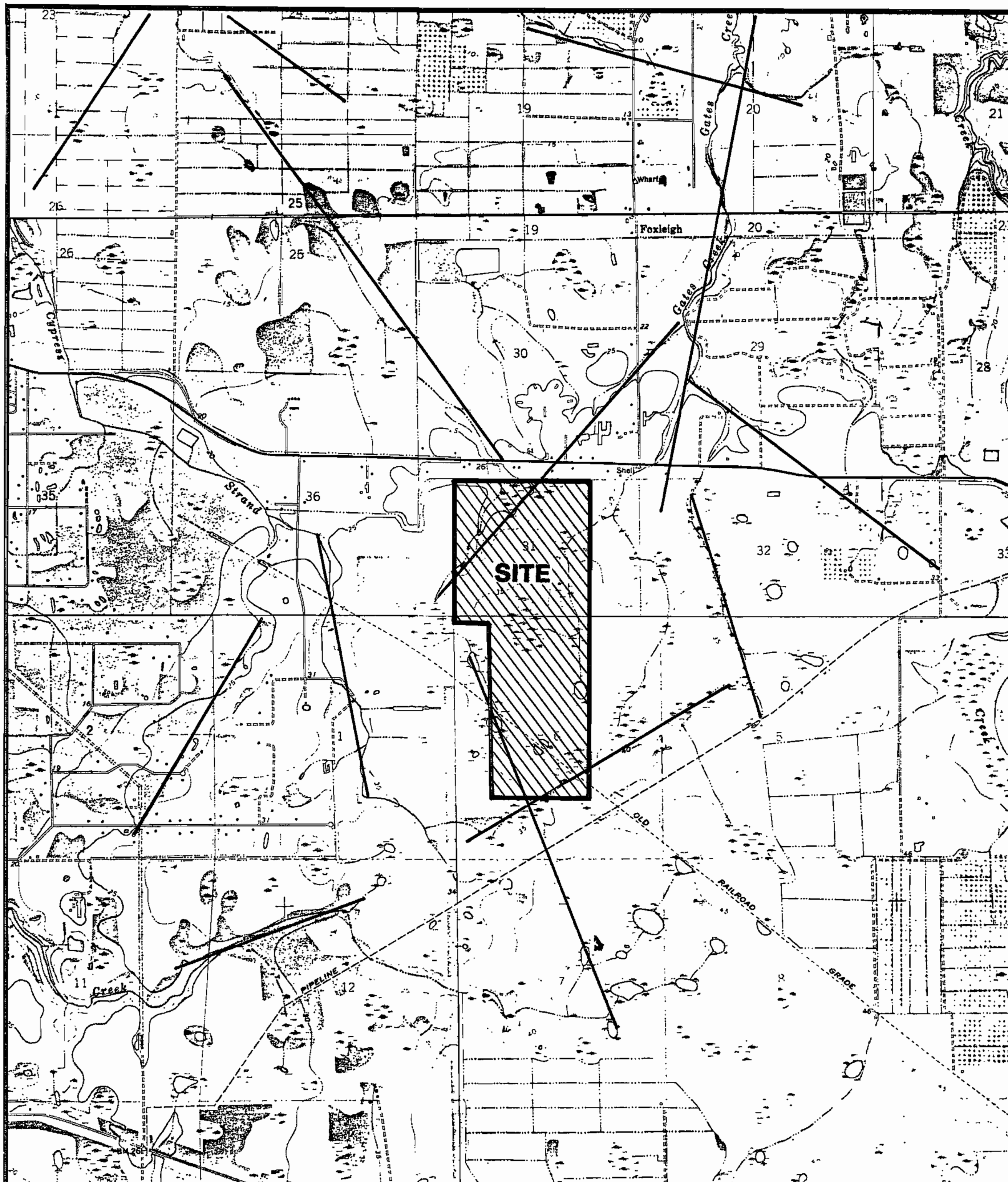
(2) SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

(3) PREVIOUS ARDAMAN & ASSOC. SINKHOLE INVESTIGATIONS

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: H.A.D.	CHECKED BY: [illegible]	DATE: 3/2/83
FILE NO. 82-7047	APPROVED BY: [signature]	



LINEAMENTS IN THE SITE VICINITY

FROM USGS QUAD MAPS: LORRAINE, 1973
PARRISH, 1973

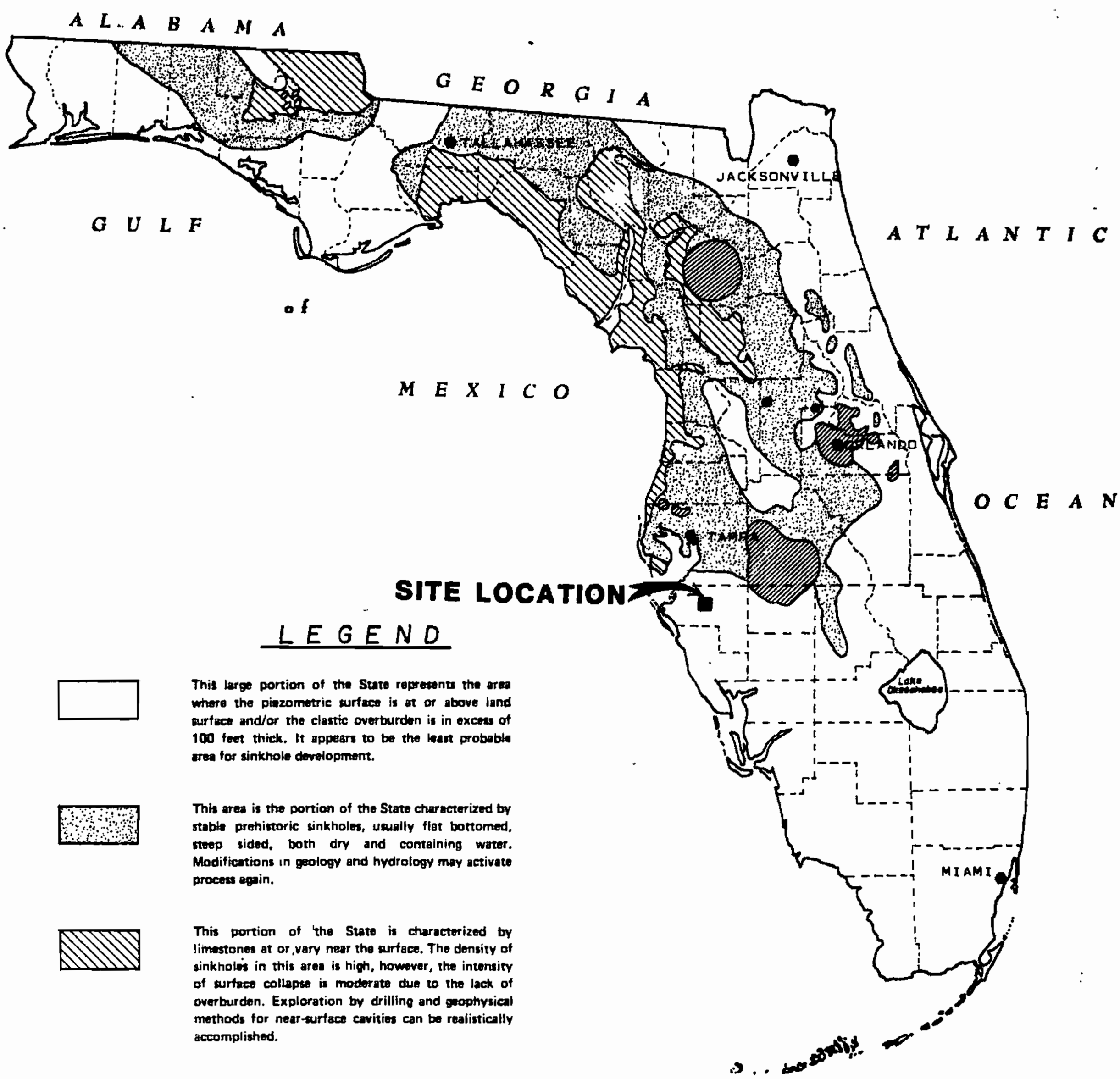
Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: H.A.D	CHECKED BY:	DATE: 3/2/83
FILE NO. 82-7047	APPROVED BY: H.G. Stangland	

FIGURE 2.3

K&E 19 1153 12-60 MC1983e



LEGEND

This large portion of the State represents the area where the piezometric surface is at or above land surface and/or the clastic overburden is in excess of 100 feet thick. It appears to be the least probable area for sinkhole development.

This area is the portion of the State characterized by stable prehistoric sinkholes, usually flat bottomed, steep sided, both dry and containing water. Modifications in geology and hydrology may activate process again.

This portion of the State is characterized by limestones at or very near the surface. The density of sinkholes in this area is high, however, the intensity of surface collapse is moderate due to the lack of overburden. Exploration by drilling and geophysical methods for near-surface cavities can be realistically accomplished.

This portion of the State has moderate overburden overlying cavernous limestones and appreciable water use. These areas have histories of steep-walled, wider sinkhole collapse but require more detailed study. A thick overburden or high water table present within these areas lessen the probability of sinks occurring.

MOST PROBABLE SINKHOLE REGIONS IN FLORIDA

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: H.A.D.	CHECKED BY: J. J.	DATE: 3/2/83
FILE NO. 82-7047	APPROVED BY: H.G. Stangland	

SOURCE: VERNON (1972), S.P. 16

FIGURE 2.4

Chapter 3

FIELD INVESTIGATION AND RESULTS

3.1 Field Investigation

The field investigation consisted of 42 Standard Penetration Test (SPT) borings and 15 piezometer installations. The locations of the test borings and piezometers are shown in Figure 3.1. The test borings were conducted utilizing the SPT method (ASTM D-1586) as summarized in Appendix A.1. The piezometers consisted of a five-foot length of two-inch diameter slotted PVC pipe connected to a solid PVC pipe riser with the top extending about three feet above the ground surface. The annular space around the slotted pipe and the 4-inch diameter open hole was filled with silica sand to just below the water table, a 6-inch thick bentonite seal was installed on top of the sand, and the remaining annular space was backfilled to the ground surface with bentonite-cement grout.

The piezometers were used as both water quality sampling points to detect the existence of a leachate plume, document background water quality and for measurement of *in situ* permeabilities. Prior to the permeability tests, each well was developed to clear the slotted section of any fine soil material. After water quality sampling was performed, each piezometer was then filled to the top with clear water and the subsequent drop of the water level in the pipe was recorded at selected time intervals.

As part of the drilling program, nine undisturbed samples of the sand and clay layers were recovered for use in laboratory determination of permeability and chemical testing.

A direct current resistivity survey was performed along the north, east and west sides of the existing landfill site and is further discussed elsewhere in this report. The south side of the site was not surveyed because of wet areas in the southeast corner and the fact that until the last few months no refuse had been placed near this edge of the property.

3.2 Test Boring Results

The results of the SPT borings are illustrated on the subsurface profile in Figures 3.2 through 3.7. Included on the profile for each test boring are the SPT "N" values. The soil stratification is based on an examination of recovered soil samples and interpretation of field boring logs by a geotechnical engineer. The stratification lines represent the approximate boundaries between soil types of significantly differing engineering properties although the actual transition may be gradual. In some cases, variations in properties not considered pertinent to our engineering evaluations have been omitted for clarity.

3.3 Groundwater Levels

The groundwater level at the time of our testing between October 12, and November 9, 1982 was approximately two feet below ground surface. The water levels for each test hole is shown adjacent to the subsurface profiles on Figures 3.2 through 3.7. It should be noted that this level does not necessarily represent extreme water-level conditions. The groundwater levels noted are perhaps slightly below what could be considered "high" water-table conditions. The "high" water table is judged to be one to three feet below land surface.

3.4 *In Situ* Permeability Tests

The results of the *in situ* falling head permeability tests performed in the piezometers are noted at the appropriate depth adjacent to the piezometer profiles in Figures 3.2 through 3.7. The test results are expressed as coefficients of permeability. The measured *in situ* permeabilities ranged from 3.5×10^{-5} cm/sec to 4.7×10^{-3} cm/sec (0.1 to 13.3 feet per day).

3.5 Surface Resistivity Results

Direct current (DC) resistivity methods involve the measurement of the resistivity of geologic units by introducing a direct current into the ground through two electrodes. The voltage (potential) difference is measured between the two current electrodes and a second pair of electrodes (potential electrodes). From the current and potential measurements, the apparent resistivity may be calculated. Apparent resistivity is a measure of a material's resistance to the flow of electricity through it. When the electrodes are placed closely together, most of the introduced current will flow in the near-surface layers. As the electrode spacings are increased, more current moves through the deeper layers. Thus, the change in apparent (measured) resistivity with increasing electrode spacings yields information about the variation of resistivity with depth.

Both changes in geology and water quality can be inferred from the data gathered during a DC resistivity survey. Typically, silicate and carbonate minerals have very high resistivities and clay units have very low resistivities. In general, the higher the porosity, the lower the resistivity. The quality of interstitial waters has a strong influence on the variation of resistivities in saturated geologic units. When ground waters have a very low dissolved solids content, most of the electrical current flows along the surfaces of the soil or rock particles. In this situation, apparent resistivity will be a measure of porosity. As dissolved solids content increases, current flow through the interstitial fluid increases, yielding a lower apparent resistivity.

Resistivity soundings were taken along the north, east and west sides of the existing landfill site and were made within a strip 100 feet outside the perimeter ditch. Our resistivity investigation was limited to the near-surface soils with Wenner electrode spacings of 5, 10, and 20 feet. These short spacings permit determinations of depth to the water table and near-surface water quality characteristics. By comparison of the resistivity data and hydrogeologic information from test borings, it was possible to make a qualitative analysis of the groundwater characteristics. Coupled with water quality of the groundwater an indication of leachate plume(s), if any, can be determined with these techniques.

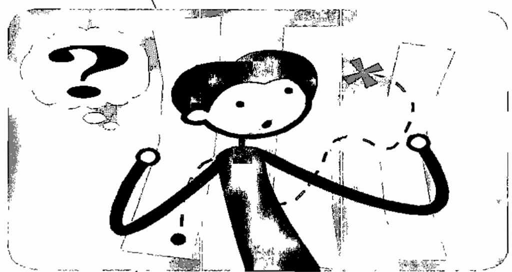
Apparent resistivity values for a spacing of 20 feet was used in this interpretative analysis. The apparent resistivity values ranged between 49 and 800 ohm-feet for this spacing. Values less than 200 ohm-feet were judged to represent groundwater contamination. The resistivity values imply that the highest quality water (e.g., low total dissolved solids) is found along the east side of the existing landfill site. Values were 110 to 538 ohm-feet. Along the west side apparent resistivity values were 100 to 200 ohm-feet. These resistivity values imply some signs of possible contamination. Resistivity values imply the worst water quality to occur between TH-14 and TH-15 along the north wall. Quality appears to improve towards the east and west ends of this north property boundary. Minimum values of 49 to 51 ohm-feet were recorded in the vicinity of TH-14 and TH-15, respectively.

The above data implies that a pollutant plume probably has exited the site along parts of the north property boundary. Water quality has deteriorated to a degree in localized areas along the west and east boundaries. The east boundary infers the best water quality except for the 110 ohm-feet reading just south of TH-11.

3.6 Well Inventory

Figure 3.1 shows the location of wells inventoried for this study. Except for the 2-inch diameter piezometers installed as part of this investigation no wells are located in Section 31. At the existing landfill area a well is located at the weigh station in the northwest corner of Section 6. Five wells were identified between State Road 64 and the proposed landfill area. Well A is reported as 6-inch diameter, 495 feet deep with 61 feet of casing. Well B is reported as 10-inch diameter, 600 feet deep and an unknown casing length. Well A is used for dairy irrigation, while Well B is not in use. All homes along State Road 64 are connected to the county water system. No information is available on other wells.

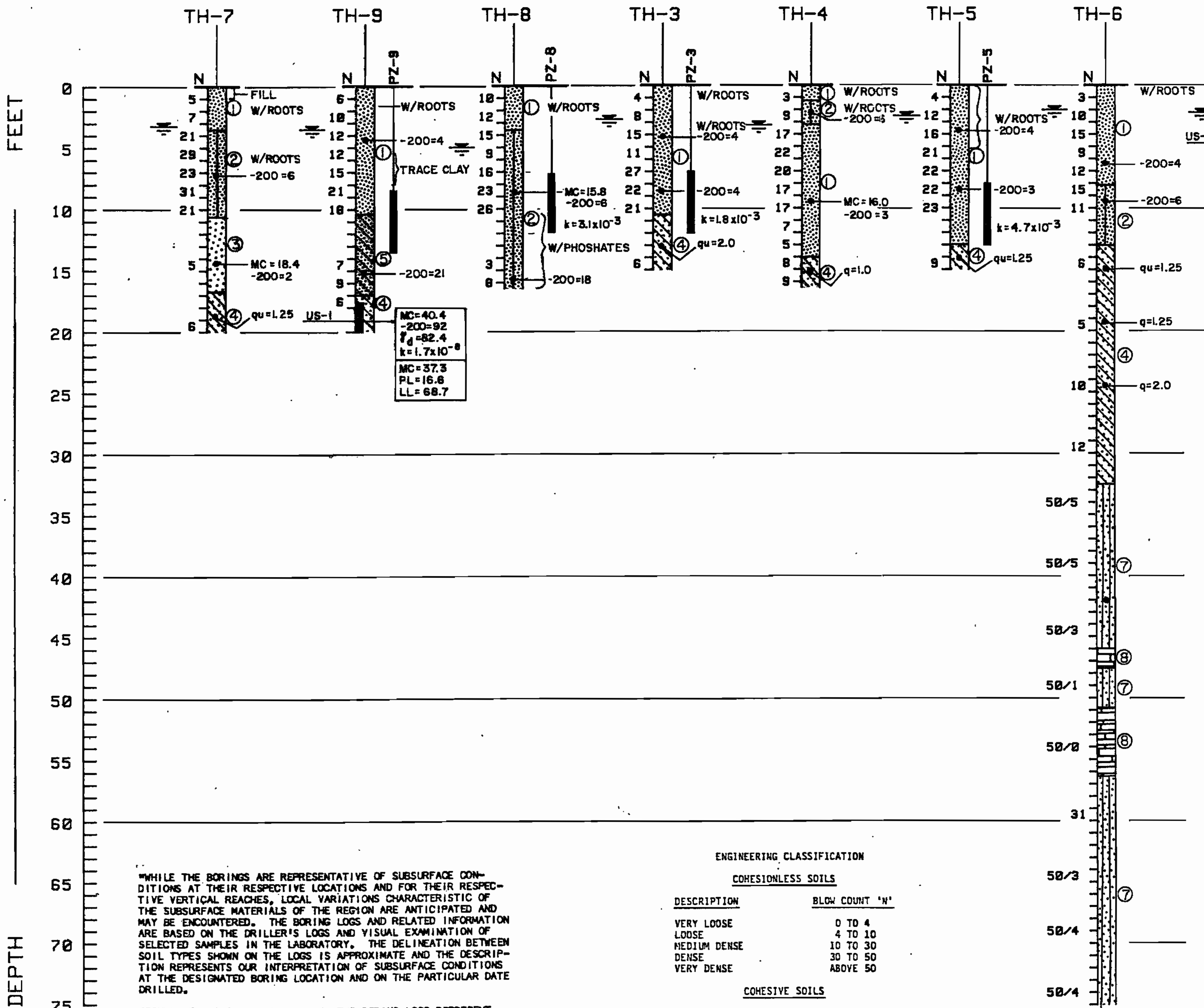
ATTENTION



AN OVERSIZED DRAWING HAS BEEN SCANNED SEPARTELY. PLEASE SEE:

- **39884-018-SO/01 LENA ROAD CLI LF OP RENEWAL RAI#1 RESPONSE-1985 HYDRO/ GEOTECH REPORT DRWG #1**

K&E 19 1153 12-81 MC33156



LEGEND

	①	LIGHT GRAY TO GRAY AND LIGHT BROWN TO YELLOWISH BROWN FINE SAND.
	②	GRAY OR LIGHT BROWN TO YELLOWISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND.
	③	GRAY AND BROWN MEDIUM TO FINE SAND TO SLIGHTLY SILTY FINE SAND WITH PHOSPHATES.
	④	GRAY AND GREEN OR BROWN TO LIGHT YELLOWISH BROWN CLAY AND SANDY CLAY WITH OCCASIONAL TRACES OF PHOSPHATES AND SEAMS OF FINE SAND.
	⑤	GRAY AND GREEN SLIGHTLY CLAYEY TO CLAYEY FINE SAND WITH OCCASIONAL TRACES OF PHOSPHATES, SHELL OR CEMENTED SAND.
	⑥	LIGHT REDDISH BROWN TO REDDISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND WITH TRACES OF ROOTS (HARDPAN TYPE).
	⑦	GRAY SANDY SILT AND SILT WITH OCCASIONAL TRACES OF CLAY AND PHOSPHATES.
	⑧	SOLID ROCK
PZ		PIEZOMETER
		GROUND WATER LEVEL DATES DRILLED: 10-12-82 THROUGH 10-21-82
N		STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT.
US-1		UNDISTURBED SAMPLE
50/3		50 BLOWS FOR 3 INCHES OF PENETRATION INTO THE SOIL.
MC		MOISTURE CONTENT IN PERCENT
-200		PERCENT PASSING THE NO. 200 SIEVE.
q_u		UNCONFINED COMPRESSIVE STRENGTH IN tsf
γ_d		IN-SITU DRY DENSITY IN lb/ft^3
PL		PLASTIC LIMIT IN PERCENT
LL		LIQUID LIMIT IN PERCENT
k		COEFFICIENT OF PERMEABILITY IN cm/sec

"WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATION AND ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR. ABSENCE OF WATER SURFACE DATA ON CERTAIN BORINGS IMPLIES THAT NO GROUNDWATER DATA IS AVAILABLE, BUT DOES NOT NECESSARILY MEAN THAT GROUNDWATER WILL NOT BE ENCOUNTERED AT THESE LOCATIONS OR WITHIN THE VERTICAL REACHES OF THESE BORINGS."

ENGINEERING CLASSIFICATION

COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT 'N'
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, TSF	BLOW COUNT 'N'
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
MAY 18 2010
SOUTHWEST DISTRICT TAMPA

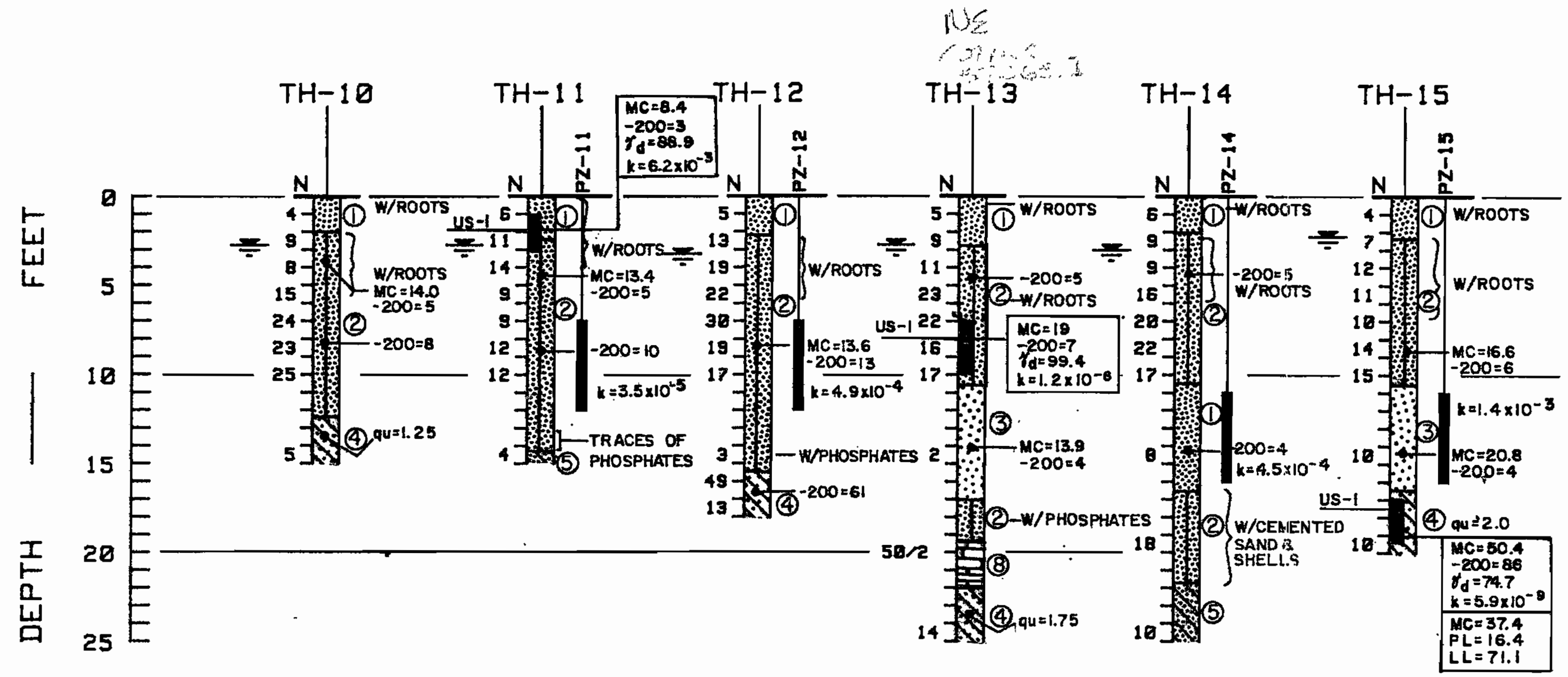
Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: R.J.F.	CHECKED BY: JF	DATE: 11/3/82
FILE NO. 82-7047	APPROVED BY: [signature]	

FIGURE 3.2

K&E 19 1153 12-81 MC3313a



LEGEND

① LIGHT GRAY TO GRAY AND LIGHT BROWN TO YELLOWISH BROWN FINE SAND.

② GRAY OR LIGHT BROWN TO YELLOWISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND.

③ GRAY AND BROWN MEDIUM TO FINE SAND TO SLIGHTLY SILTY FINE SAND WITH PHOSPHATES.

④ GRAY AND GREEN OR BROWN TO LIGHT YELLOWISH BROWN CLAY AND SANDY CLAY WITH OCCASIONAL TRACES OF PHOSPHATES AND SEAMS OF FINE SAND.

⑤ GRAY AND GREEN SLIGHTLY CLAYEY TO CLAYEY FINE SAND WITH OCCASIONAL TRACES OF PHOSPHATES, SHELL OR CEMENTED SAND.

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⑦ GRAY SANDY SILT AND SILT WITH OCCASIONAL TRACES OF CLAY AND PHOSPHATES.

⑧ SOLID ROCK

PZ PIEZOMETER

GROUND WATER LEVEL DATES DRILLED: 10-12-82 THROUGH 10-21-82

N STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT.

US-1 UNDISTURBED SAMPLE

50/3 50 BLOWS FOR 3 INCHES OF PENETRATION INTO THE SOIL.

MC MOISTURE CONTENT IN PERCENT

-200 PERCENT PASSING THE NO. 200 SIEVE.

q_u UNCONFINED COMPRESSIVE STRENGTH IN tsf

γ_d IN-SITU DRY DENSITY IN lb/ft^3

PL PLASTIC LIMIT IN PERCENT

LL LIQUID LIMIT IN PERCENT

k COEFFICIENT OF PERMEABILITY IN cm/sec

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
MAY 18 2010
SOUTHWEST DISTRICT
TAMPA

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ENGINEERING CLASSIFICATION

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MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, TSF	BLOW COUNT 'N'
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: R.J.F.	CHECKED BY: JF	DATE: 11/3/82
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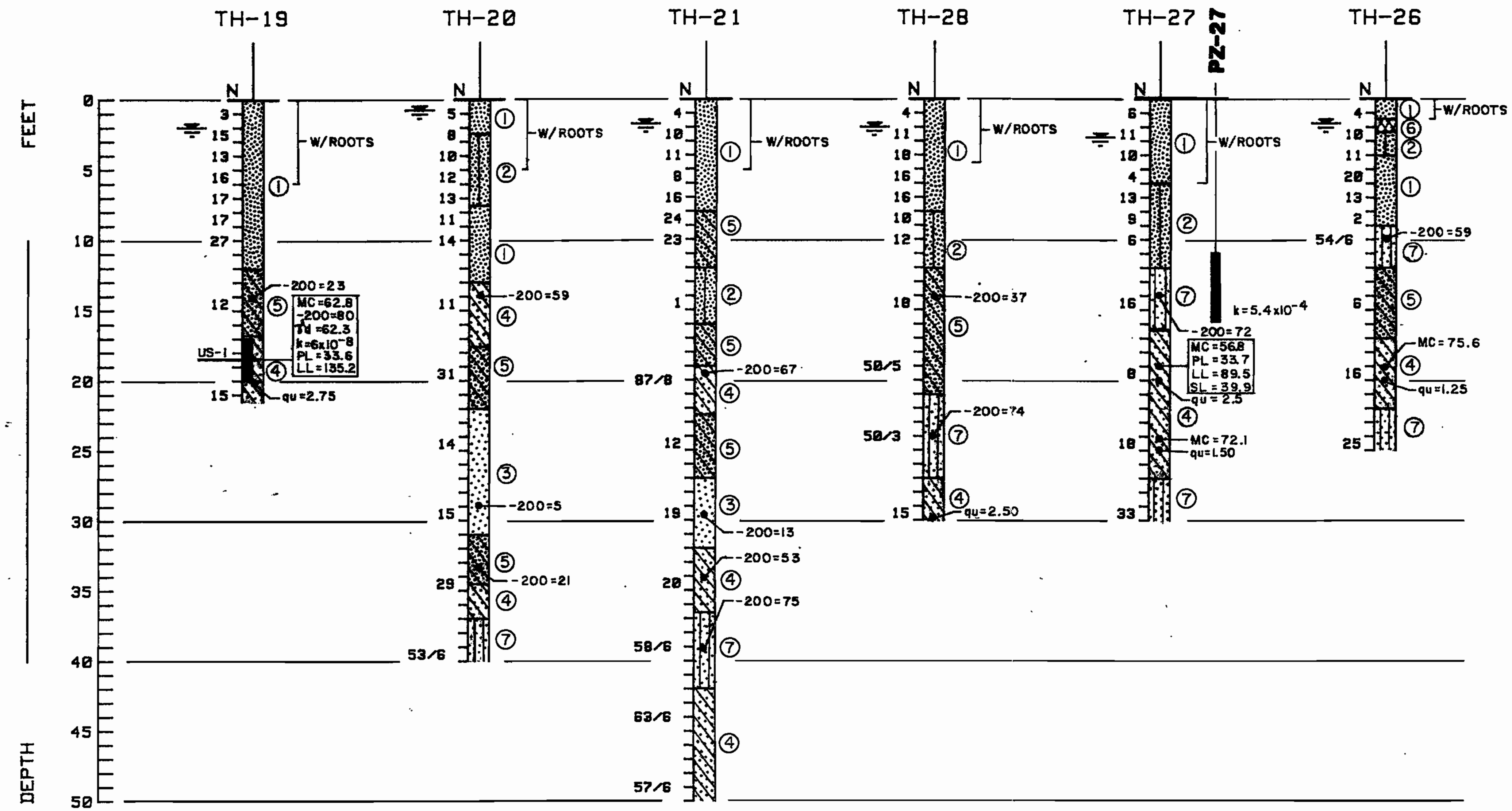
FIGURE 3.3



LEGEND

	①	LIGHT GRAY TO GRAY AND LIGHT BROWN TO YELLOWISH BROWN FINE SAND
	②	GRAY OR LIGHT BROWN TO YELLOWISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND
	③	GRAY AND BROWN MEDIUM TO FINE SAND TO SLIGHTLY SILTY FINE SAND WITH PHOSPHATES
	④	GRAY AND GREEN OR BROWN TO LIGHT YELLOWISH BROWN CLAY AND SANDY CLAY WITH OCCASIONAL TRACES OF PHOSPHATES AND SEAMS OF FINE SAND
	⑤	GRAY AND GREEN SLIGHTLY CLAYEY TO CLAYEY FINE SAND WITH OCCASIONAL TRACES OF PHOSPHATES, SHELL OR CEMENTED SAND
	⑥	LIGHT REDDISH BROWN TO REDDISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND WITH TRACES OF ROOTS (HARDPAN TYPE)
	⑦	GRAY SANDY SILT AND SILT WITH OCCASIONAL TRACES OF CLAY AND PHOSPHATES
	⑧	SOLID ROCK
	PZ	PIEZOMETER
	▼	GROUND WATER LEVEL DATES DRILLED: 10/21/82 THROUGH 11/9/82
	N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
	US-1	UNDISTURBED SAMPLE
	50/3	50 BLOWS FOR 3 INCHES OF PENETRATION INTO THE SOIL
	MC	MOISTURE CONTENT IN PERCENT
	-200	PERCENT PASSING THE NO. 200 SIEVE
	qu	UNCONFINED COMPRESSIVE STRENGTH IN tsf
	γd	IN-SITU DRY DENSITY IN lb/ft^3
	PL	PLASTIC LIMIT IN PERCENT
	LL	LIQUID LIMIT IN PERCENT
	SL	SHRINKAGE LIMIT IN PERCENT
	k	COEFFICIENT OF PERMEABILITY IN cm/sec

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
MAY 18 2010
SOUTHWEST DISTRICT TAMPA

ENGINEERING CLASSIFICATION

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LOOSE	4 TO 10
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DENSE	30 TO 50
VERY DENSE	ABOVE 50

COHESIVE SOILS

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SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

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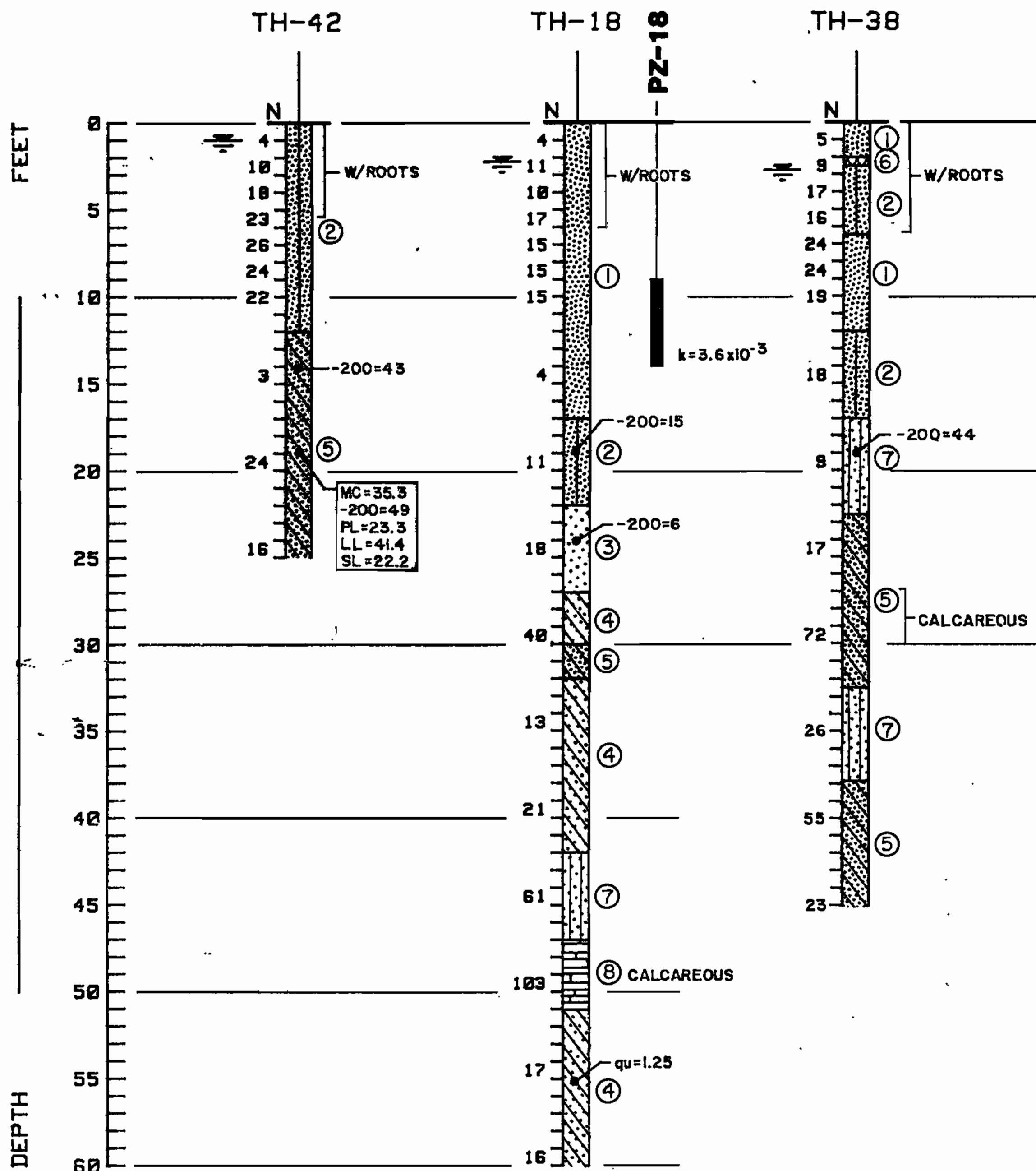
HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: RJF	CHECKED BY: [signature]	DATE: 1/21/83
FILE NO. 82-7047	APPROVED BY: H.G. Stangland	

FIGURE 3.4



LEGEND

	①	LIGHT GRAY TO GRAY AND LIGHT BROWN TO YELLOWISH BROWN FINE SAND
	②	GRAY OR LIGHT BROWN TO YELLOWISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND
	③	GRAY AND BROWN MEDIUM TO FINE SAND TO SLIGHTLY SILTY FINE SAND WITH PHOSPHATES
	④	GRAY AND GREEN OR BROWN TO LIGHT YELLOWISH BROWN CLAY AND SANDY CLAY WITH OCCASIONAL TRACES OF PHOSPHATES AND SEAMS OF FINE SAND
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LL		LIQUID LIMIT IN PERCENT
SL		SHRINKAGE LIMIT IN PERCENT
k		COEFFICIENT OF PERMEABILITY IN cm/sec

ENGINEERING CLASSIFICATION

COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT 'N'
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LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, TSF	BLOW COUNT 'N'
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

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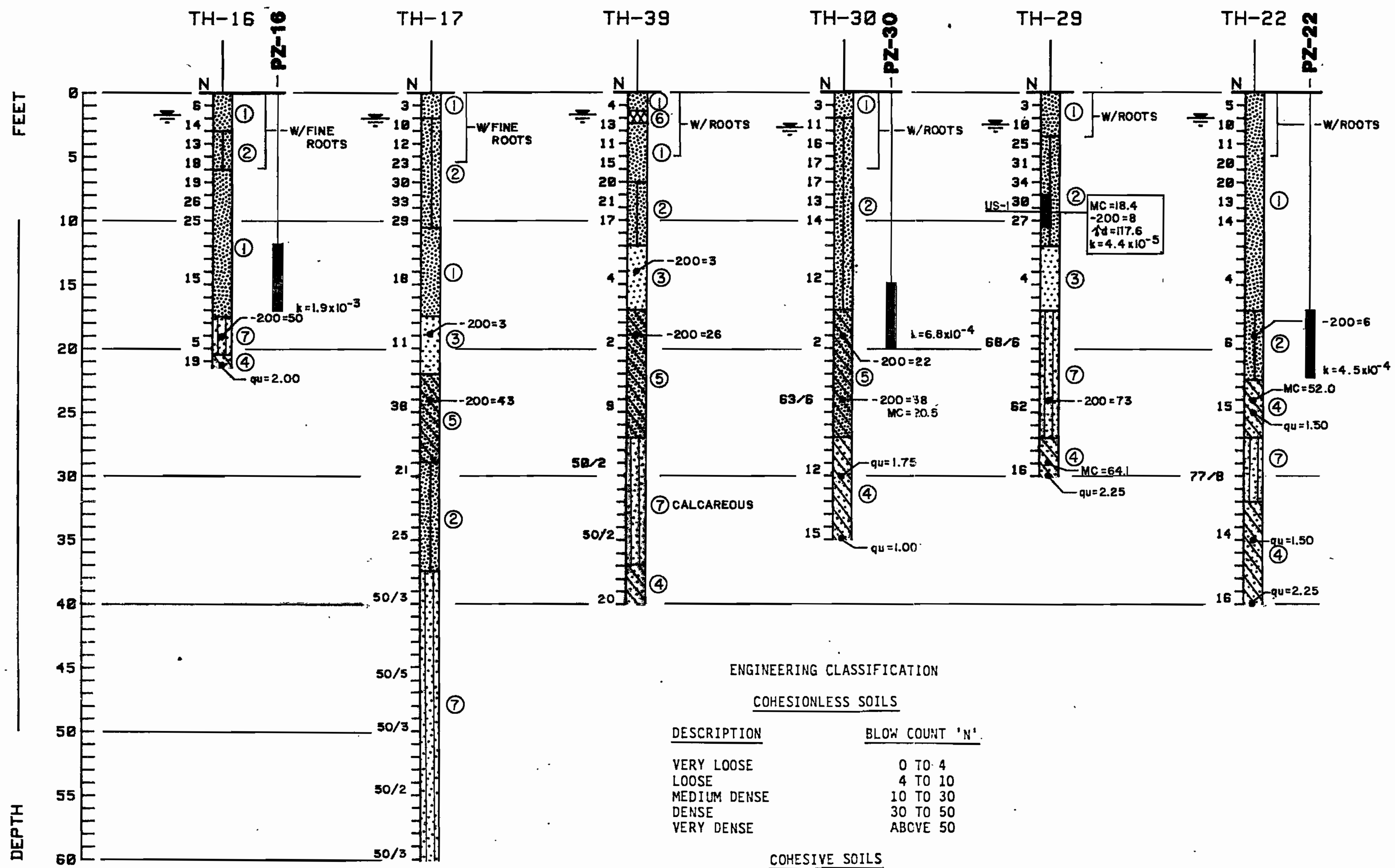
HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: RJF	CHECKED BY: [illegible]	DATE: 1/21/83
FILE NO. 82-7047	APPROVED BY: H.E. Stangland	

FIGURE 3.5



LEGEND

①	LIGHT GRAY TO GRAY AND LIGHT BROWN TO YELLOWISH BROWN FINE SAND
②	GRAY OR LIGHT BROWN TO YELLOWISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND
③	GRAY AND BROWN MEDIUM TO FINE SAND TO SLIGHTLY SILTY FINE SAND WITH PHOSPHATES
④	GRAY AND GREEN OR BROWN TO LIGHT YELLOWISH BROWN CLAY AND SANDY CLAY WITH OCCASIONAL TRACES OF PHOSPHATES AND SEAMS OF FINE SAND
⑤	GRAY AND GREEN SLIGHTLY CLAYEY TO CLAYEY FINE SAND WITH OCCASIONAL TRACES OF PHOSPHATES, SHELL OR CEMENTED SAND
⑥	LIGHT REDDISH BROWN TO REDDISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND WITH TRACES OF ROOTS (HARDPAN TYPE)
⑦	GRAY SANDY SILT AND SILT WITH OCCASIONAL TRACES OF CLAY AND PHOSPHATES
⑧	SOLID ROCK
PZ	PIEZOMETER
▼	GROUND WATER LEVEL DATES DRILLED: 10/21/82 THROUGH 11/9/82
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
JS-1	UNDISTURBED SAMPLE
50/3	50 BLOWS FOR 3 INCHES OF PENETRATION INTO THE SOIL
MC	MOISTURE CONTENT IN PERCENT
-200	PERCENT PASSING THE NO. 200 SIEVE
qu	UNCONFINED COMPRESSIVE STRENGTH IN tsf
γd	IN-SITU DRY DENSITY IN lb/ft^3
PL	PLASTIC LIMIT IN PERCENT
LL	LIQUID LIMIT IN PERCENT
SL	SHRINKAGE LIMIT IN PERCENT
k	COEFFICIENT OF PERMEABILITY IN cm/sec

ENGINEERING CLASSIFICATION

COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT 'N'
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, TSF	BLOW COUNT 'N'
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

"WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATION AND ON THE PARTICULAR DATE DRILLED.

GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR. ABSENCE OF WATER SURFACE DATA ON CERTAIN BORINGS IMPLIES THAT NO GROUNDWATER DATA IS AVAILABLE, BUT DOES NOT NECESSARILY MEAN THAT GROUNDWATER WILL NOT BE ENCOUNTERED AT THESE LOCATIONS OR WITHIN THE VERTICAL REACHES OF THESE BORINGS."

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

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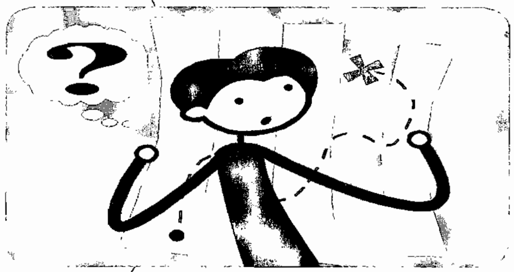
FIGURE 3.6

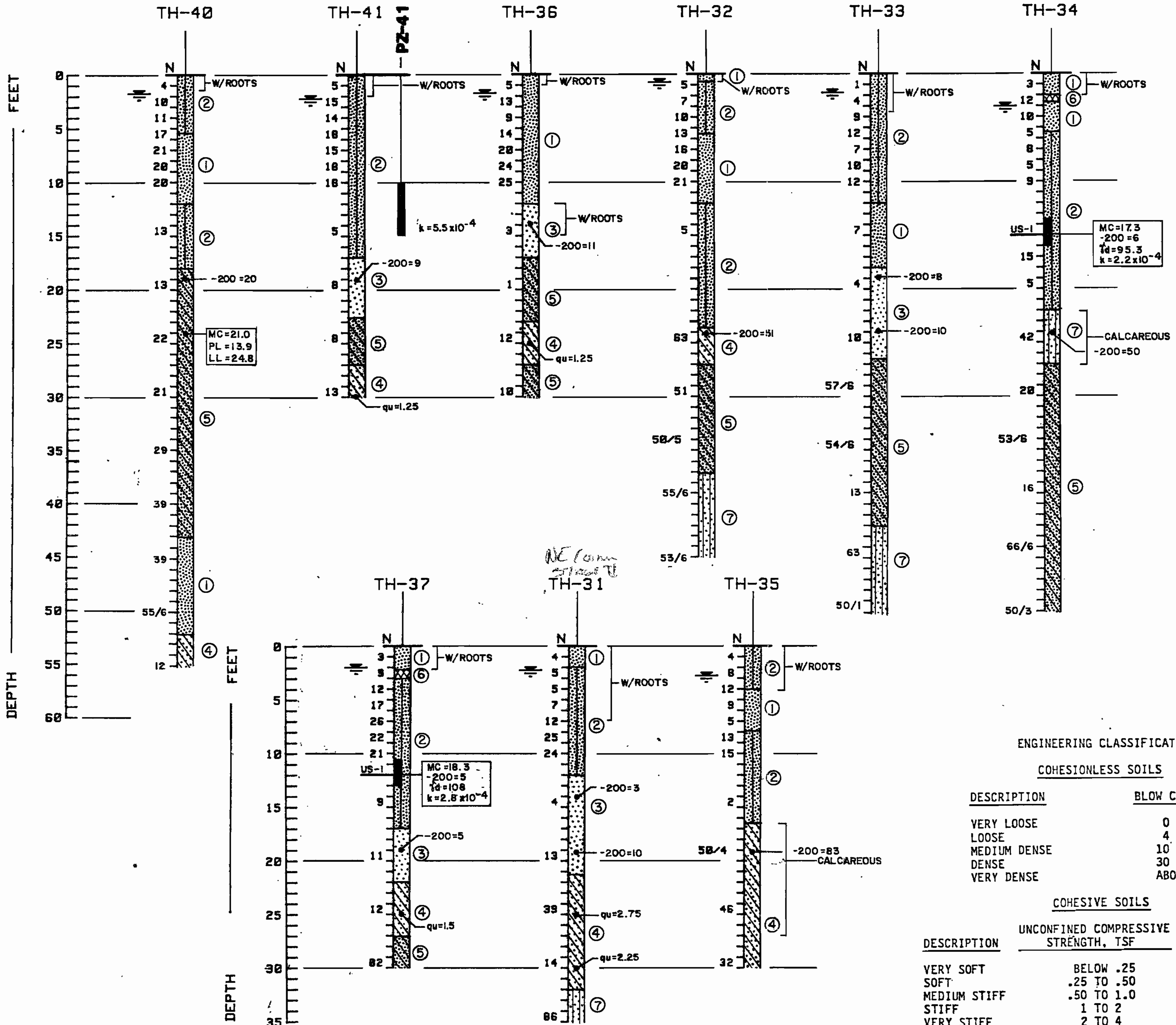
ATTENTION



AN OVERSIZED DRAWING HAS BEEN SCANNED SEPARTELY. PLEASE SEE:

- 39884-018-SO/01 LENA ROAD CLI LF OP RENEWAL RAI#1 RESPONSE-1985 HYDRO/ GEOTECH REPORT DRWG #2

K&E 19 1153 12-81 MC3313e



LEGEND

	①	LIGHT GRAY TO GRAY AND LIGHT BROWN TO YELLOWISH BROWN FINE SAND
	②	GRAY OR LIGHT BROWN TO YELLOWISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND
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	⑥	LIGHT REDDISH BROWN TO REDDISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND WITH TRACES OF ROOTS (HARDPAN TYPE)
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	SL	SHRINKAGE LIMIT IN PERCENT
	k	COEFFICIENT OF PERMEABILITY IN cm/sec

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
MAY 18 2010
SOUTHWEST DISTRICT TAMPA

ENGINEERING CLASSIFICATION

COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT 'N'
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, TSF	BLOW COUNT 'N'
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

"WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATION AND ON THE PARTICULAR DATE DRILLED.

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HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: RJF	CHECKED BY:	DATE: 1/21/83
FILE NO. 82-7047	APPROVED BY: H.G. Stang Kand	

FIGURE 3.7

Chapter 4

LABORATORY TESTING RESULTS

4.1 Classification

In addition to visual classification of the recovered samples, Atterberg limits, grain size analyses, natural moisture contents and percent fines determinations were performed on representative samples of the soil types encountered in our drilling program. The grain size distribution curves are presented in Appendix A.2. The percent passing the No. 200 sieve (percent fines) for each analysis (either complete gradation or percent fines determination) as well as the natural moisture content are noted on Figures 3.2 through 3.7 adjacent to the sample's location in the soil profile.

One objective of the laboratory testing program was to determine the suitability of the clayey onsite soils for use as an "impermeable" top liner for final cover. The top liner would limit formation of leachate through lack of infiltration/percolation and also be acceptable for supporting the high quality grass cover necessary for a golf course. Samples of the clayey soils (Stratum Numbers 4 and 5) were tested to establish their suitability as an impermeable top liner.

Atterberg limits were determined on various soil samples of Strata 4 and 5 using ASTM Nos. D-423, D-424 methodology. The Atterberg limits are used in the Unified Soil Classification System as described in ASTM D-2487. Test results are presented on Figures 3.2 through 3.7 adjacent to the sample tested. Table 4.1 summarizes the Atterberg limits data.

According to the Unified Soil Classification System Stratum 4 is classified as a highly plastic, inorganic clay or sandy clay (i.e., CH). Typical characteristics of this type material when compacted are presented in Table 4.2. Stratum 5 is classified as a clayey sand (i.e., SC). Typical characteristics for compacted clayey materials are presented in Table 4.2.

4.2 Compaction Tests

Standard Proctor tests were performed on composite remolded samples of Strata 4 and 5 according to ASTM D-698. The results of these tests are presented in Figures 4.1 and 4.2. The maximum dry unit weight at optimum water content was 79.5 and 105.5 pounds per cubic foot (PCF) for Stratum 4 and 5, respectively. The optimum water content was 21.8 percent and 16.9 percent for Stratum 4 and 5, respectively.

For each compactive effort there is a unique water content-dry unit weight relationship. For each unique relationship the maximum density occurs at a unique optimum water content. For example, the maximum density value using the Standard Proctor compactive effort on Stratum 5 soil was achieved at an optimum water content of 16.9 percent. However, if the modified compactive effort had been used, the maximum density value would have been achieved at an optimum water content less than this value. Wet of the optimum water content the relationship reduces to a common curve, i.e., wet of optimum water content different compactive efforts yield a density which is dependent only on the water content.

Samples of Stratum 5 soil were compacted at water contents at and below optimum to determine the relationship between the coefficient of permeability, water content and compactive effort. One sample was compacted just dry of optimum at a water content of 15 percent while a second sample was compacted wet of optimum at a water content of 21.8 percent. Permeability of the sample compacted dry of optimum was $1.6x10^{-7}$ cm/sec and the sample compacted wet of optimum was $1.2x10^{-8}$ cm/sec. The test results indicate that the permeability value is lower when the sample is compacted wet of optimum than when it is compacted dry of the optimum water content for a given compactive effort.

4.3 Permeability Tests

Permeability tests were conducted on eight undisturbed samples, five from the surficial aquifer (sands) and three from the first clay layer (clays). Falling head tests performed on the fine sand samples resulted in permeability values ranging between $6.2x10^{-3}$ cm/sec and $1.2x10^{-6}$ cm/sec. Constant head tests were performed on the clay under a back pressure to ensure specimen saturation. These tests produced values between $6x10^{-8}$ cm/sec to $5.9x10^{-9}$ cm/sec. All eight permeability values are noted on Figures 3.2 through 3.7 adjacent to the sample's location. The laboratory test results are also summarized in Table 4.3.

4.4 Water Quality Monitoring

CW-1, CW-2, and CW-3 are county monitor wells as part of their current monitoring program under their existing FDER permit. These wells were installed by others prior to the start of this hydrogeological investigation. Data were collected August 30 and September 1, 1982 from wells CW-1, 2 and 3 which had galvanized steel well points. These data indicated high levels of iron and zinc. Subsequent analyses of water collected November 15, 1982 (Table 4.4) from newly installed PVC wells at the same locations resulted in a significant drop in zinc verifying its originating with the galvanized screen. Iron levels dropped somewhat to levels judged to be naturally occurring background values. Concentrations above the maximum contaminant levels (MCL) were noted for iron, lead and chromium in all three wells. Well CW-2 water and well CW-1 water was at the MCL and above the MCL for mercury, respectively. Well CW-3 water was above the MCL for chloride and in well CW-1 water was above the MCL for nitrate.

On November 15, 1982 the following wells were sampled to document water quality conditions along the perimeter of the landfill: MW-1, -2, -3, -4, -5, -6, -7 and -8. The data are presented in Table 4.4. Wells MW-2, 5 and 8 had waters that exceeded the MCL for chromium and lead and were at the MCL for mercury. Wells MW-7 and 8 had waters that exceeded the MCL for chloride and MW-2 and -3 had waters that appear to be above the estimated background levels for total dissolved solids and chlorides. These data support the resistivity results that indicate: 1) a leachate plume (high chlorides, chromium, lead, mercury) has exited the existing site between TH-14 and TH-15; 2) deteriorated water quality exists at MW-2 and -3 along the west side of the site; and 3) the best quality water is found along the east side.

In January, 1983 water samples were taken from four wells in the area of the future landfill, TH-16, 22, 27 and 41, to document background water quality and determine nature of leachate plume. Results are presented in Table 4.4 and the data indicate that three of the four wells have background water quality. TH-41 water shows "high" values of nitrate and chloride and exceeds the MCL for chromium. Plume movement appears to be to the northeast in the direction of TH-41.

4.5 Cation Exchange Capacity

Two cation exchange capacities were performed on composite samples of the first clay layer and the fine sand which comprises the surficial aquifer. The cation exchange capacities ranged from 1.1 to 16.2 meq/100 grams for slightly silty to silty fine sand and clay, respectively.

Table 4.1

ATTERBERG LIMIT RESULTS

Sample	Stratum	Natural Moisture Content	Percent Fines (-200)	Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit
TH-9	4	37.3	92	68.97	16.6	52.1	-
TH-15	4	37.4	86	71.1	16.4	54.7	-
TH-19	4	62.8	80	135.2	33.6	101.6	-
TH-25	4	61.7	-	80.9	24.7	56.2	31.7
TH-27	4	56.8	-	89.5	33.7	55.8	39.9
TH-40	5	21.0	-	24.8	13.9	10.9	-
TH-42	5	35.3	49	41.4	23.3	18.1	22.2

All values are in percentages.

Table 4.2

TYPICAL PROPERTIES OF COMPACTED MATERIALS

Group Symbol	Soil Type	Range of Maximum Dry Unit Weight, pcf	Range of Optimum Moisture, Percent	Typical Value of Compression, Percent of Original Height: At 1.4 tsf (20 psi)	Typical Value of Compression, Percent of Original Height: At 3.6 tsf (50 psi)	Typical Strength Characteristics: Cohesion (as compacted) psf	Typical Strength Characteristics: Cohesion (saturated) psf	Typical Strength Characteristics: (Effective Stress Envelope) degrees	Tan	Typical Coefficient of Permeability ft/min.	Range of CBR Values	Range of Subgrade Modulus k lb/cu.in.
GW	Well graded clean gravels, gravel-sand mixtures	125-135	11-8	0.3	0.6	0	0	38	0.79	5×10^{-2}	40-80	300-500
GP	Poorly graded clean gravels, gravel-sand mix	115-125	14-11	0.4	0.9	0	0	37	0.74	10^{-1}	30-60	250-400
GM	Silty gravels, poorly graded gravel-sand silt	120-135	12-8	0.5	1.1	...	...	34	0.67	10^{-6}	20-60	100-400
GC	Clayey gravels, poorly graded gravel-sand-clay	115-130	14-9	0.7	1.6	...	...	31	0.60	10^{-7}	20-40	100-300
SW	Well graded clean sands, gravelly sands	110-130	16-9	0.6	1.2	0	0	38	0.79	10^{-3}	20-40	200-300
SP	Poorly graded clean sands, sand-gravel mix	100-120	21-12	0.8	1.4	0	0	37	0.74	10^{-3}	10-40	200-300
SM	Silty sands, poorly graded sand-silt mix	110-125	16-11	0.8	1.6	1050	420	34	0.67	5×10^{-5}	10-40	100-300
SM-SC	Sand-silt clay mix with slightly plastic fines	110-130	15-11	0.8	1.4	1050	300	33	0.66	2×10^{-6}	-	
SC	Clayey sands, poorly graded sand-clay mix	105-125	19-11	1.1	2.2	1550	230	31	0.60	5×10^{-7}	5-20	100-300
ML	Inorganic silts and clayey silts	95-120	24-12	0.9	1.7	1400	190	32	0.62	10^{-5}	15 or less	100-200
ML-CL	Mixture of inorganic silt and clay	100-120	22-12	1.0	2.2	1350	460	32	0.62	5×10^{-7}	-	
CL	Inorganic clays of low to medium plasticity	95-120	24-12	1.3	2.5	1800	270	28	0.54	10^{-7}	15 or less	50-200
OL	Organic silts and silt-clays, low plasticity	80-100	33-21	...	...	...	...	...	...	...	5 or less	50-100
MH	Inorganic clayey silts, elastic silts	70-95	40-24	2.0	3.8	1500	420	25	0.47	5×10^{-7}	10 or less	50-100
CH	Inorganic clays of high plasticity	75-105	36-19	2.6	3.9	2150	230	19	0.35	10^{-7}	15 or less	50-150
OH	Organic clays and silty clays...	65-100	45-21	...	...	...	...	...	...	...	5 or less	25-100

Notes:

1. All properties are for condition of "standard Proctor" maximum density, except values of k and CBR which are for "modified Proctor" maximum density.
2. Typical strength characteristics are for effective strength envelopes and are obtained from USBR data.
3. Compression values are for vertical loading with complete lateral confinement.
4. ( ) indicates that typical property is greater than the value shown. (...) indicates insufficient data available for an estimate.

Source: NAVFAC, 1971

Table 4.3

SUMMARY OF PERMEABILITY TESTS

Test No.	Test Hole	Depth (feet)	Classification Unified	Classification % Minus 200 Sieve	Type of Test	Specimen Type	Dry Density (PCF)	Coeff. of Permeability (cm/sec)	Void Ratio Assumed Gs=2.65
1	TH-11	1.0-3.0	SP	3	F	U	98.7	6.2×10^{-3}	0.68
2	TH-29	8.0-10.5	SP-SM	8	F	U	106.6	4.4×10^{-5}	0.55
3	TH-34	13.5-16.0	SP-SM	6	F	U	108.5	2.2×10^{-4}	0.52
4	TH-37	10.5-13.0	SP-SM	5	F	U	107.9	2.8×10^{-4}	0.53
5	TH-9	17.5-19.5	CH	92	C	U	78.1	1.7×10^{-8}	1.12
6	TH-13	7.5-10.0	SP-SM	7	C	U	106.9	1.2×10^{-6}	0.55
7	TH-15	17.5-19.5	CH	86	C	U	77.2	5.9×10^{-9}	1.14
8	TH-19	17.0-20.0	CH	80	C	U	59.8	6.0×10^{-8}	1.76
9	TH-42	15.0-20.0	SC	44	C	R	105.8	1.2×10^{-8}	0.56
10	TH-42	15.0-20.0	SC	43	C	R	110.0	1.6×10^{-7}	0.50

Table 4.4

WATER QUALITY TEST RESULTS

Parameter (units) Sampling Date:	CW-1 (82-955) 11-15-82	CW-2 (82-956) 11-15-82	CW-3 (82-957) 11-15-82	MW-2 (82-959) 11-15-82	MW-5 (82-962) 11-15-82	MW-8 (82-965) 11-15-82
Conductivity (umhos)	313	434	1,400	652	240	4,270
Nitrate (mg N/L)	175	2.0	0.3	-	-	-
Iron (mg Fe/L)	4.5	5.5	29	17	5.5	27
Ammonia (mg N/L)	<0.3	<0.3	<0.3	-	-	-
pH (units)	8.90	8.70	8.70	7.95	8.20	8.85
Chloride (mg Cl/L)	49	35	315	116	38	400
Sulfate (mg SO_4/L)	20*	110*	21*	-	-	-
Chemical Oxygen Demand (mg/L)	124	119	230	-	-	-
Biological Oxygen Demand (mg/L)	8.2	26	21	-	-	-
Cadmium (mg Cd/L)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (mg Cr/L)	0.06	0.09	0.11	0.08	0.13	0.08
Copper (mg Cu/L)	<0.05	0.06	0.07	-	-	-
Mercury (mg Hg/L)	0.003	0.002	<0.002	0.002	0.002	0.002
Lead (mg Pb/L)	0.17	0.15	0.17	0.16	0.16	0.16
Zinc (mg Zn/L)	2.6	3.3	2.4	-	-	-
Color (Pt.Co. Units)	120*	30*	50*	50*	120*	250*
Arsenic (mg As/L)	-	-	-	0.010	<0.010	<0.010
Barium (mg Ba/L)	-	-	-	0.15	0.07	0.18
Silver (mg Ag/L)	-	-	-	<0.05	<0.05	<0.05

*Note: All color results on filtered samples (0.45 u) due to interferences in test from particulates.

Table 4.4 (cont'd)

WATER QUALITY TEST RESULTS

Parameter (units)	MW-1 (82-958)	MW-3 (82-960)	MW-4 (82-961)	MW-6 (83-963)	MW-7 (82-964)
Sampling Date:	11-15-82	11-15-82	11-15-82	11-15-82	11-15-82
Conductivity (umhos)	204	696	239	402	5,130
Chlorides mg (Cl/L)	33	107	35	32	567
Iron (mg Fe/L)	6.1	8.8	4.9	24	22
Color (Pt.Co. Units)	100*	40*	40*	600*	250*
pH (units)	8.45	6.90	7.70	8.20	8.80

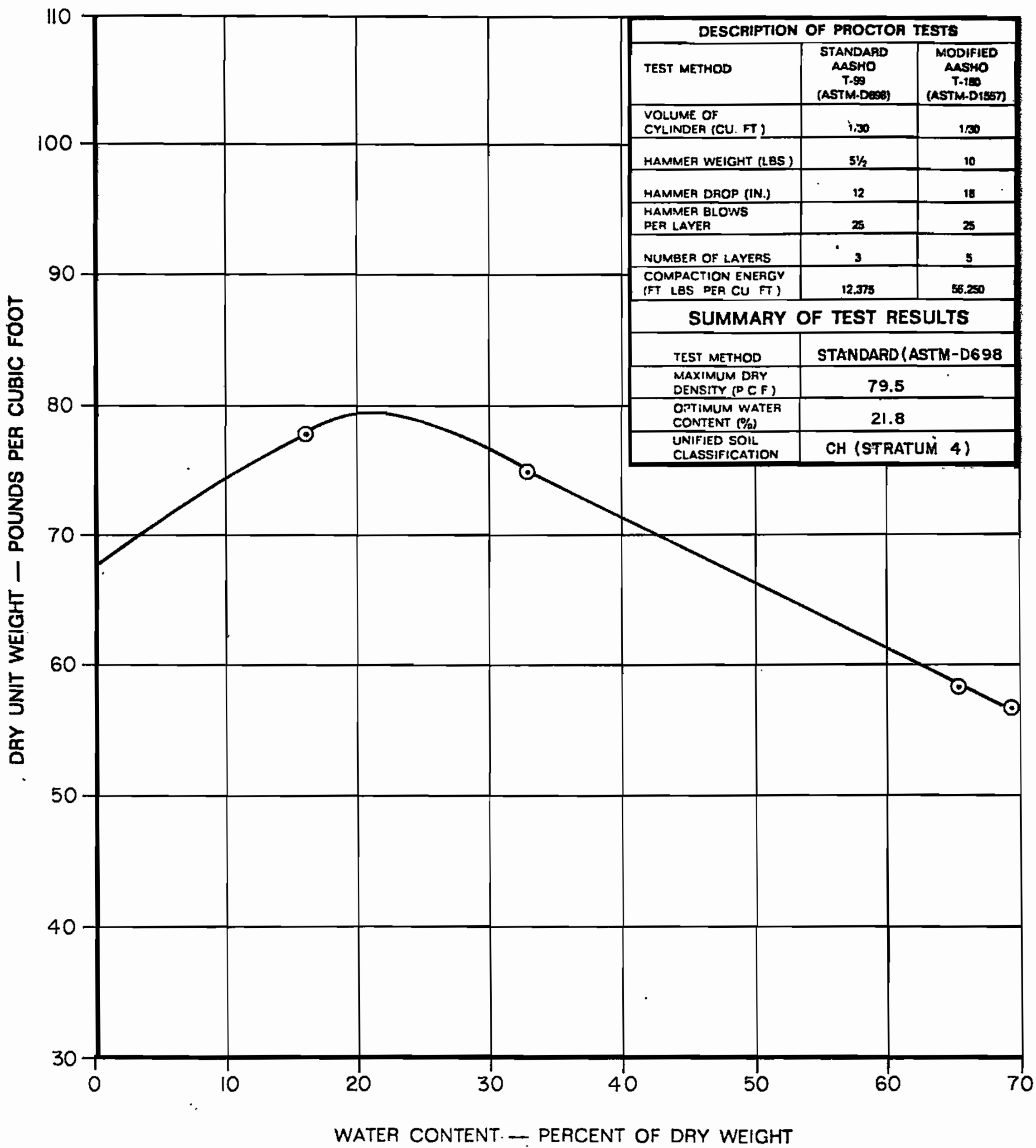
*Note: All color results on filtered samples (0.45 u) due to interferences in test from particulates.

Table 4.4 (cont'd)

WATER QUALITY TEST RESULTS

Parameter (units) Sampling Date:	TW-16 (83-060) 1/83	TW-22 (83-061) 1/83	TW-27 (83-062) 1/83	TW-41 (83-063) 1/83
Conductivity (umhos)	339	400	487	579
Nitrate (mg N/L)	1.0	2.8	1.5	9.8
Iron (mg Fe/L)	8.8	0.40	6.9	13.8
pH (units)	6.50	10.80	6.80	7.10
Chloride (mg Cl/L)	32	22	50	82
Color (Pt.Co. units)	25*	20*	20*	100*
Arsenic (mg As/L)	<0.01	<0.01	<0.01	<0.01
Barium (mg Ba/L)	<0.20	<0.20	<0.20	0.20
Cadmium (mg Cd/L)	<0.01	<0.01	<0.01	<0.01
Chromium (mg Cr/L	<0.05	<0.05	<0.05	0.20
Lead (mg Pb/L)	<0.05	<0.05	<0.05	<0.05
Mercury (mg Hg/L	<0.002	<0.002	<0.002	<0.002
Silver (mg Ag/L)	<0.05	<0.05	<0.05	<0.05

*Note: All color results on filtered samples (0.45 u) due to interferences in test from particulates.



DESCRIPTION OF PROCTOR TESTS		
TEST METHOD	STANDARD AASHO T-99 (ASTM-D698)	MODIFIED AASHO T-180 (ASTM-D1557)
VOLUME OF CYLINDER (CU. FT.)	1/30	1/30
HAMMER WEIGHT (LBS.)	5½	10
HAMMER DROP (IN.)	12	18
HAMMER BLOWS PER LAYER	25	25
NUMBER OF LAYERS	3	5
COMPACTION ENERGY (FT. LBS. PER CU. FT.)	12,375	56,250

SUMMARY OF TEST RESULTS	
TEST METHOD	STANDARD (ASTM-D698
MAXIMUM DRY DENSITY (P.C.F.)	79.5
OPTIMUM WATER CONTENT (%)	21.8
UNIFIED SOIL CLASSIFICATION	CH (STRATUM 4)

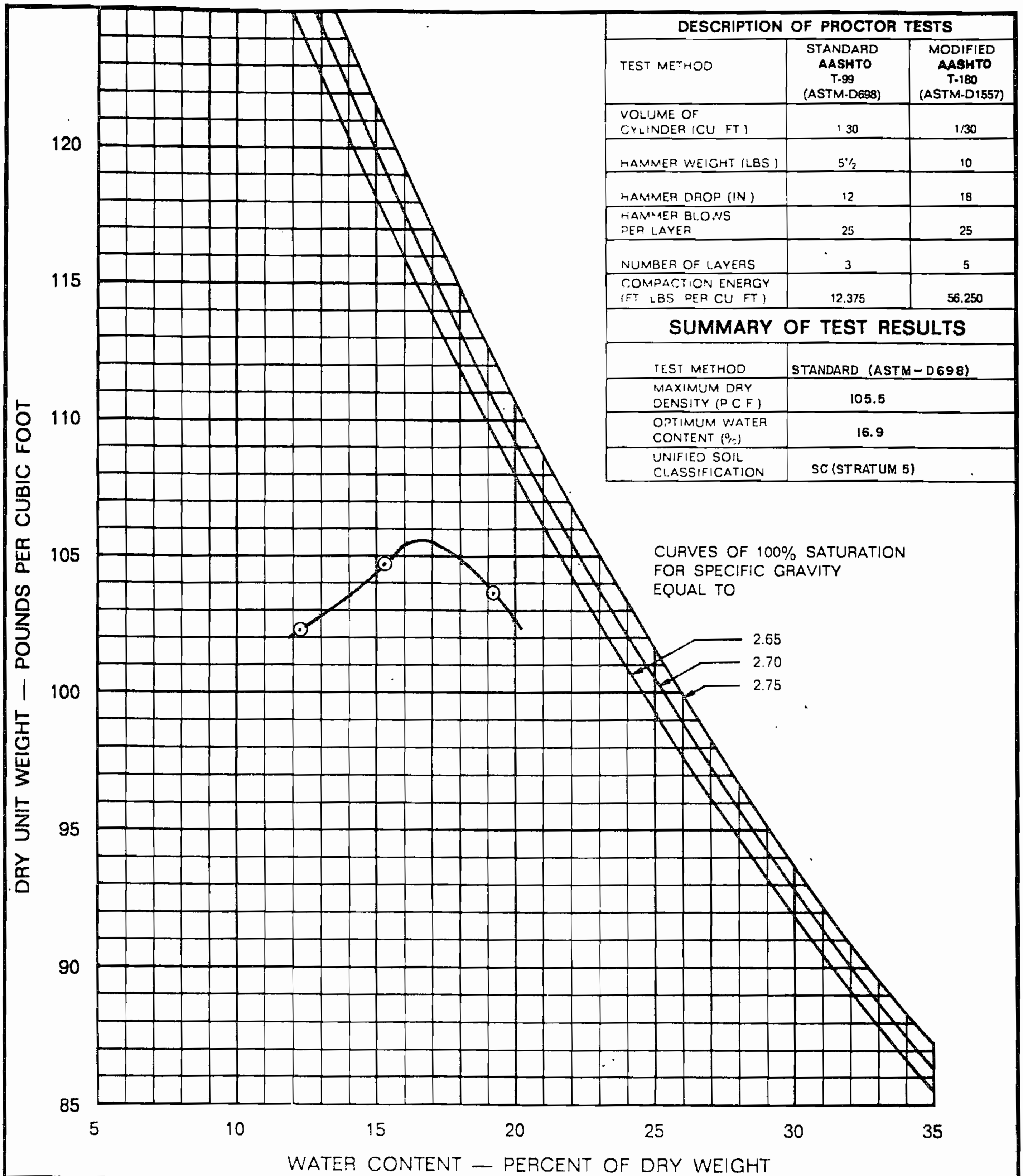
MOISTURE-DENSITY RELATIONSHIP

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: H. A.D	CHECKED BY: [illegible]	DATE: 2/28/83
FILE NO. 82-7047	APPROVED BY: H.G. Stangland	

FIGURE 4.1



DESCRIPTION OF PROCTOR TESTS

TEST METHOD	STANDARD AASHTO T-99 (ASTM-D698)	MODIFIED AASHTO T-180 (ASTM-D1557)
VOLUME OF CYLINDER (CU FT)	1/30	1/30
HAMMER WEIGHT (LBS)	5½	10
HAMMER DROP (IN)	12	18
HAMMER BLOWS PER LAYER	25	25
NUMBER OF LAYERS	3	5
COMPACTION ENERGY (FT LBS PER CU FT)	12,375	56,250

SUMMARY OF TEST RESULTS

TEST METHOD	STANDARD (ASTM-D698)
MAXIMUM DRY DENSITY (P C F)	105.5
OPTIMUM WATER CONTENT (%)	16.9
UNIFIED SOIL CLASSIFICATION	SC (STRATUM 5)

SOIL DESCRIPTION:

☐ NATURAL GROUND ☐ FILL

MOISTURE - DENSITY RELATIONSHIP

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

Ardaman & Associates, Inc.
CONSULTING ENGINEERS IN
SOIL SCIENCES AND MATERIALS TESTING

File No. 82-7047

FIGURE 4.2

Chapter 5

ANALYSES

5.1 Leachate Collection System

The proposed design concept to control and collect leachate at the subject site is to deepen the existing perimeter ditch system to 10 to 15 feet below the land surface around the east, west and south perimeter of the site and to install a slurry wall and underdrain system along the northern perimeter of the site. This would place the bottom of the collection ditch always below the lowest anticipated groundwater level. The maximum "dry season" water table depth in this area is anticipated not to exceed 4 to 5 feet lower than the depths recorded during our field investigation program. Near the west ditch the "maximum" water-table depth could approach 10 feet. Maintenance of the ditch water level below the natural water table would be necessary to intercept any leachate and prevent leachate from moving beyond the ditch. The water in the ditch would be pumped back onto the site for recycling and/or treatment as needed. The existing county equipment could excavate this ditch system. In order for this system to be effective, the eight monitoring wells already installed around the existing landfill would have to be monitored carefully and regularly to make sure that the ditch water level is maintained approximately one foot below the natural groundwater level. A similar system of monitoring wells would also have to be installed around the proposed expansion landfill area for utilization of this design system.

The amount of leachate which must be collected and the height of the groundwater mound beneath the landfill are a function of the steady state percolation through the landfill at the end of development and the transmissivity of the surficial aquifer. The following table presents the predicted range in height of the groundwater mound at the center of the landfill and the leachate which must be collected for a fill of 30 feet above existing natural land surface (i.e., above 35 feet NGVD) for different values of the steady state percolation and for a permeability range for the surficial aquifer of 1 to 10 feet per day.

Steady State Percolation (in/year)	Elevation of Groundwater Mound at Center of Landfill (ft NGVD)	Leachate to be Collected (gpm)
	Ditch	Ditch
0.4	31-39	10
2.0	35-53	75
4.0	38-65	90

The actual rate of percolation through the landfill will depend on the amount of runoff from the completed landfill, which is a function of the permeability of the top cover and the final topography of the reclaimed landfill. During construction and early years of a cell life, most of the percolation would be absorbed by the refuse. After close out of the landfill, placement of a relatively impervious top cover over the fill will limit the amount of leachate produced by minimizing downward percolation through the landfill.

5.2 Water Balance

The water balance for a landfill includes rainfall, evapotranspiration, runoff and percolation. To minimize percolation and thus limit the formation of leachate, runoff from the landfill must be encouraged. A cell initially will absorb most of the rainfall infiltrating the cells. The amount of runoff from a completed landfill is a function of the permeability of the top cover and the final topography of the reclaimed landfill. Evapotranspiration can range from less than 40 inches per year under natural conditions to over 60 inches per year for a high quality irrigated turf grass. The annual rainfall rate is approximately 56 inches.

Two water balance calculations were performed utilizing the method described in EPA, 1975. The first calculation was based on a non-irrigated grass cover and produced no infiltration/percolation each year.

The second water balance calculation was based on an irrigated turf grass. Using potential evapotranspiration for the grass (McCloud, 1970), the necessary irrigation amounts were generated to replenish soil moisture each month. Table 5.1 shows this water balance calculation. Percolate was 0.48 inches per year occurring in January and February during months when no irrigation was needed.

5.3 Top Cover Considerations

The following geotechnical factors must be considered in designing the top cover for a sanitary landfill:

- Availability of borrow materials
- Permeability of borrow materials
- Workability of borrow materials
- Type of cover crop and root development

A golf course is being considered for the subject site after close-out, the top cover must be capable of supporting a high quality grass cover and the water balance must include year-round irrigation. As shown in the preceding section, irrigation water will result in minimal percolation if it is applied only as required. However, proper management of the irrigation system is essential if long-term collection/treatment of leachate is to be avoided. Furthermore, the rate and amount of decomposition of the organic portions of the refuse is directly related to the available moisture which fuels the process. Therefore, excess irrigation could also lead to large differential settlements of the golf course elements.

Soil texture, soil thickness, and water table location are properties of soils important in achieving a high quality grass cover. A clayey sand is the preferred soil texture because it has a relatively high available moisture and nutrient holding capacity and because it does not soften excessively if saturated.

Roots for turf grass penetrate 1 to 2 feet into the ground; therefore, it is desirable to have at least two feet of soil depth for root development. Shallow root systems are not desirable for a high quality grass.

The proposed borrow material for the top liner is a clayey fine sand of low to medium plasticity. It also has a low to medium shrink/swell potential (Peck, Hanson & Thornburn, 1974). Although the shrinkage limit for this soil may vary over a wide range depending on fines composition, it is generally expected to be close to or less than the compaction optimum moisture content. To prevent shrinkage cracks from developing in the top liner, it must be compacted at or below the shrinkage limit or it must be protected against surface desiccation by burying it below a layer of soil with no crack potential. The top layer must also provide a suitable root zone for the grass cover. Since in this project it is desirable to compact the top liner material at a moisture content wet of optimum in order to achieve the lowest permeability, a surface layer with no crack potential would be the alternative for negating the potentially damaging effects of surface desiccation. Therefore, the proposed design should include a surface cover of the more sandy top soils (minus 200 less than 20%) twelve (12) inches thick over the "impermeable" clayey sand blanket. The "impermeable" blanket should be a minimum thickness of 18 inches.

Based on the available subsoil data it is estimated that a total of 500,000 cubic yards of clayey fine sand (Stratum 5), are suitable for use as a relatively impervious top liner material. This amount is enough to provide a 1.0-foot thick relatively impervious top liner for the refuse to be contained in Parcels A and B. All of the required borrow should be available in the areas which have been designated for construction of leachate or retention ponds. Additional material, if required, may be obtained by mixing the highly plastic clay material (Strata 4) with the sandy near surface soils to obtain a workable material. In its natural state, Stratum 4 is not suitable as a construction material due to its highly plastic condition.

The borrow material should have a percent fines (i.e., percent by weight passing the U.S. No. 200 standard sieve) content of at least 20 percent by dry weight so that the desired after compaction permeability is obtained. Figure 5.1 presents the relationship between percent fines and permeability which was determined for the site soils and from our experience with similar *in situ* soils in Manatee County. Strict quality control of the top liner with respect to density, compaction, moisture content, gradation and plasticity of the material is essential to satisfactory performance of the top liner blanket. Testing indicated that the clayey sand materials are in a natural state which will enable them to be worked easily if reasonable care and judgement is used during the excavation and compaction operations.

The remolded compacted clayey fine sand soil (Stratum 5) has a measured permeability ranging between 10^{-5} and 10^{-8} cm/sec depending upon the compaction moisture content and the fines content. Compaction wet of optimum results in lower permeabilities for a given fines content than compaction dry of optimum. The borrow material should be placed in thin, (8-inch thick, loose) lifts and compacted with a sheepsfoot roller or loaded scraper pans to 95 percent of the standard Proctor dry density.

In-place densities of the rolled fill sould be frequently checked during construction. In addition, the gradation and plasticity of the borrow material should be checked on a regular basis and representative samples selected for permeability testing. Single point Standard Proctor compaction tests on material with a moisture content equal to or less than optimum should also be performed frequently to document the maximum dry density of the borrow material.

The extent of available and suitable cover material should be more accurately defined. This could be accomplished relatively inexpensively with a grid of auger borings spaced 300 feet on centers. These auger borings averaging 30 feet deep, combined with existing data would provide sufficient detail to accurately estimate available borrow. At present, it is expected that suitable clayey fine sand borrow (Stratum 5) will be located approximately between 20 to 40 feet below existing ground surface as indicated by the results of our test borings. Dewatering to lower the water table may be necessary to facilitate excavation operations. The use of the dragline method of excavation would most likely be the most efficient and cost effective method for obtaining the clayey materials. Another factor to be considered is the stockpiling of the sandy overburden soils which must be removed to reach the clayey stratum.

5.4 Bottom Liner

Forty-one of the 42 test borings conducted at this site, encountered clay, silt or very clayey sand which can be defined as impermeable. The only boring not encountering an impervious stratum was TH-8 which was a shallow boring only 16 feet deep. All of the deep borings, i.e., ±60 feet, encountered thick dense strata of fine grained (i.e., clay and silt) impervious soils. These strata represent the upper units of the confining Hawthorn Formation which separates the surficial aquifer from the artesian aquifer systems. This confining bed has good continuity in this area and will effectively prevent downward percolation of leachate.

5.5 Settlement Considerations

Settlement of sanitary landfills are caused by a number of complex and interrelated mechanisms:

- Mechanical: Distortion, bending, crushing and reorientation of the materials, similar to the consolidation of organic soils.
- Ravelling: The erosion or sifting of fine materials into the voids between large particles.
- Physio-Chemical Change: Corrosion, oxidation and combustion.
- Bio-Chemical Decay: Fermentation and decay, both aerobic and anerobic.
- Interaction: Methane from bio-chemical decay may support combustion, ignited spontaneously from the heat of decay. Organic acids from decay may produce corrosion; volume changes from consolidation may trigger ravelling.

Of these mechanisms, only the first is load related and can be analyzed in terms of the stresses involved. The other mechanisms are related to the environment: air, moisture, and temperature and other local conditions including the percolation of ground water. A waste fill is dynamic, changing with the environment and partially creating its own environment. For example, temperatures 60°F (33C) above ambient are common during biochemical decay. Decay utilizes moisture and the oxygen in the air voids to form carbon dioxide; when the oxygen is depleted, methane is produced which is poisonous and flammable.

Mechanical settlement due to an applied load (i.e., surcharge or structural) or from the consolidation of the fill under the weight of the fill materials themselves, causes the void spaces between and within the solids to be compressed and the settlement corresponds to volume change. This initial primary phase of settlement is normally complete in less than one month.

Settlement produced by ravelling and combustion is erratic and cannot be predicted. When the fill consists of large solids with open spaces between and finer materials adjacent or above, there is sporadic movement of these fines into the open voids. The movement may be induced by water seepage through the fill, by vibration, or by changes induced by chemical or biological decomposition. Movement generally occurs in sudden episodes of varying magnitude following progressive deterioration. Deterioration is related to environmental changes. These include rapid changes in ground water, flooding due to torrential rainfall or broken water pipes, and drying and exposure to air from making excavations in the soil cover or the fill.

Chemical and biological decomposition is accompanied by the production of gas and a substantial reduction in solid volume. The rate of settlement due to physico-chemical and bio-chemical decay is high if the organic content subject to decay is large and the environment is favorable: (warm, moist, with fluctuating water table that pumps fresh air into the fill). The rate is low for more inert materials and in unfavorable environments. "Venting" of the landfill is necessary to relieve any gases which may develop.

The ultimate settlement of a landfill is related to the initial void ratio and the environmental conditions favorable to deterioration, decay, ravelling and combustion. By using typical properties for the refuse condition, long-term secondary compression of the landfill has been estimated. The following table presents the results of our settlement analyses for various conditions and surcharge options:

Surcharge Loading	3 Feet	5 Feet	10 Feet
Initial Settlement at end of 1 month	0.76-2.78 ft.	1.16-4.26 ft.	1.95-7.14 ft.
Settlement during construction of Golf Course at end of 1 year	1.14-3.61 ft.	1.09-3.57 ft.	0.99-3.49 ft.

Settlement during life of Golf Course at end of 30 years	2.69-8.55 ft.	2.58-8.45 ft.	2.35-8.26 ft.

From the settlement analyses it is evident that the size of the surcharge does not have a significant effect on the amount of long-term (i.e., > 1 month) secondary compression. The initial primary settlement should not pose a problem since it will be essentially "built out" of the landfill (i.e., within one month) during construction of the top liner/cover. However, success of the project may hinge on the magnitude of the potentially damaging secondary compression. For this reason a field test implementation of a settlement plate observation program is necessary in order to establish more accurately the limits for design. The settlement analyses are based on a maximum possible thickness of refuse equal to 45 feet and an initial density of 1000 pounds per cubic yard (lb/c.y.). Implementation of the settlement plate program would enable us to evaluate and refine our settlement predictions in relation to the actual conditions affecting settlement in the field. Settlement of waste fills can be minimized by compaction; but in order to be effective the fill should be compacted in lifts not exceeding 6 to 8 feet in thickness. Chemical control of decomposition is possible but very costly.

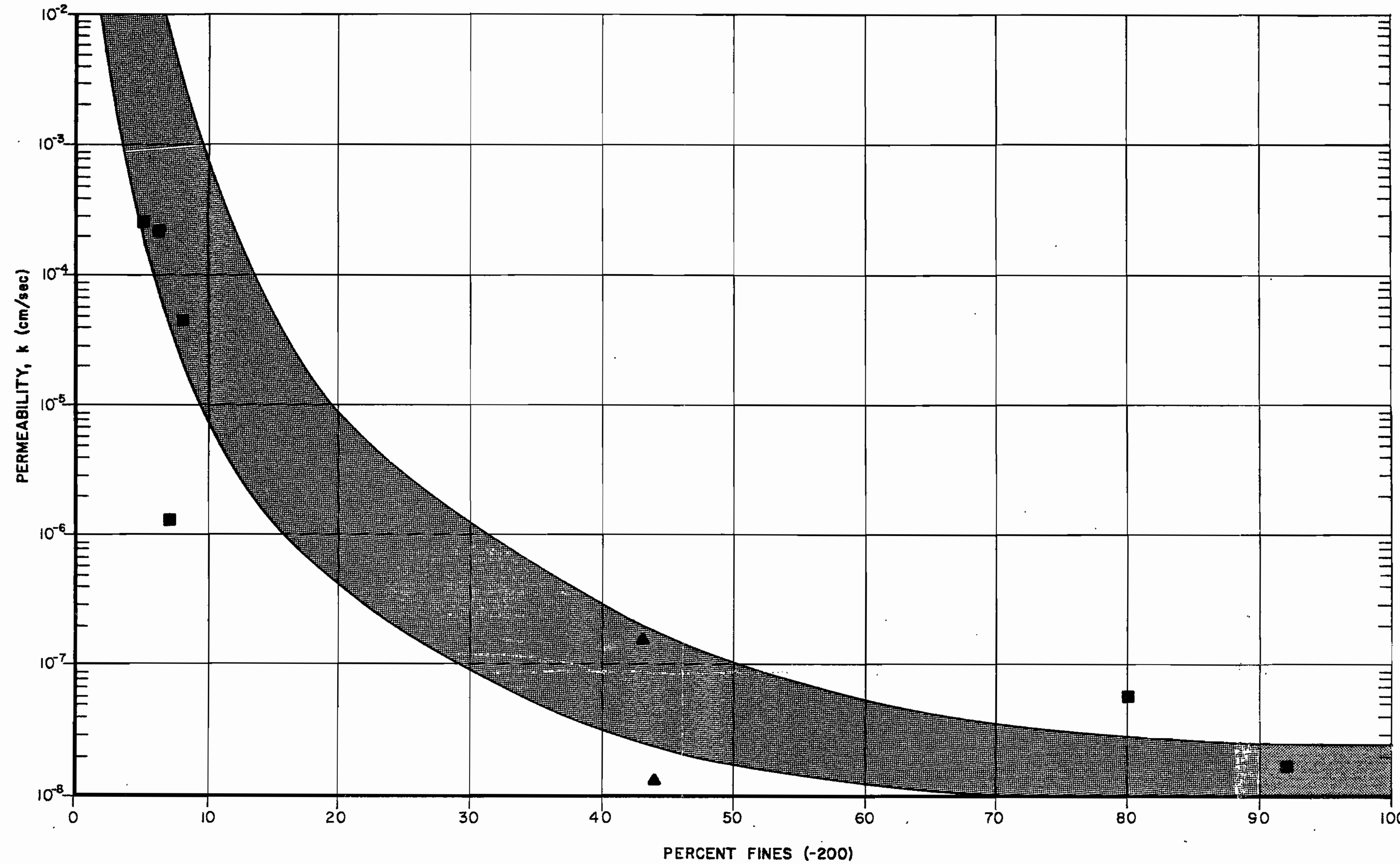
The most practical acceptable alternative for controlling settlement of the refuse fill is to control the amount of available moisture for decomposition by construction of an "impervious" liner on top of the refuse. This approach will not only reduce the amount of settlement over the years but will also eliminate the problem of leachate contamination of the surrounding environment.

Table 5.1

WATER BALANCE WITH GOLF COURSE IRRIGATION

	J	F	M	A	M	J	J	A	S	O	N	D	Year
PET	1.86	1.68	2.79	4.20	6.82	9.00	9.92	9.92	8.40	5.27	2.70	1.66	64.42
P	2.68	2.87	3.65	2.43	2.60	7.63	8.94	9.55	8.68	3.24	1.91	2.17	56.35
RO Coef.	.275	.275	.275	.25	.25	.30	.30	.30	.30	.275	.275	.275	
RO	.74	.79	1.00	.61	.65	2.29	2.68	2.86	2.60	.89	.52	.60	16.23
I (P-RO)	1.94	2.08	2.65	1.82	1.95	5.34	6.26	6.69	6.08	2.35	1.39	1.57	40.12
I-PET	+.08	+.040	-0.14	-2.38	-4.87	-3.66	-3.66	-3.23	-2.32	-2.92	-1.31	-0.29	
Irrigation	0	0	+.14	2.38	4.87	3.66	3.66	3.23	2.32	2.92	1.31	0.29	+24.78
Σneg (I-PET)	0	0	0	0	0	0	0	0	0	0	0	0	
Soil Moist. Storage	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	
ΔStorage	0	0	0	0	0	0	0	0	0	0	0	0	
ACT ET	1.86	1.68	2.79	4.20	6.82	9.00	9.92	9.92	8.40	5.27	2.70	1.86	64.42
Percolation	0.08	0.40	0	0	0	0	0	0	0	0	0	0	0.48

PET - Potential Evapotranspiration
P - Precipitation
RO - Runoff
I - Infiltration
ACT ET - Actual Evapotranspiration



LEGEND

▲ REMOLDED SAMPLES (STRATUM 5)

■ UNDISTURBED SAMPLES

BAND REPRESENTS ARDAMAN & ASSOCIATES, INC., EXPERIENCE CURVE FROM SOILS IN MANATEE COUNTY

COEFFICIENT OF PERMEABILITY VS. PERCENT FINES

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: H.A.D.	CHECKED BY:	DATE: 3/1/83
FILE NO. 82-7047	APPROVED BY: H.G. Stengland	

FIGURE 5.1

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

A "deep" perimeter ditch concept is recommended for the leachate collection/ containment system for the subject site. The ditch water and/or leachate will be recycled or treated within the project site. This concept calls for a 10- to 12-foot deep trench along the east, south and west sides of the landfill sites. The water level in the ditch must always be maintained lower than the adjacent water table on the off-site side of the ditch. No surface discharge of ditch water should be allowed offsite unless treated sufficiently to meet Class III surface water standards. Rainfall and irrigation water, after a final cover has been placed, should not be allowed to comingle with the ditch water so that this large volume of water can be recycled as irrigation water on the site or discharged from the site with no treatment. The runoff water should not be allowed to become contaminated with leachate; therefore, a dual water management system is recommended after final cover has been installed.

The slurry wall system is recommended between the landfill and stormwater retention ponds and surrounding the leachate ponds. Provision for drainage must be made behind the wall, e.g., an underdrain system, so leachate will not overtop the wall. The slurry wall should tie into the underlying clay layer (Strata 4) and intercept the leachate ditch so that leachate will not escape around the end of the wall.

Differential settlement is a major geotechnical concern for greens, tees, and structures. A settlement plate data program is recommended for defining the design problem. The settlement plate data will give us a much better idea of the expected magnitude of total and differential settlements. One or two test cells utilizing surcharge loads should be an intergal part of the settlement plate investigation. Recommendations for the settlement plate data program have been submitted previously under separate cover.

The final top liner/cover section shall consist of an 18-inch thick compacted layer of clayey fine sand material with a percent fines content (percent by weight passing the U.S. No. 200 sieve) not less than 20 percent, and be classified as an SC or CL soil in accordance with the Unified Soil Classification System (ASTM D-2487-66T). Additionally, a twelve (12) inch thick surface layer of sandy (minus 200 less than 20 percent) overburden soils shall be placed over the impermeable top liner to prevent desiccation damage to the clayey material. Venting of methane and other generated gases is recommended.

The integrity of the cover material against water erosion and differential settlement must be inspected monthly during the first few years. During an unusually heavy rainfall event an immediate inspection should be made. An annual inspection is probably adequate after the first 5 years. The potential for problems to develop are most probable in the first few years because of insufficient vegetative cover and because landfills undergo most of their settlement in these years.

Side slopes below the water level for retention ponds should not be steeper than 1.75 (Horizontal) to 1.0 (Vertical). Slopes above the water line need to be considerably flatter at 3.5 (Horizontal) to 1.0 (Vertical) to prevent erosion and enable proper maintenance.

Leachate type water has been encountered across the ditch along the north boundary from the landfill. Based on a combination of the resistivity and water quality data (i.e., 4000-5000 umhos per cm^2) the worst area is along the middle half of the north boundary primarily between TH-14 and-15. Since this area is going to be part of the new expanded landfill area no remedial action is required at this time. Once the plans for the new site are finalized a review of this recommendation will be necessary.

Leachate type waters are beginning to show up in limited areas and limited distances away from the landfill. A study is recommended to fully document the extent and quality of the leachate plume. The study would also evaluate alternative remedial measures. Until the above mentioned study has been completed and a plan of action has been determined, the eight monitoring wells presently installed at the site, i.e., MW-1, MW-2, etc., the three county wells, and piezometers at TH-16 and TH-41 need to be monitored quarterly.

The following suite of parameters are suggested for this monitoring program:

- Conductivity
- pH
- Chlorides
- Chromium
- Lead

The procedures for sampling are summarized as follows:

- Transport the sample bottles and preservatives as provided by the water analysis laboratory to the site.

- Sterilize the sampling equipment to be used for sample collection.

- Measure *in situ* water level, temperature, pH, and electrical conductivity of pumped water at 1-2 gallon intervals after pumping is initiated. A minimum of two casing volumes should be removed before sampling. A vacuum pump or gas lift method is recommended for sampling.

- Withdraw water sample and place into proper container once measurement values from three consecutive readings are constant. Laboratory instructions (e.g., type of bottle, quantity of sample, and preservative) must be followed carefully and thoroughly.

- Label sample properly and completely.

- Ice samples down and prepare for transportation to water analysis laboratory.

- Complete field note-taking as per water sample log sheet shown in Table 6.1. Document the period of time pump was on prior to collection of sample plus pumping rate at well in gallons per minute.

- Transmit collected samples to water analysis laboratory within 24 hours of sampling. The chain of custody form to be used is shown in Table 6.2.

The analysis and recommendations submitted in this report are based upon the available data obtained at the locations indicated. This report does not reflect any variations which may occur at other locations where field data are not available. The nature and extent of variations between the locations may not become evident until later when more data becomes available.

If variations then appear evident, it will be necessary for a reevaluation of the recommendations of this report to be made after performing on-site observations and noting the characteristics of any variations.

This report has been prepared in accordance with generally accepted geotechnical and hydrogeological engineering practices. In the event any changes occur in the design, nature or location of the landfill system and for final land use for the site 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 in order that hydrogeological recommendations are properly interpreted and implemented in the design specifications.

Table 6.1

WATER SAMPLE LOG SHEET

Project No. ____________________ Sample No. ____________________
Location ____________________ Well No. ____________________
Sampled By ____________________ Date ____________ Time ________
Water Depth ____________________ Field pH ____________
Volume Removed Before Sampling ____________ Field Cond. ____________
Preservative/Handling ____________ Field Temp. ____________
Sampling Comments ____
____
Required Analyses ____
Notes:

Received by ____________________ Lab ____________________
Date ____________________ Time ____________________
Comments ____

Lab Results Rec. & Attached By ____________ Date ____________
Comments on Results:

Comments By ____________________ Date ____________________

Table 6.2

TRANSFER OF CUSTODY SHEET

I, ______________________________ of ______________________________
(Signature) (Company)

hereby transfer the items listed below to

______________________________ of ______________________________
(Name) (Company)

Items Transferred

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Receipt of above listed items acknowledged by

______________________________ ______________ ______________
(Signature) (Date) (Time)

Chapter 7

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Appendix A.1

SPT BORING PROCEDURES

STANDARD PENETRATION TEST

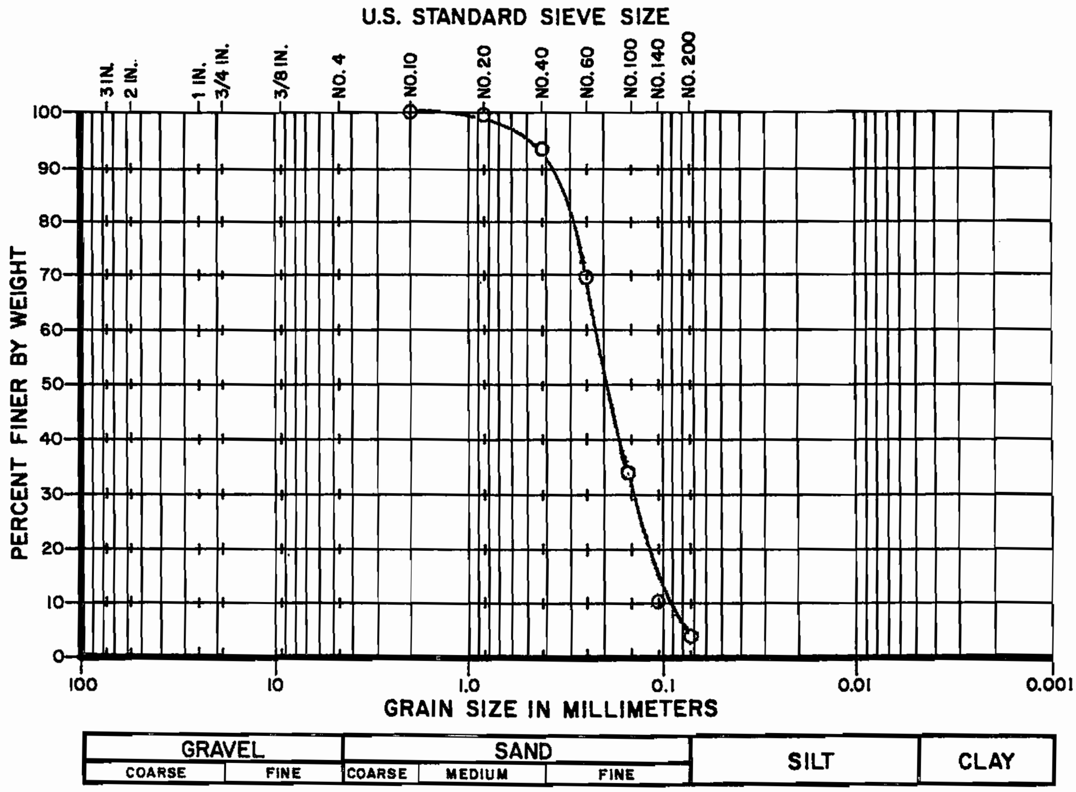
The standard penetration test is a widely accepted method of *in situ* testing of foundation soils (ASTM D-1586). A 2-foot long, 2-inch O.D. split-barrel sampler attached to the end of a string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 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 A.2

SIEVE ANALYSES



TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
11	1	1.0-3.0	o	GRAY FINE SAND	SP

GRAIN SIZE DISTRIBUTION

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Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

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FILE NO. 82-7047	APPROVED BY:	

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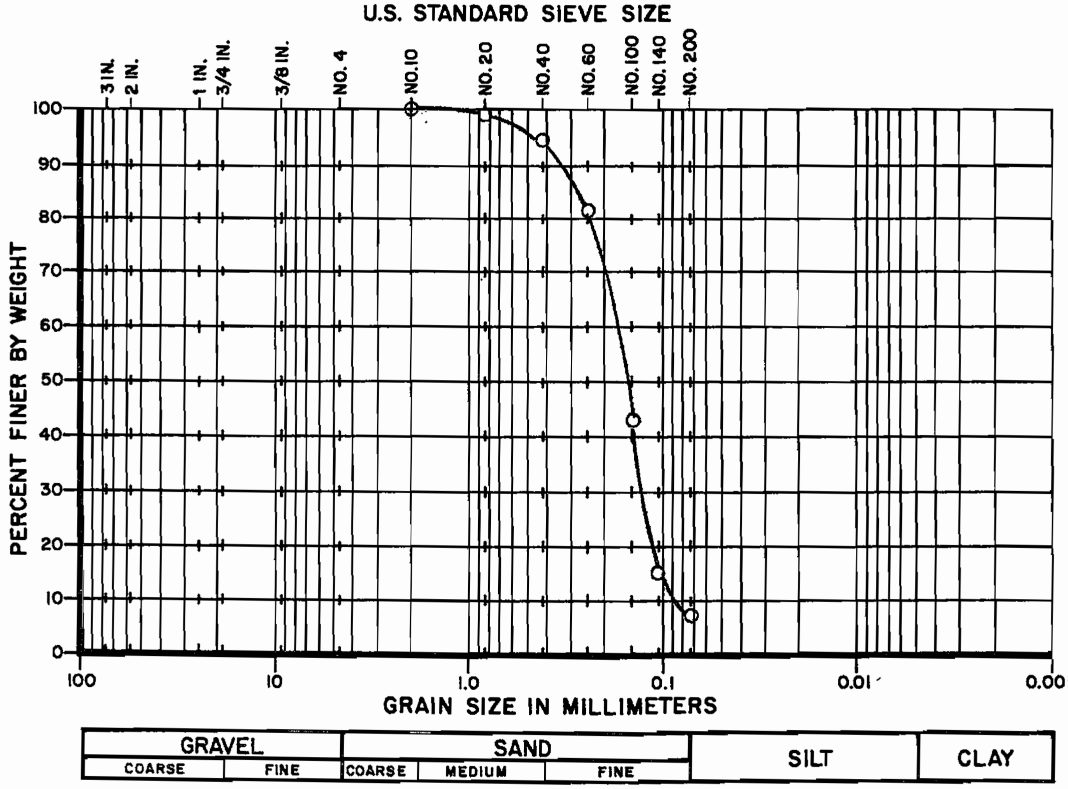

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
29	1	8.0-10.5	o	BROWN SLIGHTLY SILTY FINE SAND	SP-SM

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MANATEE COUNTY, FLORIDA

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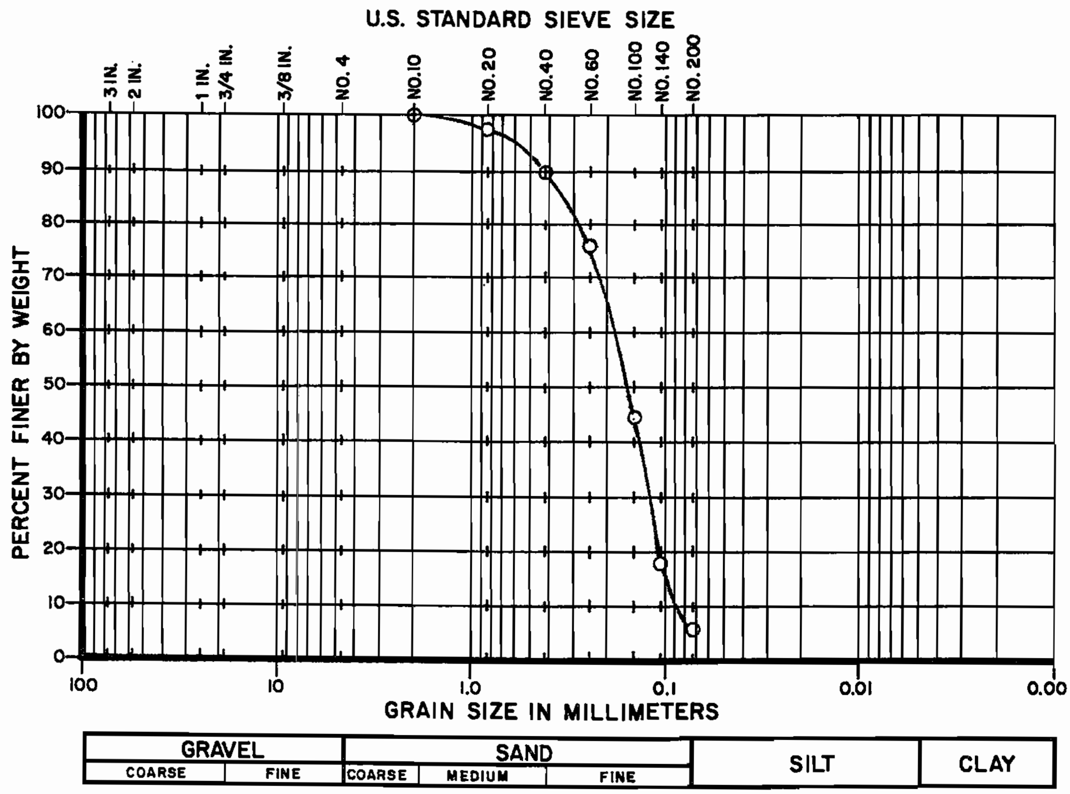

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
34	1	13.5-16.0	o	GRAY TO BROWN SLIGHTLY SILTY FINE SAND	SP-SM

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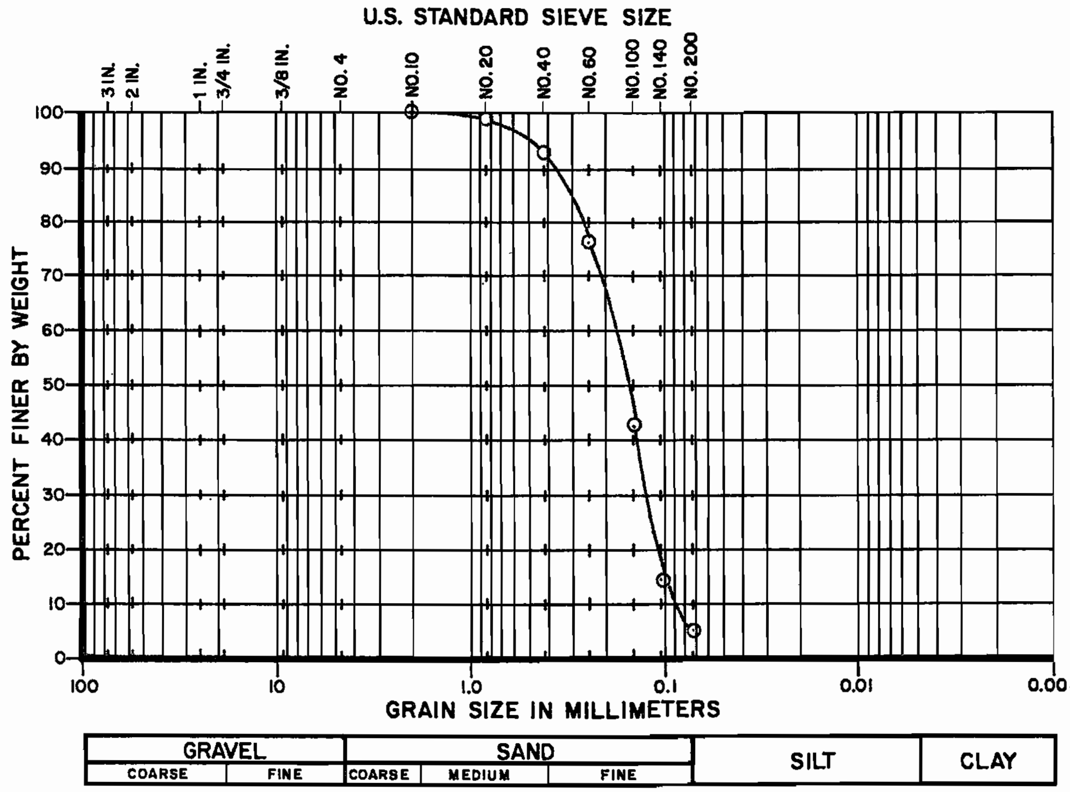

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
37	1	10.5-13.0	O	LIGHT GRAY SLIGHTLY SILTY FINE SAND	SP-SM

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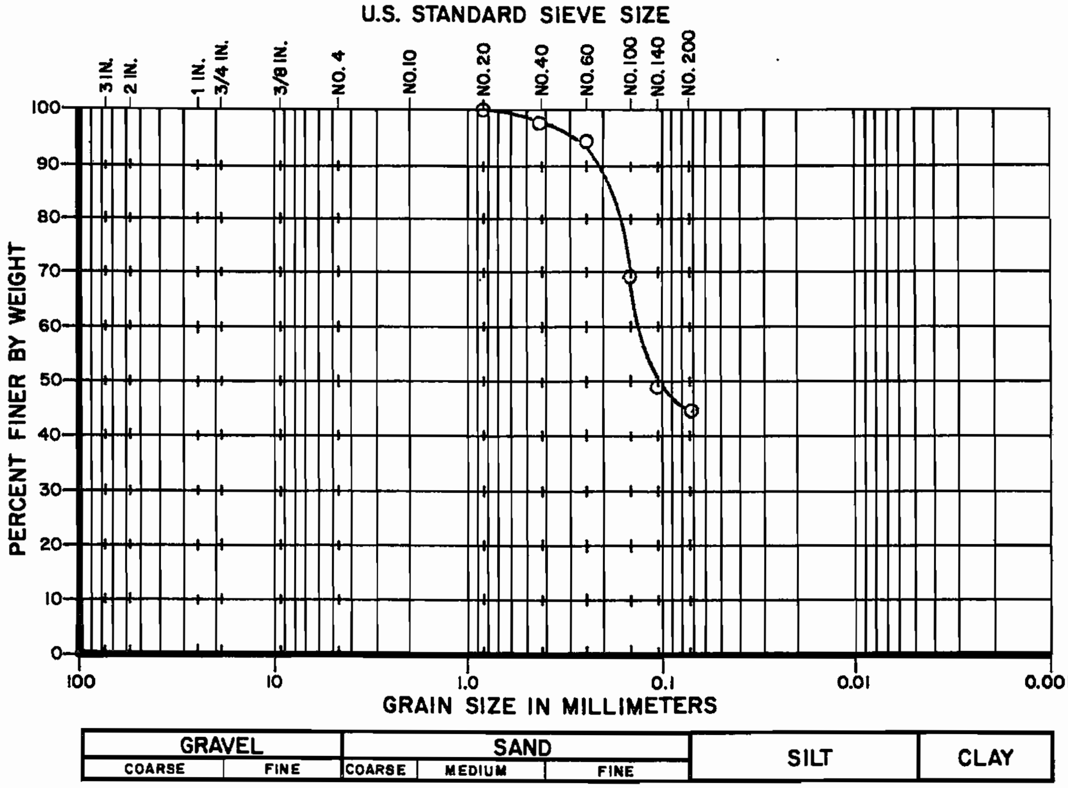

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
42	1	15.0-20.0	o	GREENISH-GRAY CLAYEY FINE SAND (STRATUM 5	SC
				REMOLDED SAMPLE)	

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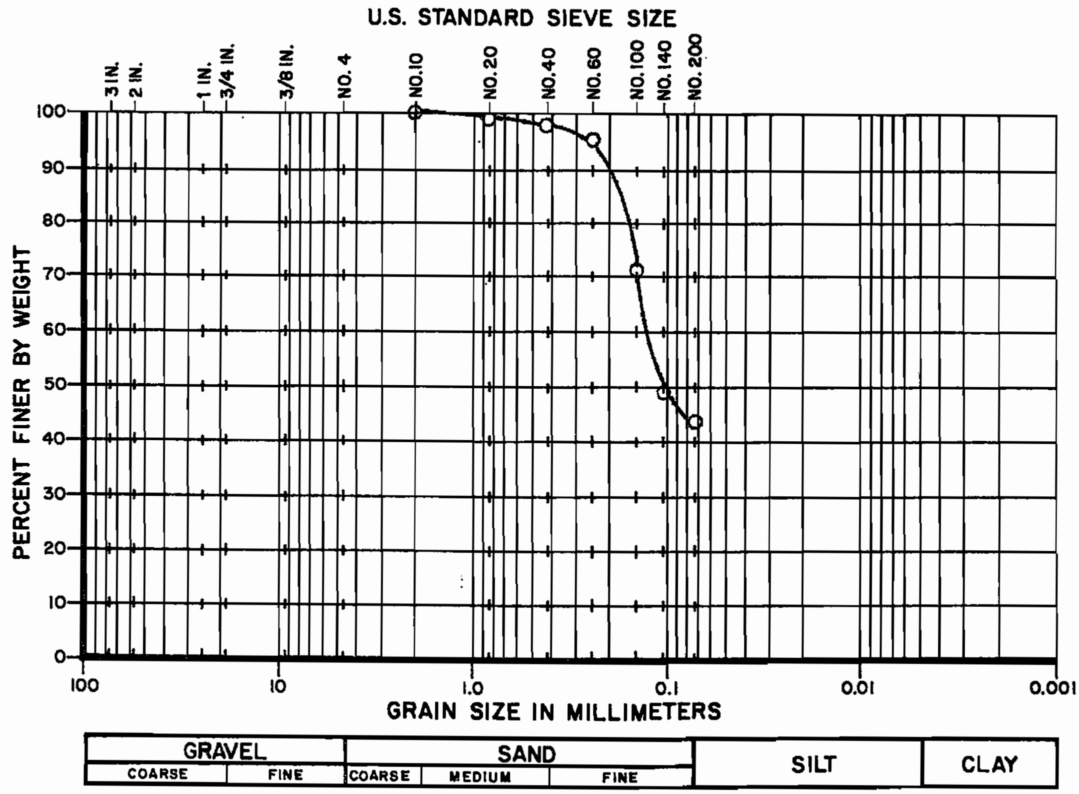

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
42	2	15.0-20.0	O	GREEN CLAYEY FINE SAND (STRATUM 5 REMOLDED	SC
				SAMPLE)	

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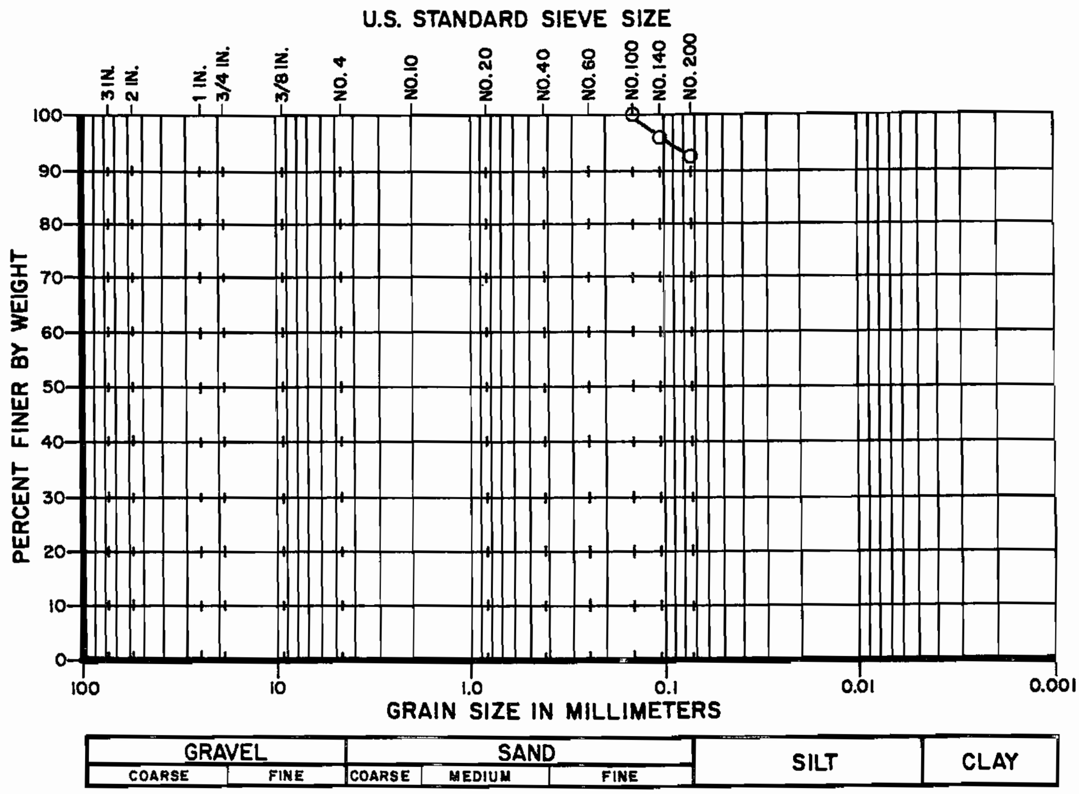

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
9	1	17.5-19.5	o	LIGHT GREENISH-BROWN SANDY CLAY	CH

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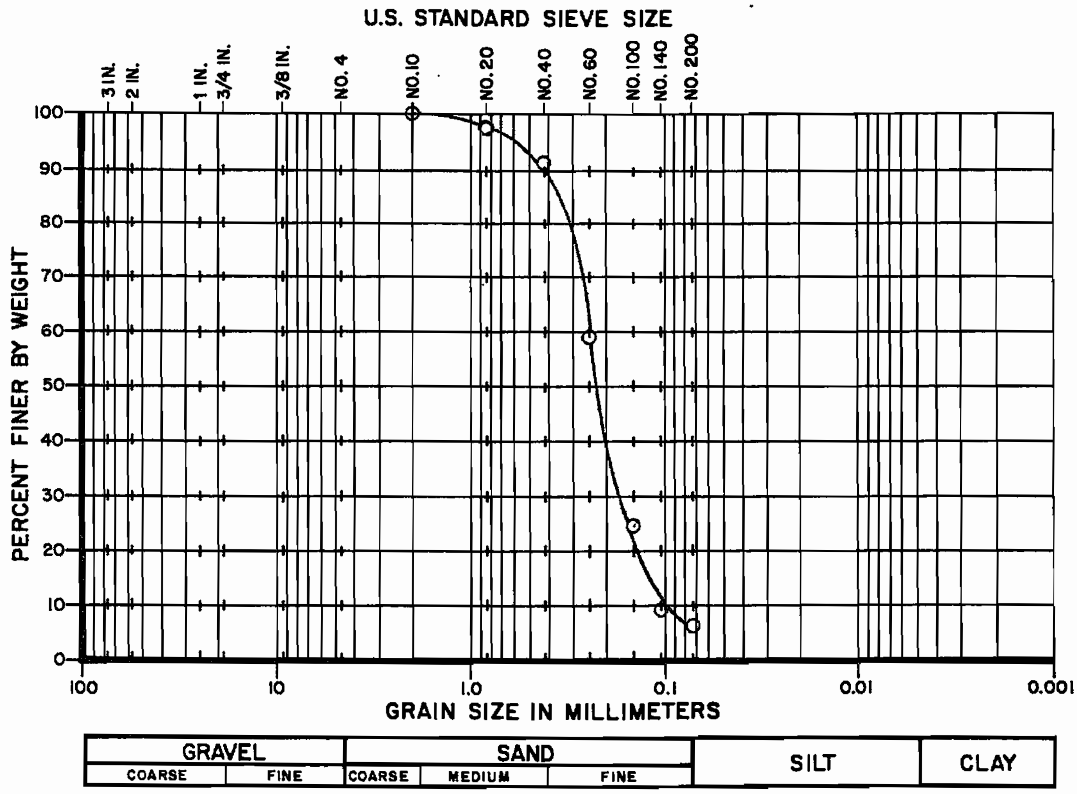

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
13	1	7.5-10.0	o	GRAY TO BROWN FINE SAND	SP-SM

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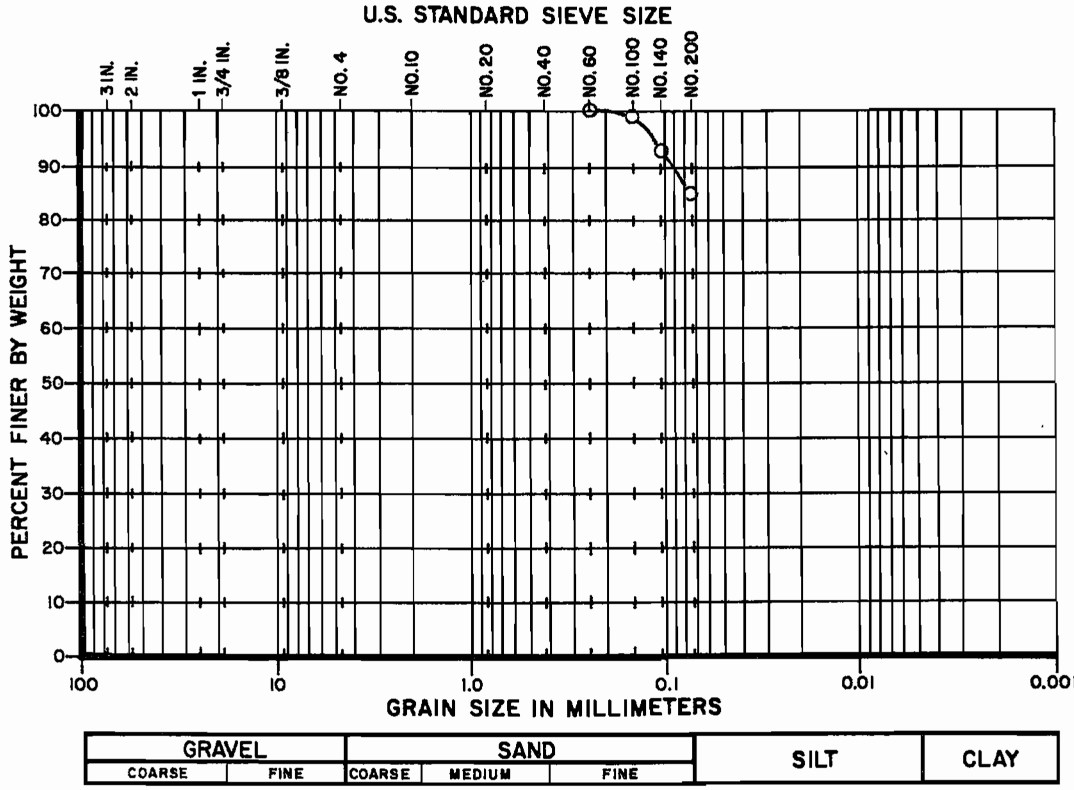

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
15	1	17.5-19.5	o	DARK GRAY SANDY CLAY	CH

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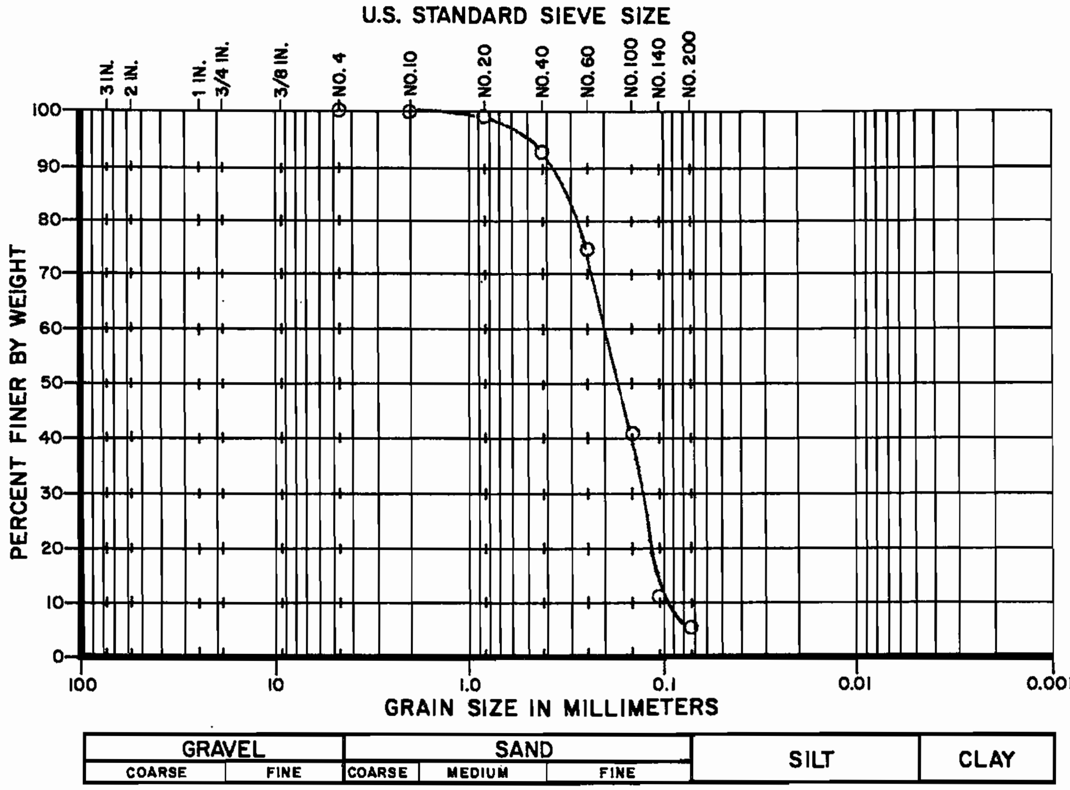

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
10	2	2.0-5.75	o	LIGHT YELLOWISH-BROWN SLIGHTLY SILTY FINE SAND	SP-SM

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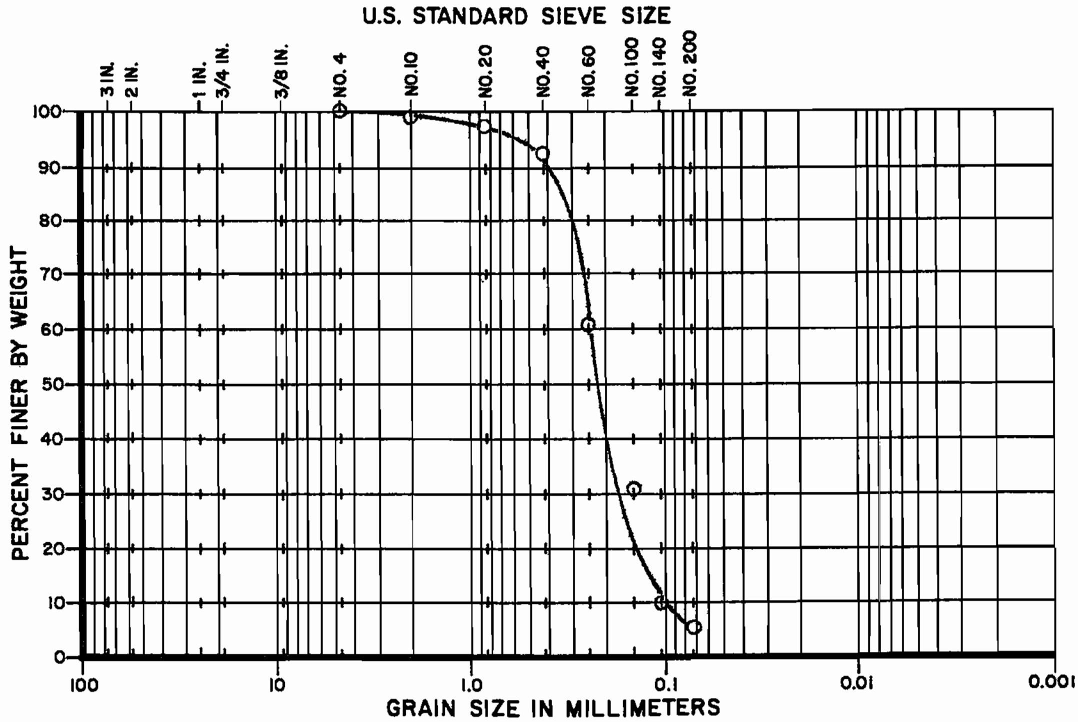

GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
8	3	7.0-10.5	O	LIGHT YELLOWISH-BROWN SLIGHTLY SILTY FINE SAND	SP-SM

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MANATEE COUNTY, FLORIDA

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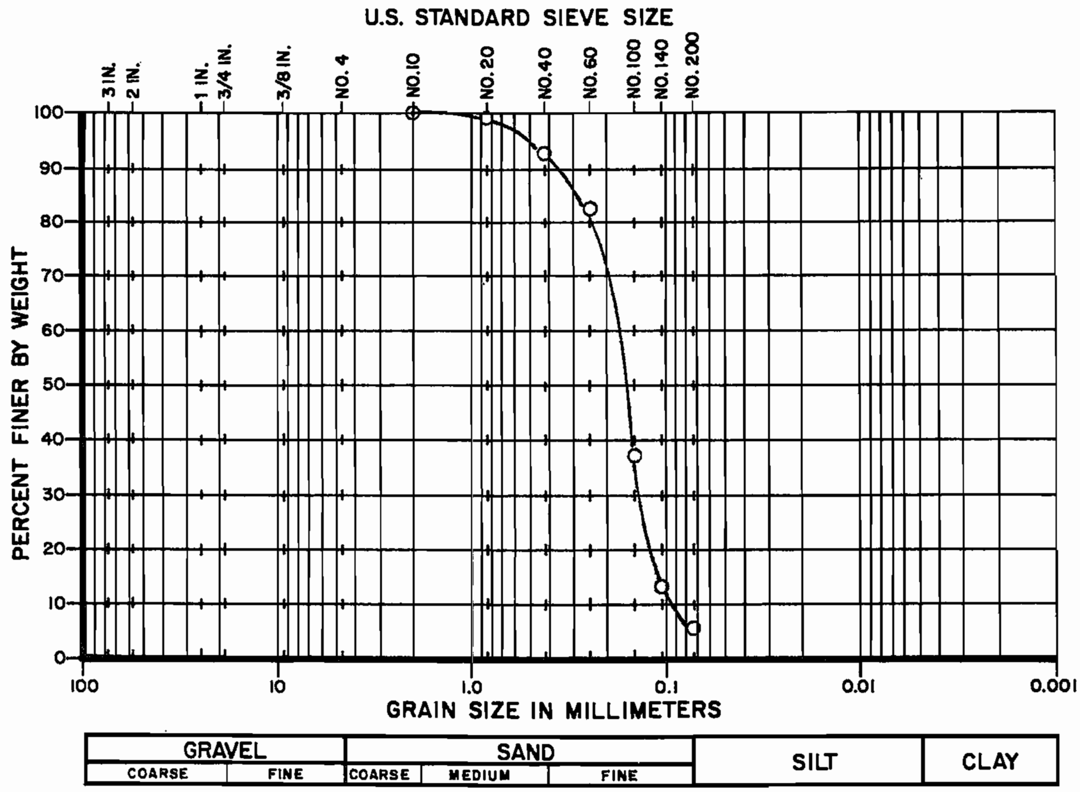

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
11	2	2.25-7.0	o	LIGHT BROWN-GRAY SLIGHTLY SILTY FINE SAND	SP-SM

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MANATEE COUNTY, FLORIDA

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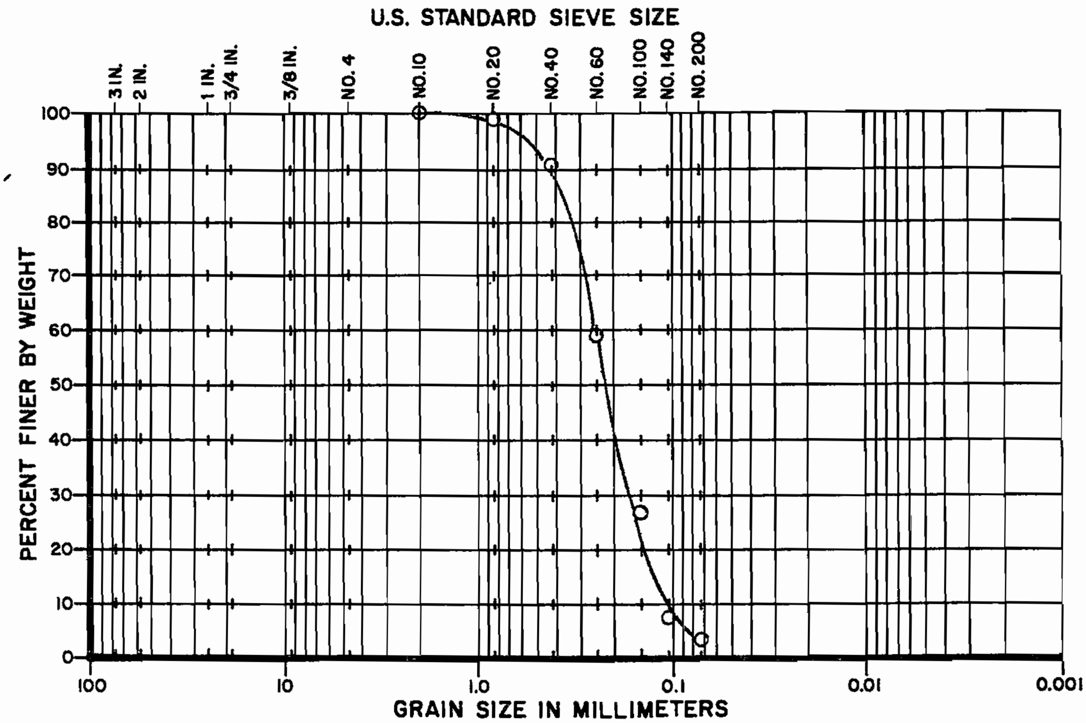

GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
4	4	8.25-11.0	O	LIGHT GRAYISH-BROWN FINE SAND	SP

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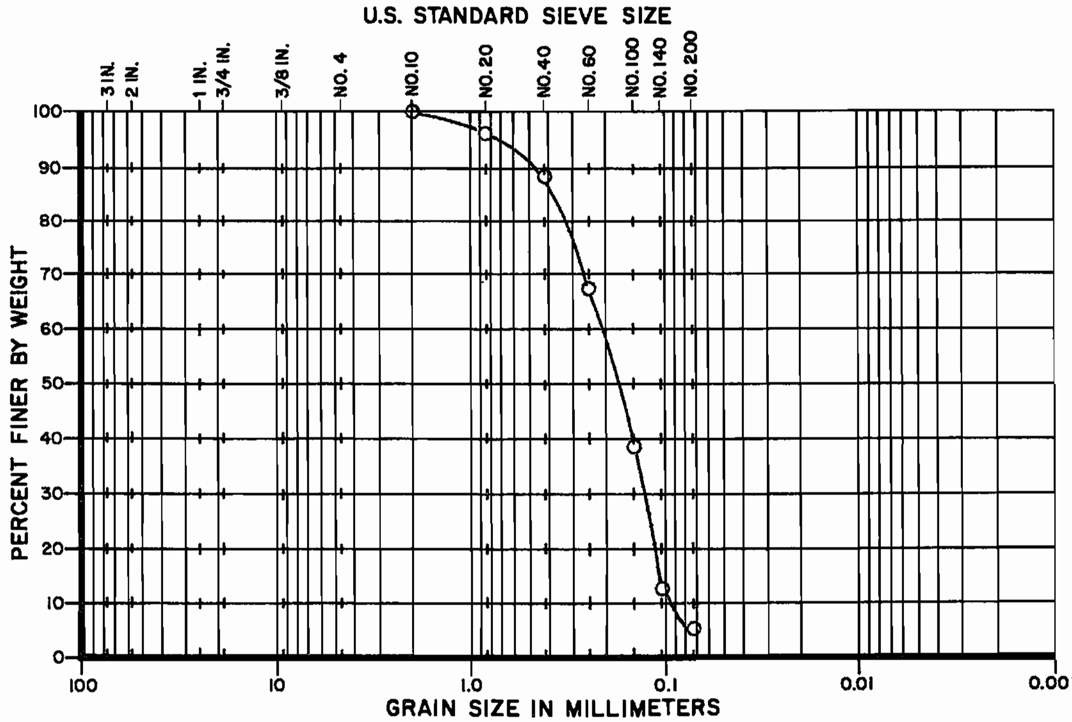

GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
1	2	3.5-10.5	o	LIGHT YELLOWISH-BROWN SLIGHTLY SILTY FINE SAND	SP-SM

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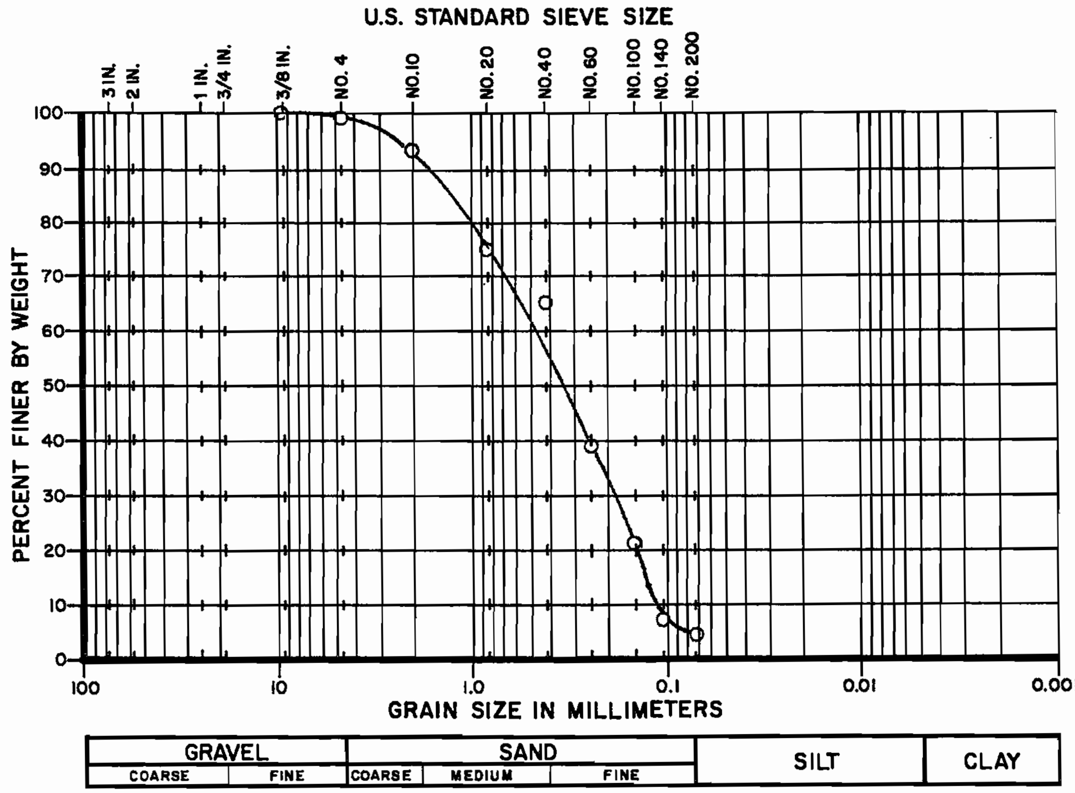

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
13	4	13.5-15.0	o	LIGHT BROWN MEDIUM TO FINE SAND	SP

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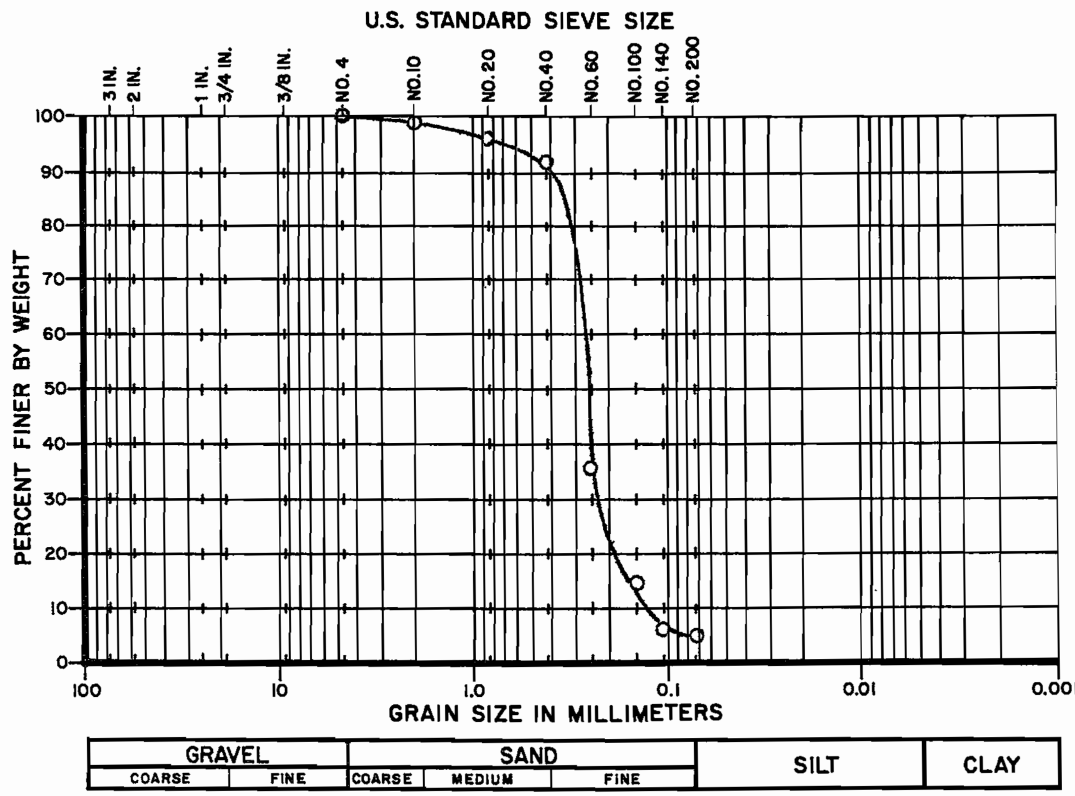

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
15	4	13.5-15.0	O	BROWN MEDIUM TO FINE SAND	SP

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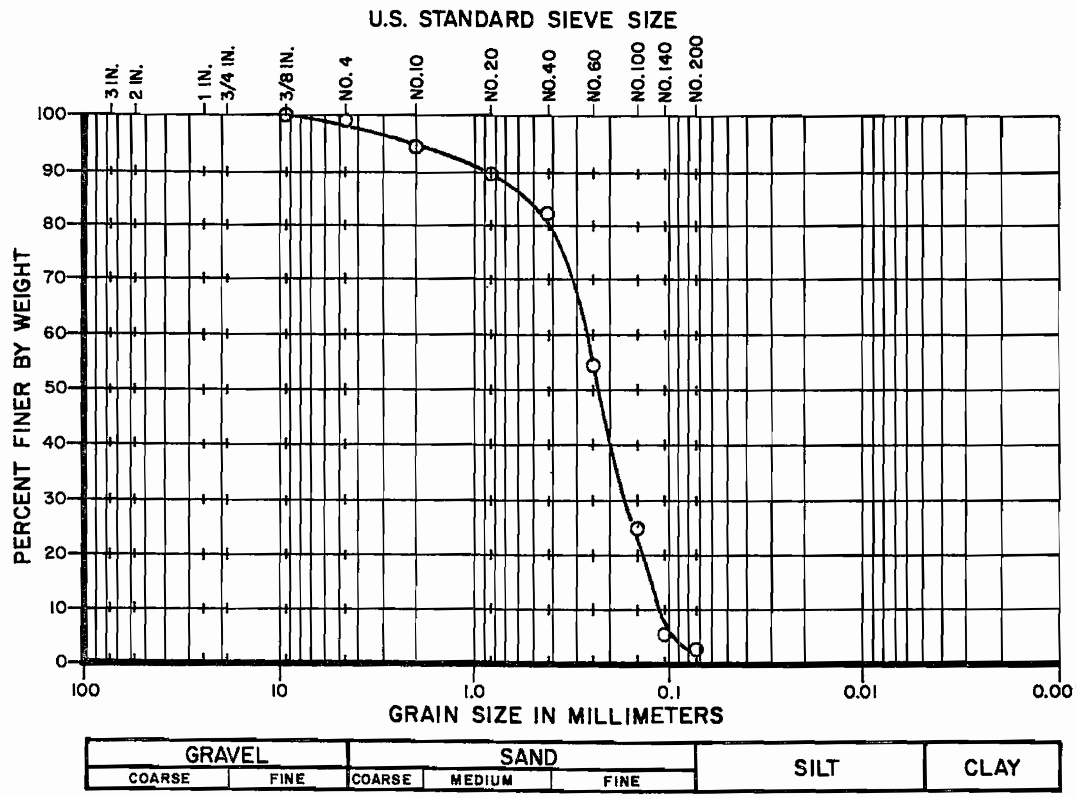

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
7	3	13.5-15.0	O	BROWN MEDIUM TO FINE SAND WITH PHOSPHATES	SP

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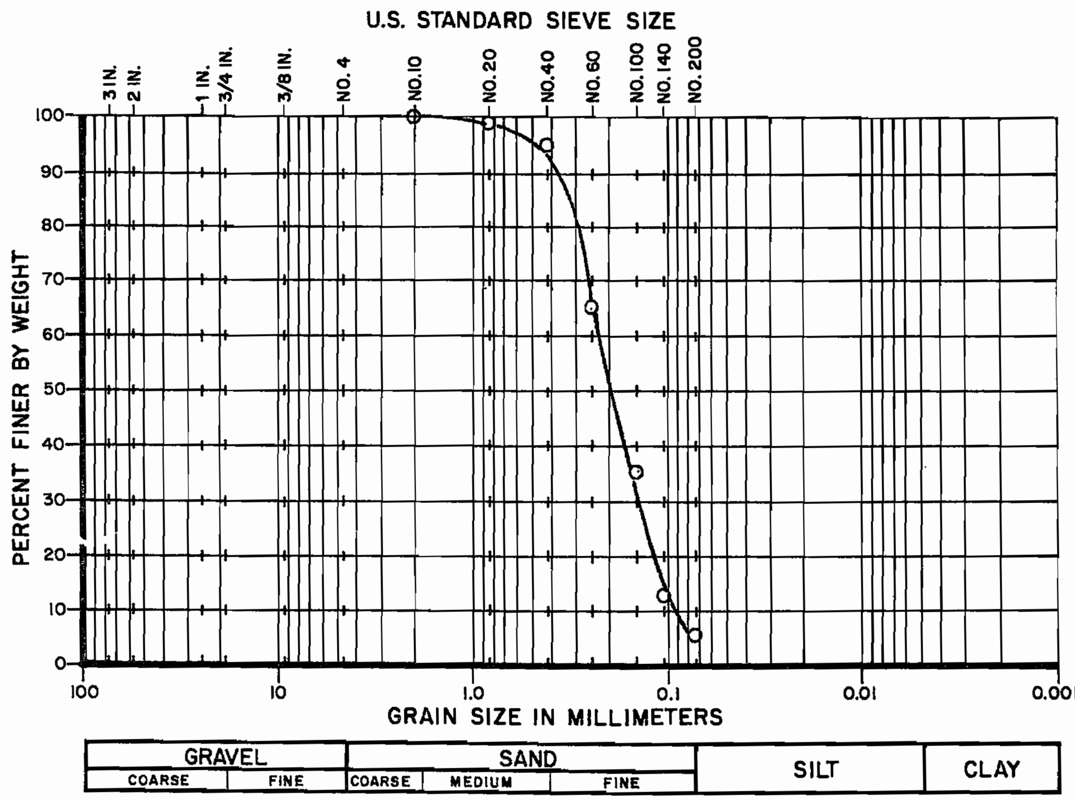

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
15	3	7.0-10.5	o	LIGHT BROWN SLIGHTLY SILTY FINE SAND	SP-SM

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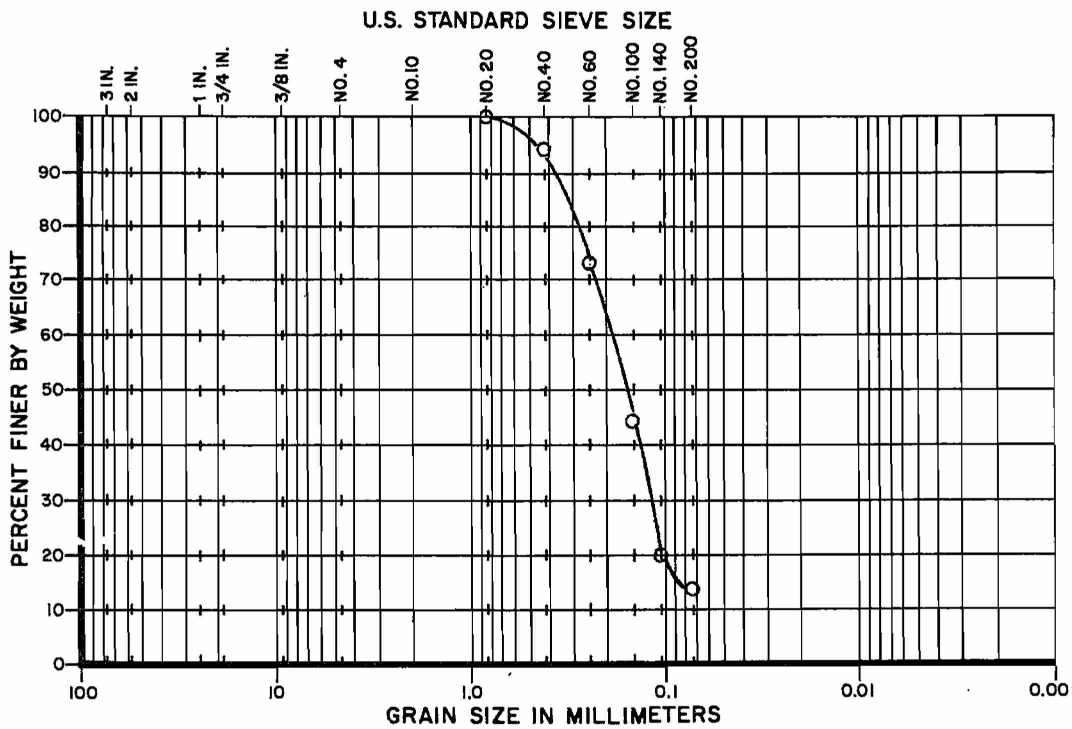

GRAVEL		SAND			SILT	CLAY
COARSE	FINE	COARSE	MEDIUM	FINE		

TEST HOLE NO.	SAMPLE NO.	DEPTH	SYMBOL	SAMPLE DESCRIPTION	UNIFIED CLASS.
12	3	6.25-10.5	o	LIGHT BROWN SILTY FINE SAND	SM

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Ardaman & Associates, Inc.

Consultants in Soils, Hydrogeology,
Foundations and Materials Testing

May 27, 1983
File Number 82-7047

Briley, Wild & Associates, Inc.
5000 U.S. Highway #1 North
P.O. Box 607
Ormond Beach, Florida 32074

Attention: Mr. Bertram B. Reilly, P.E.

Subject: Reply to letter dated April 18, 1983 from Mr. E.G. Snipes of Florida DER on Lena Road Landfill, Manatee County

Gentlemen:

This letter contains our responses to the FDER questions identified by Mr. Reilly in his letter to Dr. Garlanger dated May 3, 1983. These answers were discussed with FDER on May 20, 1983.

9. The following information is submitted together with the completed 17-1.216 (3) form:

   a. A further discussion of groundwater flow direction in the surficial aquifer is provided for your information. The discussion of groundwater movement between the surficial aquifer and the artesian aquifers and the movement within the artesian aquifers is addressed on pages 2-2 and 2-3 in the Ardaman report.

   b. An expanded well inventory is provided to encompass a one-mile radius from the site. The inventory of wells within 0.25 mile is provided in the Ardaman report. The expanded inventory was obtained by getting a listing of all wells permitted through the Manatee County Health Department from 1965 to May 1983. Table 3.1 summarizes the known characteristics of the inventoried wells within a one-mile radius of the existing and proposed expansion area of the landfill. The wells are generally not located more precisely than the section number. Figure 3.8 shows the precise location of the only wells precisely located at this time from the Health Department records. Table 3.2 summarizes the well inventory information for the monitor wells in the study area identified on Figure 3.1.

   c. The well sampling and analytical procedures are provided on pages 6-2 and 6-3 in the Ardaman report. The Enviro Lab of Ormond Beach provided sample kits with appropriate bottles and preservatives as per FDER protocol. Prior to pumping, the wells were developed with a pitcher pump. Ardaman personnel collected the grab samples using a PVC type bailer sampler. The collected samples were iced down and shipped by bus to Ormond Beach where Enviro Lab personnel took care of the analyses. The field data at the time of the sampling on November 1982 are as follows:

	pH (units)	Conductivity at 25°C (μmhos/cm)
CW-1	7.5	434
CW-2	6.9	450
CW-3	7.2	1180
MW-1	6.8	7500*
MW-2	7.2	950
MW-3	7.0	1600*
MW-4	8.0	1550*
MW-5	7.8	350
MW-6	6.7	490
MW-7	6.2	6000
MW-8	6.3	3450

*Data questionable (samples were turbid)

d. The description of monitor well construction details is provided on page 3-1 and the collection zone for each well is shown in Figures 3.2-3.7 in the Ardaman report. The slot size for the PVC wells is No. 10 slot. The joints are glued. A summary table of pertinent monitor well facts (Table 3.2) is provided for your information.

11. The "controlled irrigation program" is discussed on page 5-2 in the Ardaman report. The irrigation occurs after the landfill is closed and the golf course is operational. The "controlled irrigation program" is not used during operation of the landfill but during operation of the golf course after closure. The water balance calculations are provided in Table 5.1 of the Ardaman report as per U.S. EPA methodology.

14. Calculations for the groundwater flow to the leachate collection ditch is provided on page 5-1 in the Ardaman report. The quantities given do include groundwater inflow from adjacent lands.

21. Based on the literature data and the initial pre-1982 borings in the area the thickness of the surficial aquifer was judged to be 10-15 feet. Chapter 2 of the Ardaman report discusses literature data. In Chapters 3,4 and 5 of the Ardaman report the site specific field data are presented and discussed. The bottom of the surficial aquifer is defined by either Stratum 4,5 and 7 soils. There is no doubt that these soils do in fact represent the top of the impervious layer below the surficial aquifer. The measured thickness of the aquifer at the locations of our borings ranges from 9.0 to 27.0 feet. The average thickness from all the borings probably still falls within the 10 to 15 foot value.

22. Refer to the attached writeup with reference to your question 9a.

23. Page 5-4 in the Ardaman report says the following about the clay layer: "Forty-one of the 42 test borings conducted at this site encountered clay, silt, or very clayey sand which can be defined as impermeable. The only boring not encountering an impervious stratum was at TH-8 which was a shallow boring, only 16 feet deep. All of the deep borings, i.e., ± 60 feet, encountered thick dense strata of fine grained (i,e., clay and silt) impervious soils. These strata represent the upper units of the confining Hawthorn Formation which separates the surficial aquifer from the artesian aquifer systems. This confining bed has good continuity in this area and will effectively prevent downward percolation of leachate." In addition no permeability data taken from soil samples completely within these impermeable layer(s) had values higher than 1.7×10^{-8} cm/sec.

The clays at the site were not tested to determine their minerology. However, two samples of -140 fraction clay obtained from the phosphate producing zones of two other sites in Manatee County, Florida were tested by Ardaman & Associates using X-ray diffraction analyses to determine their clay mineralogy. The information in the following table can be used for approximating the clay mineralogy at the subject site in the absence of tests on the site specific clays.

	Approximate Weight Percent of Clay Minerals	
Clay Mineral	Site 1 Manatee County Florida	Site 2 Manatee County, Florida
Smectite	45%	29%
Illite	32%	29%
Palygorskite	21%	42%
Kaolinite	2%	1%

During slurry wall construction a qualified technician will be present to document that slurry wall is embedded in the aquiclude.

24. The specific groundwater monitoring program with respect to controlling the water levels in the ditches has not yet been decided. An initial quarterly monitoring program has been proposed on pages 6-2 and 6-3 of the Ardaman report. A strategy will be developed during this period of monitoring water levels in the ditches and the monitor wells. At least two possible approaches for this ultimate program are presented here for your consideration. In the first approach, pumps are operated as needed based on daily or weekly water-level readings in monitor wells and the ditches. One or two monitor wells would be located on each side of the existing landfill and approximately 100 feet from the edge of the ditch. The second approach would be to set up a telemetering system to automatically turn on the pumps and remove water from the ditch when the difference between the water level in the well and in the ditch exceeds a certain threshold value, say zero feet. For example, when the water level elevation in the ditch equals or exceeds the water level elevation in the well, the pump would be turned on to lower the water level in the ditch below the water level elevation in the well or wells by say 0.5 foot. The details of a specific monitoring program have yet to be worked out.

25. We did not test for mercury, chromium and lead in all wells as we felt the wells that were tested gave us a representative sample of the area in question. The tables are complete and accurate.

26. The surface resistivity data (i.e., apparent resistivity value) for a Wenner electrode spacing of 20 feet at each separate location are presented in Figure 3.1 of the Ardaman report. At several stations one or two offset stations were set up to evaluate resistivity values away from the landfill. These stations were spaced at 25-foot intervals from the closest station to the landfill. No areal map showing contours of apparent resistivity was prepared for two reasons. One, the only area with an "obvious" plume was along a portion of the property north of the existing landfill. No "obvious" plume was documented beyond 50 feet of the site elsewhere along the perimeter. However, above-background water quality characteristics are suspected at TH-5 along the west side and at resistivity site 15, south of TH-11, along the east side. Two, the area north of the existing landfill is a part of the proposed expansion area for the landfill. This property will be utilized for the expanded landfill and the contamination area will be addressed as part of the design program process for the new facilities. Linear profiles of the resistivity data were plotted up in draft form.

27. The statement that plume movement appears to be to the northeast is consistent when you consider at the present time the highest part and oldest part of the landfill is at the north end of the site. Once the top of the cells within the landfill are all this high the potential for plume movement is most likely radially away from the highest land surface elevations in the area. For a further discussion of the groundwater flow system in the surficial aquifer at the landfill refer to attachment 9a.

28. The Ardaman statements about projections of the "dry season" water table are presented in the analyses not the field investigation part of the report and, therefore, consider the season of the field investigation and the hydrologic conditions at that time. In addition, if you read the next sentence after the one quoted you would realize that we stated that in certain locations on the site the maximum water-table depth "could approach 10 feet".

30. No site specific tests have been performed to determine vertical flow through confining layers. We did document vertical permeabilities through the " top part of the impermeable" layer. We have no reason to conclude that the U.S. Geological Survey estimate of less than 2 inches per year (Stewart, 1980) is not representative for this site. Refer to pages 2-2 and 2-3 in the Ardaman report for a discussion on this subject.

31. The Ardaman report on pages 6-2 and 6-3 discuss a scope for further study relative to off-site groundwater contamination.

We expect that these responses meet with your needs at this time. We are prepared to discuss these items and other items as necessary during the week of May 30, 1983. Please do not hesitate to contact us when we can be of further assistance.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

Herbert G. Stangland, Jr., P.E.
Senior Water Resources Engineer
Florida Registration No. 16713

John E. Garlanger, Ph.D., P.E.
Principal
Florida Registration No. 19782

HGS:ed
Attachments
cc: S. Davidson (w/attach)
J. Cumming (w/attach)

9a. Groundwater Flow Direction in the Surficial Aquifer

The groundwater flow direction within the Surficial Aquifer system is complicated at a landfill site because of the changing dynamics of the system with respect to such man-controlled variables as landfill heights, fill areas, varying compaction, varying types of refuse, varying porosities of refuse, the biochemical reactions with time in the cells, and varying cover permeabilities and placement procedures. In addition to these man-controlled variables, the natural variables of rainfall, evapotranspiration rates and aquifer transmissivities adjacent to the landfill must also be considered.

A water table map gives a "snap shot" of the groundwater system at an instant of time. With all these variables interacting at this site one instantaneous "snap shot" was not considered essential to the evaluation of the site.

The water-table elevations in the landfill at various times during its life will probably be higher than the adjacent water-table elevations adjacent to the landfill. Therefore, water would move radially outward from points of high to low water elevations. (This is why we recommended a leachate collection/contaminant system surrounding the landfill.) The magnitude of groundwater outflow and the length of time for this outflow depends on man-controlled and natural variables at the landfill.

During the early stages of a cell life a large proportion of the water percolating through the landfill is absorbed by paper and other substances within the fill. The amount of infiltration/percolation is variable through the life of the landfill. Initially, infiltration/percolation is highest because intermediate or daily cover is all that is in place during this time. These type covers have relatively high infiltration/percolation rates. Once the final cover is placed over a cell, percolation is significantly reduced. An equilibrium condition probably is not reached until after the final cover is in place.

In the final analysis, the direction and rate of groundwater movement away from the landfill toward the leachate collection system at anytime in the life of the landfill will depend on whether a groundwater mound with respect to the water level in the leachate collection system exists at the landfill. The probability for a mound to develop at the site is directly related to the infiltration/percolation into the landfill. A low infiltration/percolation rate supports a low probability for a mound. Conversely a high infiltration/percolation rate supports a high probability for a mound. This concept is illustrated in the table on page 5-1 of the Ardaman report.

Groundwater level contours outside of the landfill and leachate collection system are a subdued reflection of the ground surface contours, i.e., at any time, the depth to the water table below a given ground surface contour is approximately the same along the contour. The groundwater flows toward relief points along natural or artificial channels and depressions in the land surface.

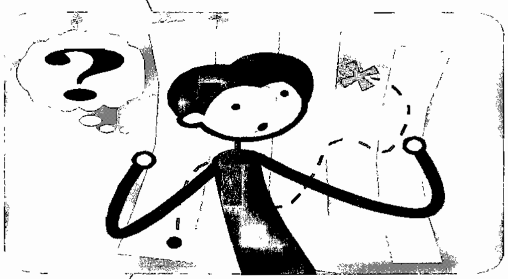
Table 3.1

WELL INVENTORY FOR LENA ROAD LANDFILL

No.	Section Location	Name Address	Use	Total Depth	Casing Depth	Casing Diameter
1	S25, T34S, R18E*	Roland Pompey 1918 1st Ave. E.	Domestic	100'	42'	3"
2	S25, T34S, R18E	Tom Emmer Rubonia	-	-	-	4"
3	S25, T34S, R18E	Tom Emmer Rubonia	-	-	-	4"
4	S25, T34S, R18E	Harvey Brock 1833 8th Ave. E.	Irrigation	-	32'	3"
5	S25, T34S, R18E	Leon Esechenko Magnolia Manor	-	90'	37'	3"
6	S25, T34S, R18E	H.B. Brower Lena Road	Household	100'	30'	4"
7	S36, T34S, R18E	Frank Castoral Lena Road	Livestock	365'	42' 63'	4" 3"
8	S36, T34S, R18E	Howard Brower Brower Drive off Lena Road	Domestic	105'	51'	4"
9	S36, T34S, R18E	Hardie		450'	76'	4"
10	S36, T34S, R18E	Schmitt Rt.#64 Lorain Road	-	175'	89'	-

*Section 25, Township 34 South, Range 18 East
Source: Manatee County Health Department Well Records 1965 to May 1983

ATTENTION



AN OVERSIZED DRAWING HAS BEEN SCANNED SEPARTELY. PLEASE SEE:

- **39884-018-SO/01 LENA ROAD CLI LF OP RENEWAL RAI#1 RESPONSE-1985 HYDRO/ GEOTECH REPORT DRWG #3**

Table 3.1 (cont'd)

WELL INVENTORY FOR LENA ROAD LANDFILL

No.	Section Location	Name Address	Use	Total Depth	Casing Depth	Casing Diameter
11	S36, T34S, R18E	Schaeffer Lena Road near Brower Drive	Domestic	202'	40'	4"
12	S1, T35S, R18E	Lehman Interprises 9800 Blk. of Cortez Road	Irrigation	100'	80'	4"
13	S1, T35S, R18E	Wiley Jackson P.O. Box 1316	Abandoned	-	-	-
14	S1, T35S, R18E	John Stephens 41st Street E.	Household	175'	84'	3"
15	S1, T35S, R18E	Jim Gay Braden River Ranchetts	Household	150'	50'	-
16	S1, T35S, R18E	MarNav Builders Braden River Ranchetts	Household	160'	42'	3"
17	S1, T35S, R18E	Kenneth M. Watts Lena Road	Water Horses	95'	35'	3"
18	S1, T35S, R18E	I.I. Redins Braden River Ranchetts	-	158'	52'	3"
19	S1, T35S, R18E	Bernard Mitchell 2808 41st Avenue E.	-	167'	37'	3"
20	S1, T35S, R18E	John Sanville	Cattle Watering	126'	50'	3"
21	S1, T35S, R18E	C.T. Adams 2508 Lena Road	Household	239'	84'	3"

Table 3.1 (cont'd)

WELL INVENTORY FOR LENA ROAD LANDFILL (cont'd)

No.	Section Location	Name Address	Use	Total Depth	Casing Depth	Casing Diameter
22	S1, T35S, R18E	Luther Willis Braden River Ranchetts	Household	140'	62'	3"
23	S1, T35S, R18E	Pete Griffin Braden River Ranchetts	-	135'	44'	3"
24	S12, T35S, R18E	Ray Redell 5007 Coral Blvd.	Domestic Irrigation	-	63'	3"
25	S29, T34S, R19E	Tom & Evelyn Charies Hwy. 64	Irrigation	638'	85'	8"
26	S29, T34S, R19E	Tom & Evelyn Charies Hwy. 64	Irrigation	-	86'	8"
27	S29, T34S, R19E	Tom & Evelyn Charies Hwy. 64	-	658'	84'	8"
28	S29, T34S, R19E	Tom & Evelyn Charies Hwy. 64	-	654'	81'	8"
29	S29, T34S, R19E	Tom & Evelyn Charis Hwy. 64	Irrigation	640'	84'	8"
30	S29, T34S, R19E	Tom & Evelyn Charis Hwy. 64	-	681'	83'	8"
31	S29, T34S, R19E?	Robert Gadbois Upper Man. River Rd.	Domestic	110'	33'	4"
32	S29, T34S, R19E	Joe Warner Upper Man. River Rd.	- -	160'	63'	3"

Table 3.1 (cont'd)

WELL INVENTORY FOR LENA ROAD LANDFILL

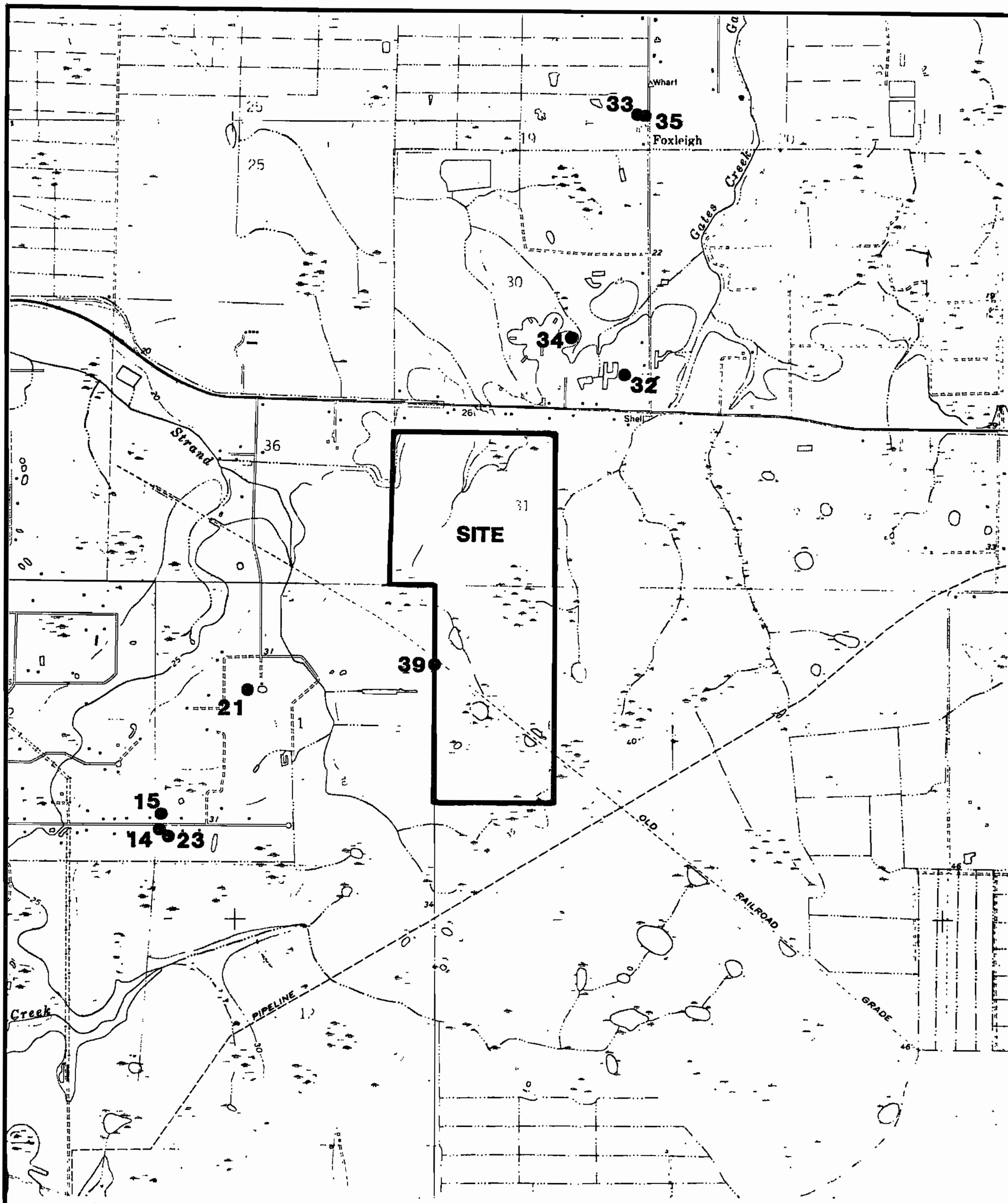
33	S29, T34S, R19E?	Moores Dairy Upper Man. River Rd.	Domestic	310'	63'	4"
34	S30, T34S, R19E	Manatee Dairies Rt.2 Box 3271	Dairy	490'	61'	6"
35	S30, T34S, R19E	R.F. Moore Upper Man. River Rd.	Lawn	88'	40'	4"
36	S32, T34S, R19E	Glen Watkins GWE Dairy Farms 717 1st Street	Stock	450'	98'	8"
37	S32, T34S, R19E	Louise Simmons Rt. 1 Parrish	Irrigation	525'	126'	4"
38	S5, T35S, R19E	Jack Taylor off Pope Road	Irrigation	1056'	102'	10'
39	S6, T35S, R19E	Manatee County Landfill Lena Road	-	160'	46'	3"
40	S7, T35S, R19E	Paul Tedder off SR 70	Irrigation	870'	82	6"
41	S7, T35S, R19E	Paul Tedder off SR 70	Irrigation	880'	80'	6"
42	S7, T35S, R19E	Paul Tedder	Irrigation	860'	83'	6"

Table 3.2

PIEZOMETERS/OBSERVATION WELLS FOR LENA ROAD LANDFILL

Id Number	Well Dia. (inches)	Land Surface Elevation ft. (NGVD)	Riser Height (feet)	Collection Zone Elevation ft. (NGVD)	Aquifer	Latitude/Longitude Location	Lithology for Screen Interval	Permeability of Material at Screen Interval (cm/sec)	Remarks
MW-1	2	36.8	2.95	25.8 to 30.8	Surficial	82°26'43", 27°27'53"	fine sand	$1.8x10^{-3}$*	at TH-2
MW-2	2	35.9	1.97	23.9 to 28.9	Surficial	82°26'49", 27°28'02"	fine sand	$1.8x10^{-3}$	at TH-3
MW-3	2	35.6	0.35	22.6 to 27.6	Surficial	82°26'49", 27°27'56"	fine sand	$4.7x10^{-3}$	at TH-5
MW-4	2	36.8	2.65	23.3 to 28.3	Surficial	82°26'49", 27°28'12"	fine sand & clayey fine sand	-	at TH-9
MW-5	2	37.3	3.90	25.3 to 30.3	Surficial	82°26'23", 27°28'03"	sl. silty to silty fine sand	$3.5x10^{-5}$	at TH-11
MW-6	2	37.8	2.45	25.8 to 30.8	Surficial	82°26'23", 27°28'11"	sl. silty to silty fine sand	$4.9x10^{-4}$	at TH-12
MW-7	2	36.5	3.45	20.5 to 25.5	Surficial	82°26'32", 27°28'20"	fine sand	$4.5x10^{-4}$	at TH-14
MW-8	2	34.9	4.04	18.9 to 23.9	Surficial	82°26'41", 27°28'20"	fine sand	$1.4x10^{-3}$	at TH-15
MW-16	2	35.9	2.00	18.9 to 23.9	Surficial	82°26'40", 27°28'27"	fine sand	$1.9x10^{-3}$	at TH-16
MW-18	2	34.8	2.17	20.8 to 25.8	Surficial	82°26'48", 27°28'33"	fine sand	$3.6x10^{-3}$	at TH-18
MW-22	2	27.0*	2.71	17.0 to 22.0**	Surficial	82°26'38", 27°29'01"	sl. silty fine sand	$4.5x10^{-4}$	at TH-22
MW-30	2	31.0*	1.62	15.0 to 20.0**	Surficial	82°26'38", 27°28'48"	sl. silty to clayey fine sand	$6.8x10^{-4}$	at TH-30
MW-41	2	34.5*	1.75	7.5 to 12.5**	Surficial	82°,26'22", 27°28'32"	sl. silty to silty fine sand	$5.5x10^{-4}$	at TH-41
PZ-8	2	38.0*	2.50	7.5 to 12.5**	Surficial	82°26'49", 27°28'07"	sl. silty fine sand	$3.1x10^{-3}$	at TH-8
PZ-27	2	26.0*	1.875	11.0 to 16.0**	Surficial	82°26'55", 27°28'55"	sl. silty fine sand to sandy silt	$5.4x10^{-4}$	at TH-27
CW-1	2	38.0*	0.92	11.8 to 16.8**	Surficial	82°26'20", 27°28'08"	fine sand	10^{-3}*	also called S-1
CW-2	2	34.0*	2.50	7.5 to 12.5**	Surficial	82°27'01", 27°27'59"	fine sand	10^{-3}*	at TH-19, also called S-2
CW-3	2	36.0*	0.67	10.0 to 15.0**	Surficial	82°26'51", 27°28'17"	fine sand	10^{-3}*	near weight station

*Land surface elevations estimated from November 1982 Southern Resource Mapping Corporation 1" = 100' scale 2' contour interval topo map of landfill.
**Values in depth below land surface.



INVENTORIED WELLS

N

0 1000 2000
SCALE—FEET

LEGEND

● WELL LOCATION

14 WELL NUMBER

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: T. S.	CHECKED BY:	DATE: 5/24/83
FILE NO. 82-7047	APPROVED BY: [signature]	

35304

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

SUPPLEMENT TO DER FORMS 17-1.204(2), 17-1.205(1), and ANY OTHER PERMIT APPLICATION WHERE THERE ARE DISCHARGE IMPACTS ON GROUND WATER

The following information shall be submitted to the Department for any installation requiring permitting or monitoring pursuant to Rule 17-4.245, in order that the application be considered "complete" for processing. For new facilities the information shall be submitted in conjunction with any other appropriate Department application, or separately, if no other application is required. For existing installations, the information shall be submitted at the time set forth in the timetable in Rule 17-4.245(6)(c)2. Owners of installations whose permits expire prior to the date set forth in the timetable are encouraged to submit this information at the time of permit renewal in order to streamline the permitting process.

It is recommended that approval be secured sufficiently in advance that all background water quality data collected can be included in your application.

1. Your program (including construction and sampling/analysis schedules) for the sampling/characterization of the "background" ground waters (see Attachments "A", "B", and "C").

2. Physical, chemical and hydrogeological characteristics of the receiving formations.

3. Direction(s) of flow of the receiving ground water.

4. Map showing location of property limits and treatment plant site limits (including disposal system within site).

5. Proximity of present and known future sources of water pollution within one mile radius of the site.

6. Proximity of present and known future ground water withdrawal points or wells within a one mile radius of the site.

7. Chemical, physical and microbiological analysis (whichever is applicable) of wastewater constituents (see Attachment "C").

8. Discussion of known synergistic effects of the wastewater discharge caused by reaction with other pollutants or substances which are present in the receiving aquifers and which would cause a violation of water quality standards of the receiving aquifers at present or in the foreseeable future.

9. Program (including construction schedules) for the monitoring of the water quality effects of the discharge plume on the receiving ground waters (see Attachments "A" and "B").

NOTE: A monitoring program instituted under some other state, federal, or local government regulation or permit may be substituted (or referenced if contained in an existing department permit) if such program is in substantial compliance with Rule 17-4.245(6).

ATTACHMENT "B"
Construction of Test/Monitor Wells
Construction Sequence (Typical)

	ACTIVITY	PROPOSED COMPLETION DATE	DATE COMPLETED*
1.	Site approval for test boring location	October 1982	October 1982
2.	Determination of test boring depth	October 1982	October 1982
3.	Construct test hole		
	a. Driven casing	N/A	N/A
	b. Cable tool	N/A	N/A
	c. Rotary	October 1982	October 1982
	d. Other (describe)	N/A	N/A
4.	Sample formations at 5 ft. intervals and indicate lithologic changes	October 1982	October 1982
5.	Evaluate test boring	October 1982	October 1982
6.	Determine monitoring/sampling depth(s) and interval(s)	October 1982	October 1982
7.	Pull-back casing and backfill test hole with impermeable material (grout, clay, etc.) to monitoring level	October 1982	October 1982
8.	Install:		
	a. casing/liner	November 1982	November 1982
	b. well screen	November 1982	November 1982
	c. gravel pack	November 1982	November 1982
	d. other (describe)	N/A	N/A
9.	Pull back remainder of casing	November 1982	November 1982
10.	Grout or fill annular space.	November 1982	November 1982
11.	Develop well	November 1982	November 1982
12.	Sample well	November 1982	November 1982
13.	Preserve sample when appropriate	November 1982	November 1982
14.	Provide chemical, physical and microbiological analysis (Attachment "C")	December 1982	January 1983

*To be filled in during construction.

	PROPOSED DISCHARGE					BACKGROUND WATER QUALITY			
Parameter	Present (P) Absent (A)	Concentration in appropriate units	Measured (M) Estimated (E)	Analytical Method to be used	Notes or Remarks	Concentration in appropriate units	Number of Samples	Analytical Method	Notes or Remarks
Chromium						<.05	3	M	Enviro Lab
Endrin		<.000004	M			<.000004		E	Mote Marine Lab
Fluorides						-	-	-	
Lindane		<.000001	M			<.000001		E	Mote Marine Lab
Lead						<.05	4	M	Enviro Lab
Mercury						<.002	4	M	Enviro Lab
Methoxychlor		<.00003	M			<.00003		E	Mote Marine Lab
Microbiological						-	-	-	
Nitrate (N)						< 10		E	Enviro Lab
Selenium									
Silver						<.05		E	Enviro Lab
2,4, - D						<.00007		E	Mote Marine Lab
2,4,5 - TP						<.00007		E	Mote Marine Lab
Trihalomethane						<0.1		E	
Toxaphene		<.0002	M			<.0002		E	Mote Marine Lab
Radium 226						-	-	-	
Radium 228						-	-	-	
Gross Alpha Activity						-	-	-	

Ardaman & Associates, Inc.

Consultants in Soils, Hydrogeology,
Foundations and Materials Testing

November 7, 1983
File Number 82-7047

Briley, Wild and Associates, Inc.
5000 U.S. Highway 1, North
Ormond Beach, Florida 32074

Attention: Mr. John Cumming, P.E.

Subject: Proposal for Additional Hydrogeological Investigation at the Lena Road Landfill, Manatee County, Florida

Gentlemen:

In response to the Florida Department of Environmental Regulation letter of September 2, 1983 to Mr. Philip Davis, we are pleased to submit this proposal for conducting additional hydrogeological tasks at the subject site. These tasks include:

- Drilling operations
- Laboratory testing
- Engineering services

The proposed scope of work of these tasks is described below:

1. Drilling operations. Perform two Standard Penetration Test/core borings. One SPT boring will be located at the point of lowest elevation within the depression found adjacent to the northwest corner of the existing landfill. This boring is expected to be approximately 50 feet deep and will be grouted upon completion. The other SPT/core boring will be located approximately 300 feet west of the first boring (outside the depression). This hole will be advanced to a depth of approximately 150 feet by SPT and wire-line core methods. Both holes will be sampled continuously to a depth of 10 feet, every 2.5 feet thereafter to a depth of 30 feet, and then at 5-foot intervals to approximately 50 feet where the continuous wire line coring will begin in the second hole.

   At the site of the deep boring, a 1.25-inch diameter sealed piezometer will be installed with a 10-foot slotted PVC screen. The screen will be placed at either the 150-foot level or within a water loss zone, whichever is shallower. A well construction permit will be obtained from the Manatee County Health Department prior to installation.

   Six undisturbed samples of the clayey confining bed beneath the site will be obtained; three from each of the two SPT borings.

2. Laboratory testing. Four of the six undisturbed samples will be selected and used for determination of laboratory permeability values to supplement the values previously obtained and reported. Six soil samples will be analyzed for percent fines determinations.

3. Engineering services. Soil and core samples will be analyzed by our geologist and used to prepare boring profiles. Analysis of the samples from the two borings will verify the presence or lack of a continuous confining layer beneath the depression. Water level measurements in the deep piezometer will indicate the gradient between the surficial and secondary artesian aquifer.

This work will be invoiced monthly based on our current fee schedule. Drilling operations are expected to total $4,700, laboratory testing $500 and engineering services $800. Therefore, this total effort will not exceed $6,000 without further written authorization.

If you accept this proposal, please sign one of the enclosed letters and return the original to us for our record. If you have any questions, please do not hesitate to contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

John E. Garlanger, Ph.D., P.E.
Vice President

LMP:ed

ACCEPTED:

BY: ______________________
TITLE: ______________________
DATE: ______________________

Ardaman & Associates, Inc.

Consultants in Soils;Hydrogeology, Foundations and Materials Testing

February 24, 1984
File Number 82-7047

Briley, Wild and Associates, Inc.
5000 U.S. Highway 1, North
Ormond Beach, Florida 32074

Attention: Mr. John Cumming, P.E.

Subject: Additional Hydrogeologcial Investigation at the Lena Road Landfill, Manatee County, Florida

Gentlemen:

In response to the Florida Department of Environmental Regulation (FDER) letter of September 2, 1983 to Mr. Philip Davis and our letter of November 7, 1983, we are pleased to present our responses to the questions raised by the FDER. We will also address the verbal request made by Mr. Rick Hicks (FDER) for additional borings through the confining layer.

Response #23 - Aquiclude/confining layer determination

The attached graph (Figure 1), showing a plot of permeability coefficient vs. percent fines, has been updated to reflect seven additonal lab permeability test results. The additional tests were performed on soil samples ranging from clayey fine sand (four samples) to slightly sandy clay (three samples). As can be seen on the graph, these additional permeability results agree with previous data collected in Manatee County. Also note, all soils having greater than 20 percent passing the No. 200 sieve have permeabilities between $2x10^{-7}$ and $2x10^{-8}$ cm/sec. This figure is not intended to be used as a method to predict permeability based on the percent fines content of a soil. It is intended only as a rough guide as to the possible range in permeability expected from a given soil of similar lithologic origin. However, based on the measured permeabilities and the percent fines determinations, it appears that even the clayey fine sand strata encountered at the site can act as an effective aquiclude.

Response #30-Vertical flow determination

One topographic depression located at the northwest corner of the existing landfill was explored to provide an indication of the continuity of the confining layer and to determine vertical head differences between aquifers. The attached Figure 2 shows the boring profiles from TH-43 and TH-44. TH-43 was drilled outside the depression to document the undisturbed geologic conditions to a depth of 150 feet. It was felt that any significant variation from this profile in the depression boring might indicate a sinkhole condition. TH-43 encountered approximately 13 feet of Pleistocene and younger sediments overlying 137 feet of Hawthorn Formation deposits. Based on published data, the Hawthorn has a total thickness of approximately 300 feet. TH-44 was drilled in the center of the depression to a

8008 S. Orange Avenue, P.O. Box 13003, Orlando, Florida (305) 855-3860
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depth of 54 feet without encountering any signs of sinkhole activity and for that reason was terminated. TH-44 also encountered approximately 13 feet of Pleistocene and younger sediments overlying the Hawthorn. Both test holes encountered approximately 41 feet of strata 4, 5 and 7 (upper Hawthorn) sediments overlying more highly consolidated material. These more highly consolidated sediments (i.e., TH-43, cored interval) are also relatively impervious as documented by the lack of drilling fluid loss over the entire interval and the two lab permeability values. Although, we do recognize the existance of thin, pervious zones within the Hawthorn in the general area, such zones were not encountered in our drilling of TH-43.

A piezometer sealed into the Hawthorn Formation was installed at TH-43 to document the vertical head difference between the Hawthorn and the surficial aquifer. As noted on the boring profile, a head difference of between approximately 12 and 14 feet downward was documented. Although this difference indicates the potential for downward leakage exists, the low permeabilities indicate leakage to be less than 2 inches per year, which is in agreement with Stewart (1980) as referenced in our original report.

Figure 3 presents the profiles for the five additional borings requested by Mr. Rick Hicks. Based on all borings completed at this time, it is our opinion that a continuous confining layer, i.e., strata 4, 5 and 7, underlies the Lena Road landfill site.

The total thickness of this layer was not determined at each test hole location. Many of the test borings were terminated after penetrating only 2 to 3 feet into the top of this layer. The attached Table 1 documents the thickness of each strata to the depth penetrated by our test borings. Based on our evaluation of the boring data at locations where the layer was completely penetrated, it appears that the minimum thickness of the uppermost confining layer is 7 feet. At most of the deeper boring locations this layer was more than 20 feet thick.

As we discussed, we could not obtain access to the depression between TH-16 and TH-41 to drill the sixth test hole requested by Mr. Hicks. We understand filling of this area for drill rig access would require a dredge and fill permit.

We trust this letter responds completely to the issues raised by FDER. If that is not the case, please feel free to contact us.

Very truly yours,
ARDAMAN & ASSOCIATES, INC.

John E. Garlanger, Ph.D., P.E.
Principal
Florida Registration No. 19782

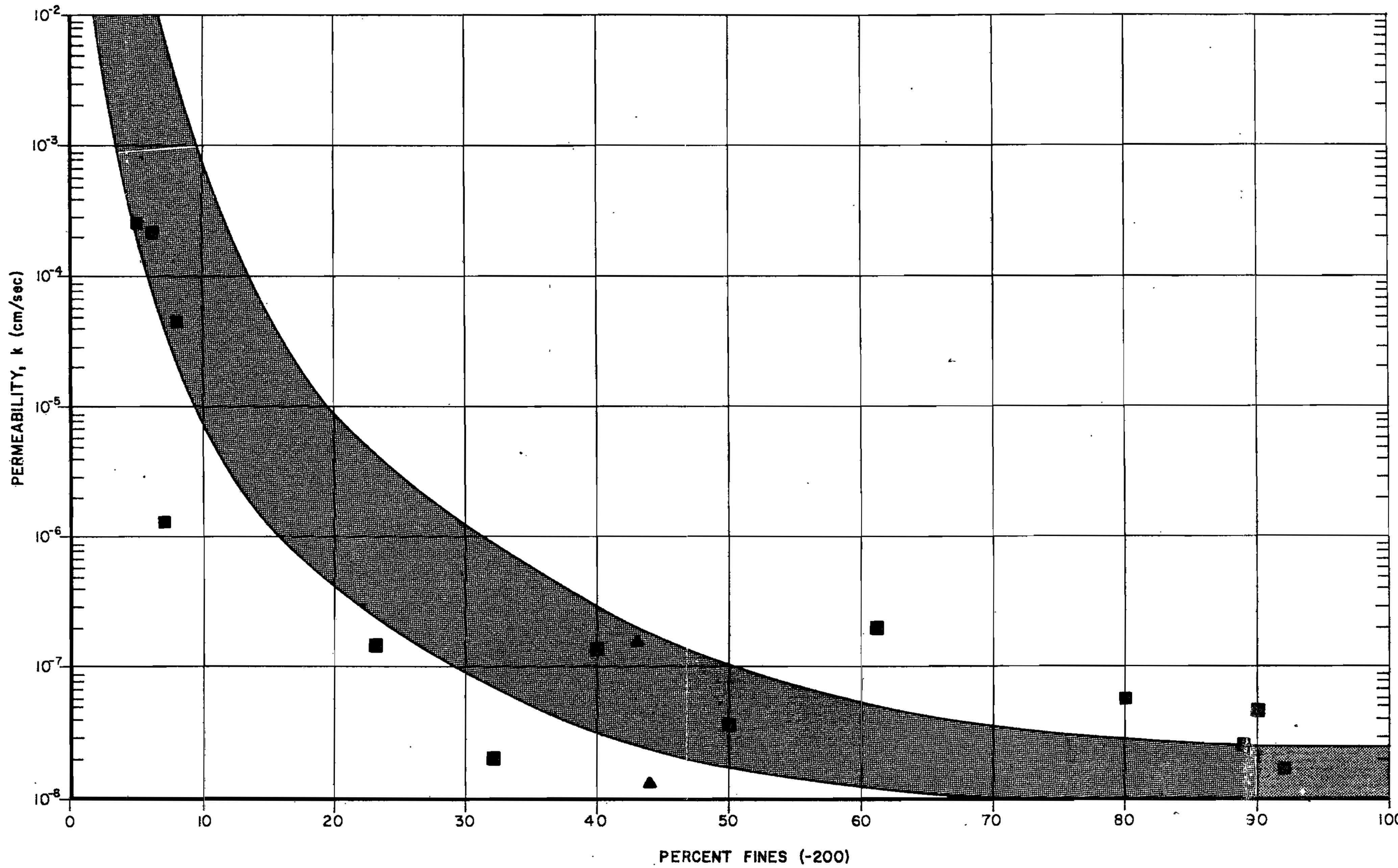
LMP/ss
cc: Rick Hicks, FDER Tallahassee

Table 1

Strata Thickness (feet)

Boring	Strata 4	Strata 5	Strata 7	Total
1	19+	4	-	23+
2	9.5	15+	-	24.5+
3	4.5+	-	-	4.5+
4	2.5+	-	-	2.5+
5	2+	-	-	2+
6	19.5+	-	35+	54.5+
7	3+	-	-	3+
8	15+	4	-	19+
9	3+	6.5	-	9.5+
10	2.5+	-	-	2.5+
11	16+	5	-	21+
12	2.5+	-	-	2.5+
13	3+	-	-	3+
14	-	6.5	12+	18.5+
15	3.5+	-	-	3.5+
16	1+	-	3	4+
17	-	7	23+	30+
18	22+	2	5	29+
19	5+	5	-	10+
20	7	8	3+	18+
21	16+	12	5.5	33.5+
22	12.5+	-	5	17.5+
23	-	7+	-	7+
24	6	3+	4.5	13.5+
25	8+	9	2	19+
26	5	5	3+	13+
27	10.5	-	7+	17.5+
28	3+	9	6	18+
29	3+	-	10	13+
30	8+	10	-	18+
31	11	-	3+	14+
32	3.5	10	8+	21.5+
33	-	15.5	8+	23.5+
34	-	23+	5	28+
35	13.5+	-	-	13.5+
36	4	9+	-	13+
37	5	3+	-	8+
38	-	17+	11	28+
39	3+	10	10	23+
40	3+	25	-	28+
41	3+	4.5	-	7.5+
42	-	13+	-	13+
43	30	8	2.5	40.5
44	17.5	19	8.5	45

(= indicates total thickness exceeds this value)



LEGEND

▲ REMOLDED SAMPLES (STRATUM 5)

■ UNDISTURBED SAMPLES

▩ BAND REPRESENTS ARDAMAN & ASSOCIATES, INC., EXPERIENCE CURVE FROM SOILS IN MANATEE COUNTY

COEFFICIENT OF PERMEABILITY VS. PERCENT FINES

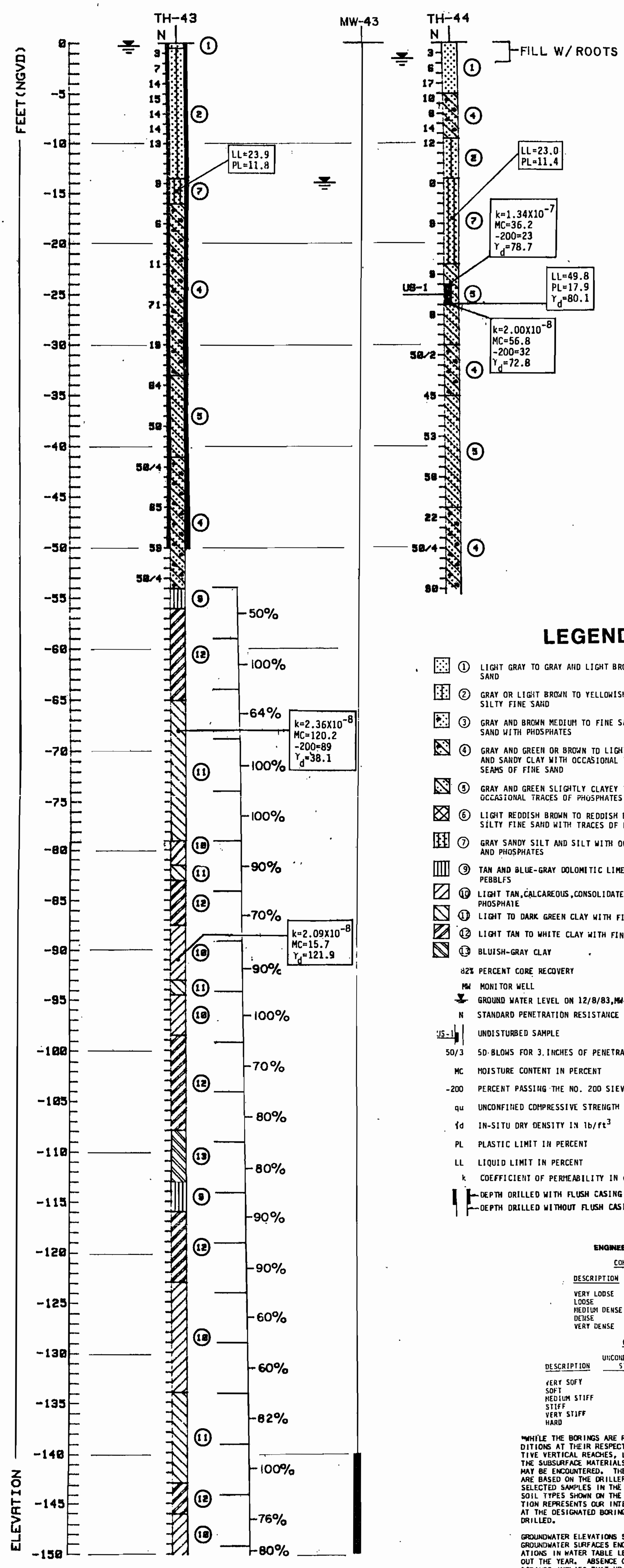
Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: H.A.D.	CHECKED BY: [signature]	DATE: 3/1/83
FILE NO. 82-7047	APPROVED BY: H.G. Stangland	

FIGURE 1

BORING PROFILES



LEGEND

①	LIGHT GRAY TO GRAY AND LIGHT BROWN TO YELLOWISH BROWN FINE SAND
②	GRAY OR LIGHT BROWN TO YELLOWISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND
③	GRAY AND BROWN MEDIUM TO FINE SAND TO SLIGHTLY SILTY FINE SAND WITH PHOSPHATES
④	GRAY AND GREEN OR BROWN TO LIGHT YELLOWISH BROWN CLAY AND SANDY CLAY WITH OCCASIONAL TRACES OF PHOSPHATES AND SEAMS OF FINE SAND
⑤	GRAY AND GREEN SLIGHTLY CLAYEY TO CLAYEY FINE SAND WITH OCCASIONAL TRACES OF PHOSPHATES, SHELL OR CEMENTED SAND
⑥	LIGHT REDDISH BROWN TO REDDISH BROWN SLIGHTLY SILTY TO SILTY FINE SAND WITH TRACES OF ROOTS (HARDPAN TYPE)
⑦	GRAY SANDY SILT AND SILT WITH OCCASIONAL TRACES OF CLAY AND PHOSPHATES
⑨	TAN AND BLUE-GRAY DOLOMITIC LIMESTONE WITH PHOSPHATE PEBBLES
⑩	LIGHT TAN, CALCAREOUS, CONSOLIDATED SILT WITH FINE GRAINED PHOSPHATE
⑪	LIGHT TO DARK GREEN CLAY WITH FINE GRAINED PHOSPHATE
⑫	LIGHT TAN TO WHITE CLAY WITH FINE GRAINED PHOSPHATE
⑬	BLUISH-GRAY CLAY
82%	PERCENT CORE RECOVERY
MW	MONITOR WELL
▼	GROUND WATER LEVEL ON 12/8/83, MW-43 WATER LEVEL ON 2/1/84
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
US-1	UNDISTURBED SAMPLE
50/3	50 BLOWS FOR 3 INCHES OF PENETRATION INTO THE SOIL
MC	MOISTURE CONTENT IN PERCENT
-200	PERCENT PASSING THE NO. 200 SIEVE
qu	UNCONFINED COMPRESSIVE STRENGTH IN tsf
γd	IN-SITU DRY DENSITY IN lb/ft^3
PL	PLASTIC LIMIT IN PERCENT
LL	LIQUID LIMIT IN PERCENT
k	COEFFICIENT OF PERMEABILITY IN cm/sec
	DEPTH DRILLED WITH FLUSH CASING
	DEPTH DRILLED WITHOUT FLUSH CASING

ENGINEERING CLASSIFICATION

COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT 'N'
VERY LOOSE	0 TO 4
LOOSE	4 TO 10
MEDIUM DENSE	10 TO 30
DENSE	30 TO 50
VERY DENSE	ABOVE 50

COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, TSF	BLOW COUNT 'N'
VERY SOFT	BELOW .25	0 TO 2
SOFT	.25 TO .50	2 TO 4
MEDIUM STIFF	.50 TO 1.0	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	ABOVE 4	ABOVE 30

"WHILE THE BORINGS ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THEIR RESPECTIVE LOCATIONS AND FOR THEIR RESPECTIVE VERTICAL REACHES, LOCAL VARIATIONS CHARACTERISTIC OF THE SUBSURFACE MATERIALS OF THE REGION ARE ANTICIPATED AND MAY BE ENCOUNTERED. THE BORING LOGS AND RELATED INFORMATION ARE BASED ON THE DRILLER'S LOGS AND VISUAL EXAMINATION OF SELECTED SAMPLES IN THE LABORATORY. THE DELINEATION BETWEEN SOIL TYPES SHOWN ON THE LOGS IS APPROXIMATE AND THE DESCRIPTION REPRESENTS OUR INTERPRETATION OF SUBSURFACE CONDITIONS AT THE DESIGNATED BORING LOCATION AND ON THE PARTICULAR DATE DRILLED.

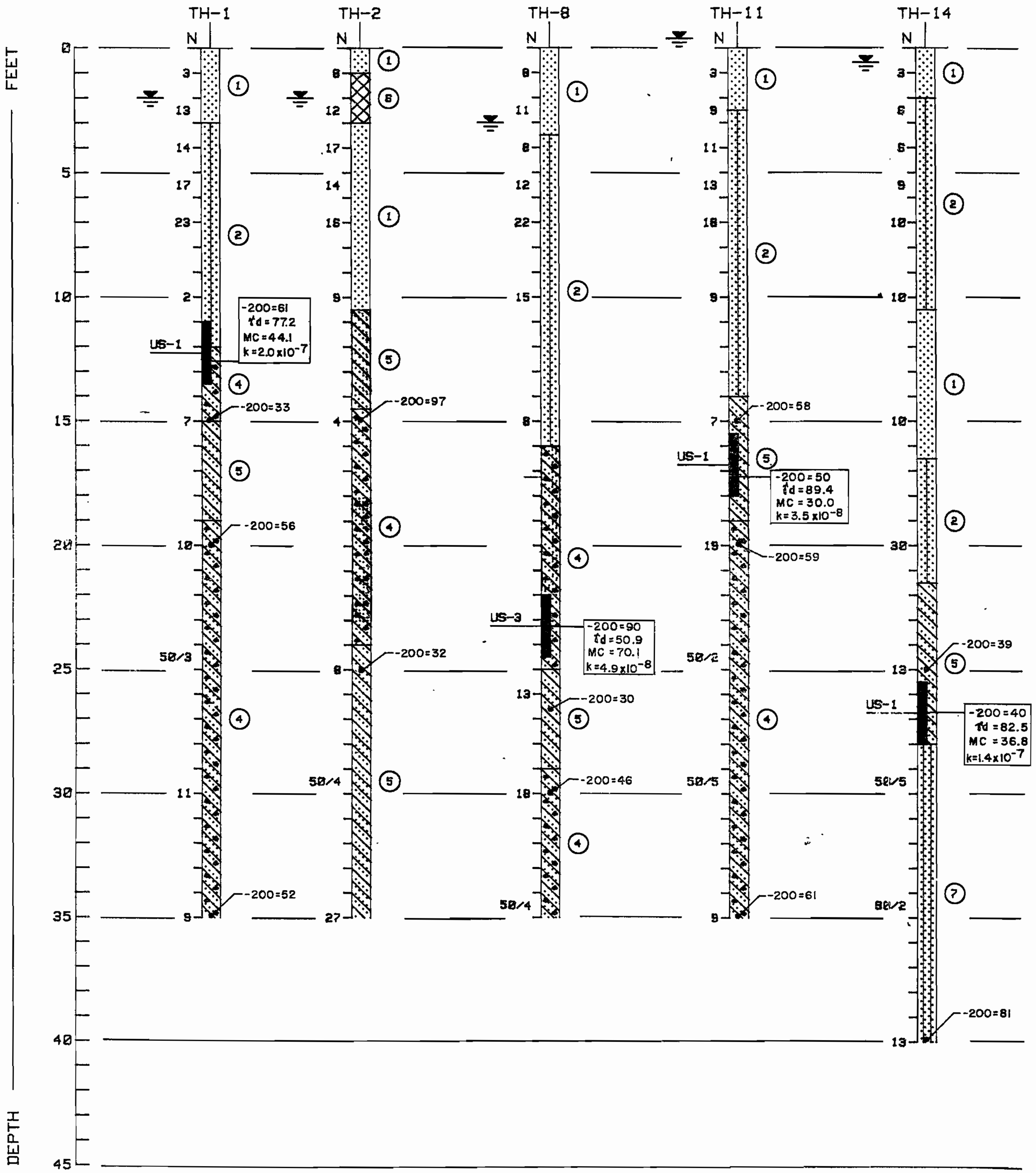
GROUNDWATER ELEVATIONS SHOWN ON THE BORING LOGS REPRESENT GROUNDWATER SURFACES ENCOUNTERED ON THE DATES SHOWN. FLUCTUATIONS IN WATER TABLE LEVELS SHOULD BE ANTICIPATED THROUGHOUT THE YEAR. ABSENCE OF WATER SURFACE DATA ON CERTAIN BORINGS IMPLIES THAT NO GROUNDWATER DATA IS AVAILABLE, BUT DOES NOT NECESSARILY MEAN THAT GROUNDWATER WILL NOT BE ENCOUNTERED AT THESE LOCATIONS OR WITHIN THE VERTICAL REACHES OF THESE BORINGS."

Ardaman & Associates, Inc.
Consulting Engineers in Soil Mechanics, Foundations, and Material Testing

HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: D.G.O.	CHECKED BY:	DATE: 1/18/84
FILE NO. 82-7047	APPROVED BY:	

FIGURE 2



LEGEND

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7. GRAY SANDY SILT AND SILT WITH OCCASIONAL TRACES OF CLAY AND PHOSPHATES

▼	GROUND WATER LEVEL ON 1/24/84 THRU 1/26/84
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
US-1	UNDISTURBED SAMPLE
50/3	50 BLOWS FOR 3 INCHES OF PENETRATION INTO THE SOIL
MC	MOISTURE CONTENT IN PERCENT
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HYDROGEOLOGICAL INVESTIGATION
LENA ROAD LANDFILL
MANATEE COUNTY, FLORIDA

DRAWN BY: H.A.D.	CHECKED BY: UMP	DATE: 2/12/84
FILE NO. 82-7047	APPROVED BY: [signature]	

FIGURE 3

LENA ROAD LANDFILL

MANATEE COUNTY, FLORIDA

STAGE II

DESIGN REPORT

NOVEMBER 1984

briley, wild & associates, inc.
CONSULTING ENGINEERS AND PLANNERS

MANATEE COUNTY, LENA ROAD LANDFILL
OPERATING PERMIT APPLICATION
FOR STAGE II

Report to Florida D.E.R.

Table of Contents

1.0 Summary

1.1 Background

This report has been prepared for Manatee County to accompany the application for a permit to construct and operate the solid waste management facility known as the Lena Road Landfill - Stage II.

Manatee County has operated a refuse landfill in a site known as the "Lena Road Landfill" for eleven years under operating permits issued by the Florida Department of Environmental Regulation. This landfill site is identified as follows:

> "The South 1/2 of the N.W. 1/4 and the N. 1/2 of the S.W. 1/4 of Section 6, Township 35 South, Range 19 East, being approximately 142 acres."

Manatee County has applied for permission to continue the landfill operation on this site in addition to an additional parcel of land identified as follows:

> "The North 1/2 of the N.W. 1/4 of Section 6, Township 35 South, Range 19 East, Township 35 South, Range 19 East, being approximately 71 acres."

Manatee County is presently operating the Stage I Landfill under an extension of the Operating Permit which ran to May 1984. DER has issued a Construction Permit for improvements to Stage I and is presently preparing a Consent Order for operation. The County recognizes the need for landfill expansion in the immediate future (2 years hence) and by means of this application is requesting permission to construct and operate an expansion of the present landfill on the parcel lying immediately north of the Stage I operation. This parcel is described legally as follows:

All of Section 31, Township 34 South, Range 19 East; less that part of Section 31 lying East of a line which is the northerly extension of the East Line of the N.W. 1/4 of Section 6, Township 35 South, Range 19 East, being approximately 229 acres."

The landfill development in Section 31 is identified as Stage II in this report.

1.2 General Design Approach

As indicated in the March 3, 1983 Ardaman & Associates report, the entire site is underlain by a deep, continuous clay layer which will effectively prevent the vertical movement of leachate to the Floridan aquifer, which is approximately 300 feet below natural grade in this area. A slurry wall will be constructed around the entire perimeter of the proposed landfill and keyed into the clay layer to prevent any lateral movement of groundwater into the fill and to prevent leachate from leaving the site. Drainage facilities, including a peripheral berm and detention pond, will be constructed to control surface runoff. Three small secondary wetland areas, totalling 6.12 acres, will be included in the landfill. To compensate for the loss of these wetlands, 6.8 acres north of the landfill will be excavated and planted as mitigated wetlands, as shown on the plans.

A leachate collection system will be installed inside of the slurry wall.

Excavation for the new landfill will begin at the western-end of the site. Borrow material from the initial excavation will be stockpiled on the area south of the site, as shown on the plans. Some of this material will also be used in constructing the peripheral berm. It is estimated that four lifts will be constructed. Constructing will proceed from west to east, with all four lifts and final cover being applied as construction progresses. Surface drainage will be away from the working face at all times.

Exhibit 1 shows the general progression of fill activity from the west to the east. Exhibit 2 shows a typical section through the landfill as each of the fill areas is constructed. Exhibit 3 shows construction of the four lifts, the slurry wall, berms and drainage facilities.

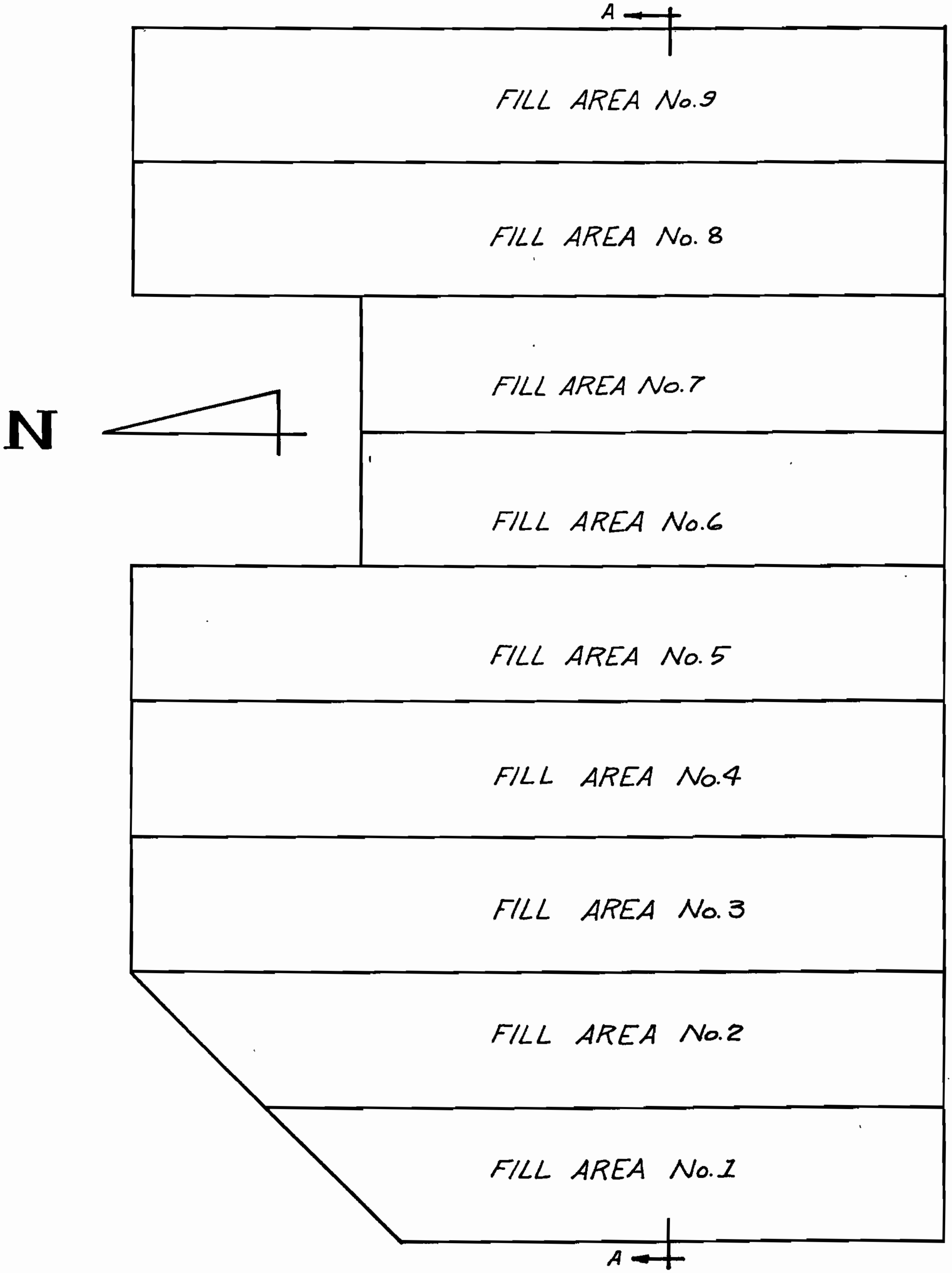


EXHIBIT 1
FILL PROGRESSION

EXHIBIT 2

CROSS SECTIONS DURING FILL PROGRESSION

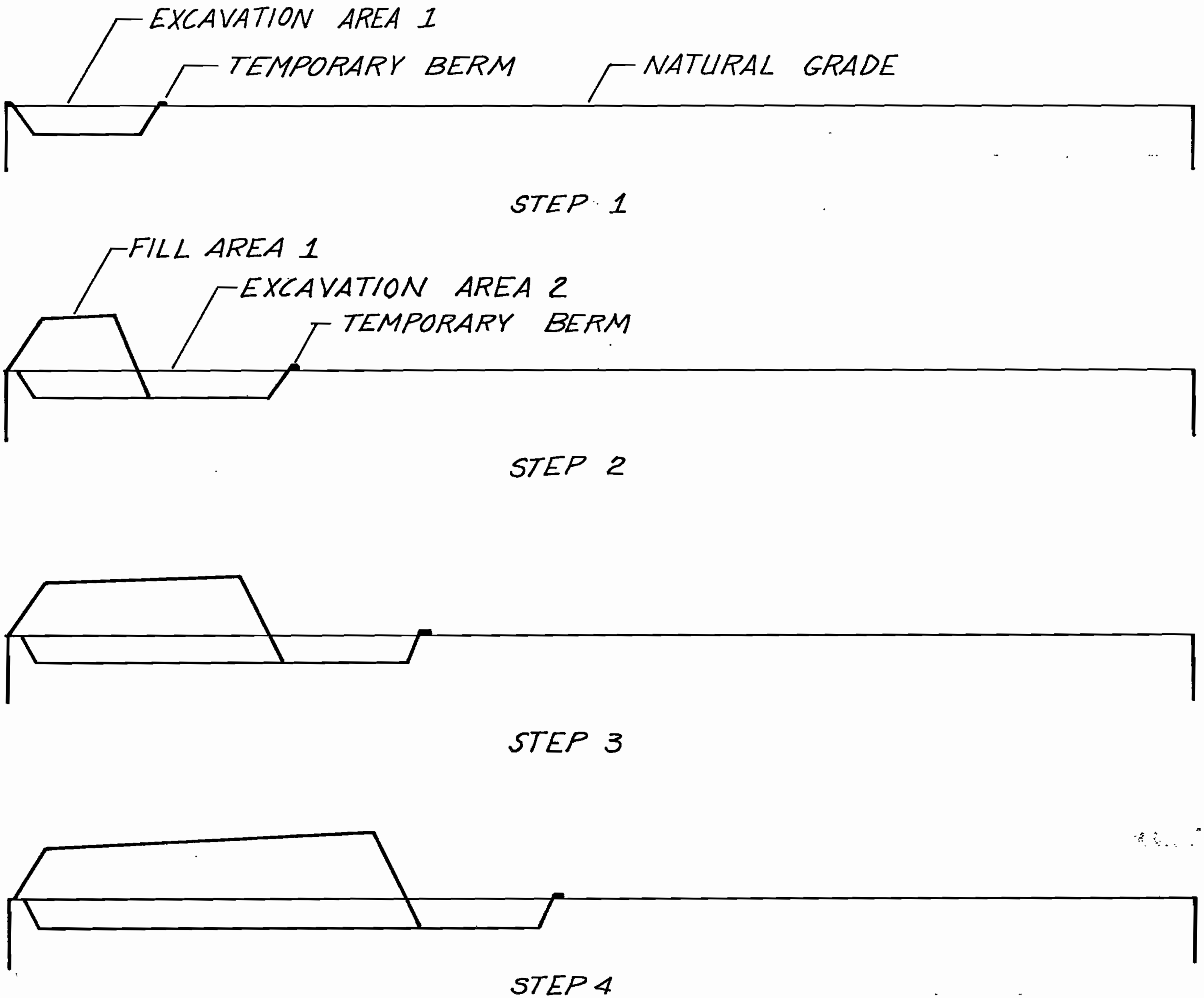
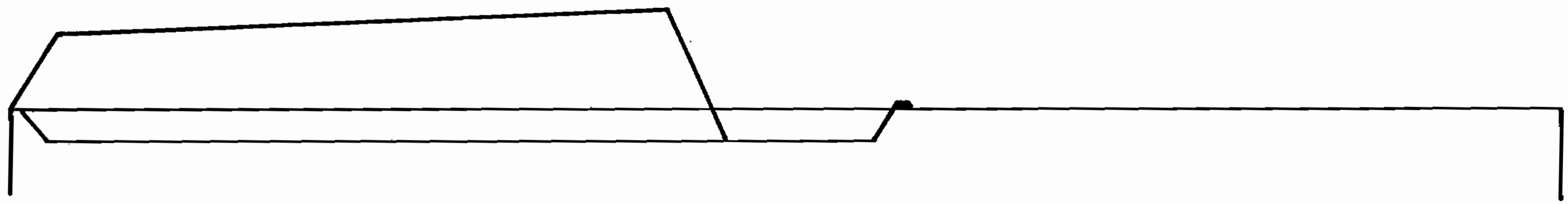
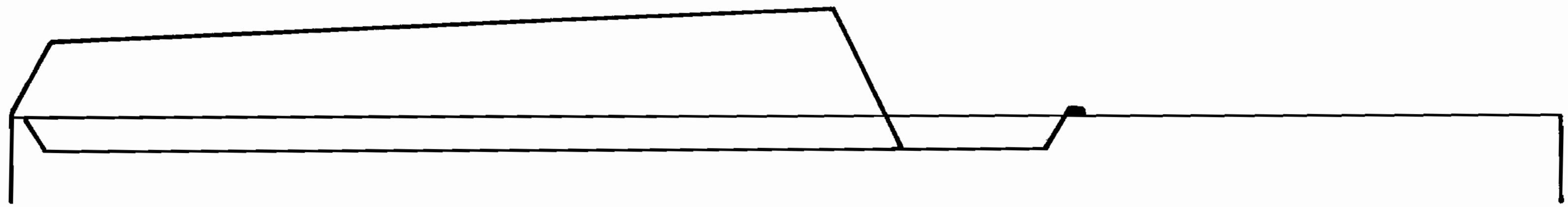


EXHIBIT 2

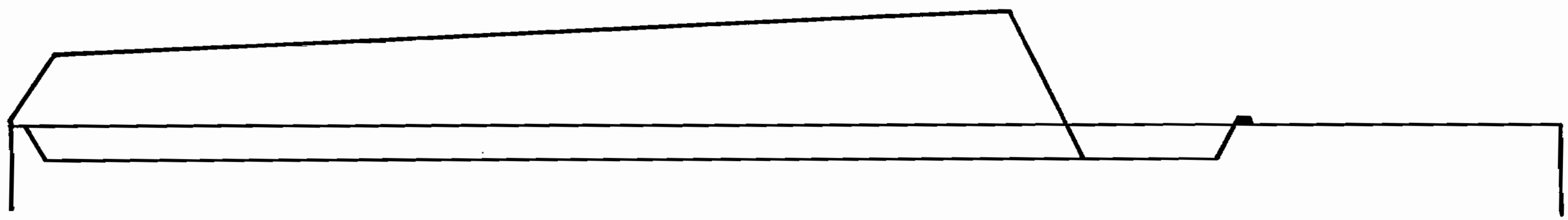
CROSS SECTIONS DURING FILL PROGRESSION



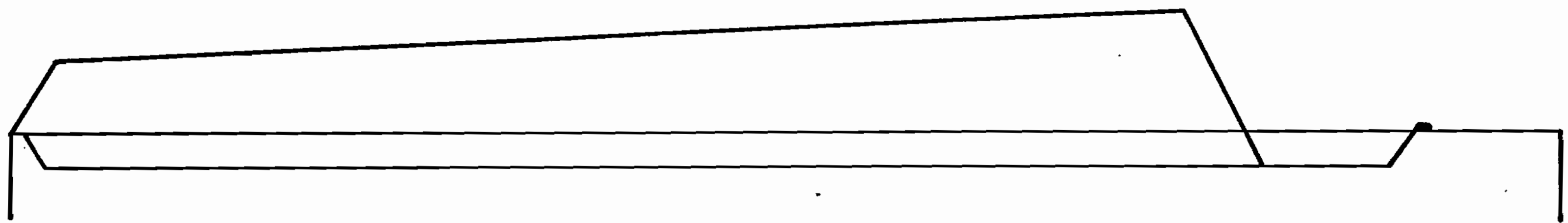
STEP 5



STEP 6



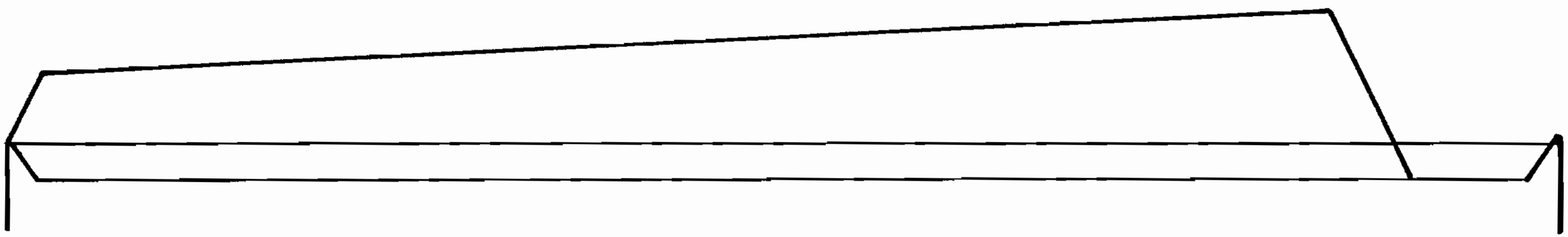
STEP 7



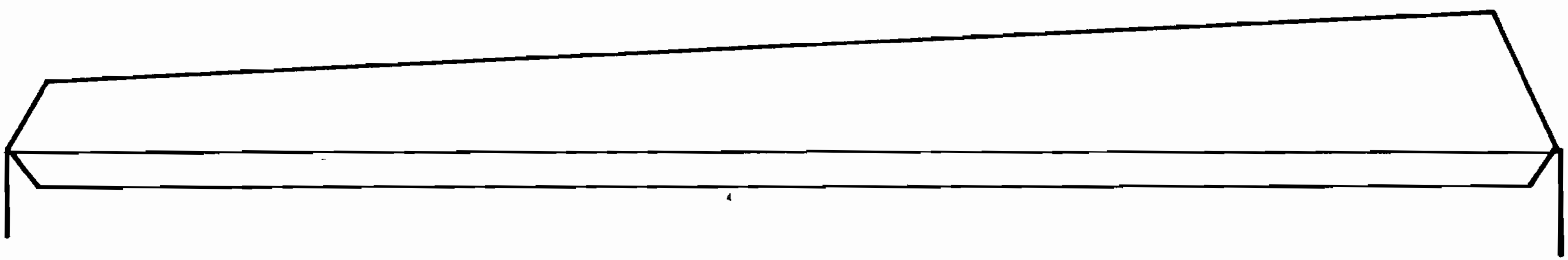
STEP 8

EXHIBIT 2

CROSS SECTIONS DURING FILL PROGRESSION



STEP 9



STEP 10

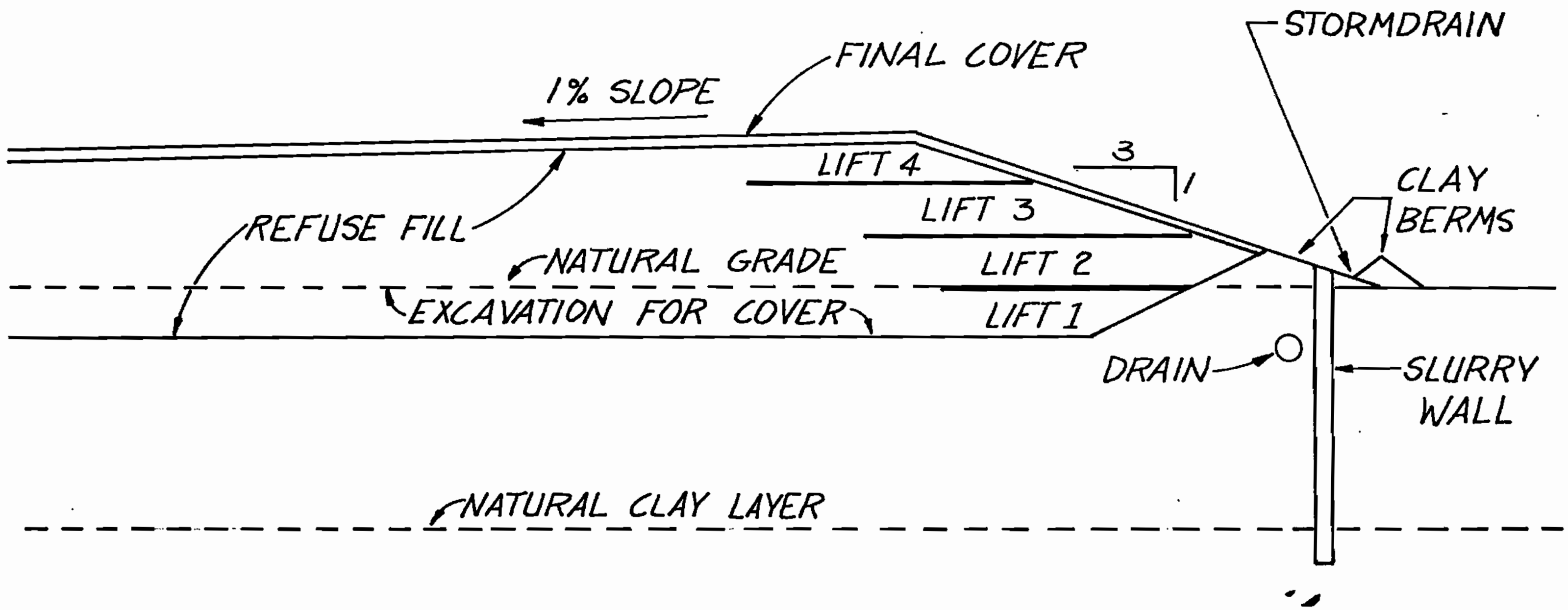


EXHIBIT 3
FINAL CONSTRUCTION DETAILS

2.0 Projections of Amount and Nature of Refuse to be Handled

It is the County's intention to accept the entire, non-hazardous, solid waste generated within Manatee County at this site. The lease agreement between the County and the property Lease Holder stipulate that landfilling at this site will terminate January 1, 1996.

Landfill records for 1982 indicated that the average daily solid waste disposal rate was 700 tons per day. The estimated population of Manatee County at the end of 1982 was 160,000. The per capita refuse load based on this data amounts to 8.75 pounds per capita per day.

The population of Manatee County is projected to be 200,000 at the end of the century, December 31, 1999. The tabulated data on Figure 3 (page 5) is based on a straight line population increase from 1982 to 1999 and a constant per capita refuse generation rate. The compacted, in-place volume of solid waste is based on an average compacted density of 1000 pounds per cubic yard or 2 cubic yards per ton. The cover soil requirement has been estimated at 20% of the compacted solid waste in the following manner:

Compacted volume of refuse per day:

2 cubic yd/ton x 700 T.P.D. = 1400 c.y.

Average area of an 8 foot lift =

$$\frac{1400}{8} \times 27 = 472.5 \text{ S.F.}$$

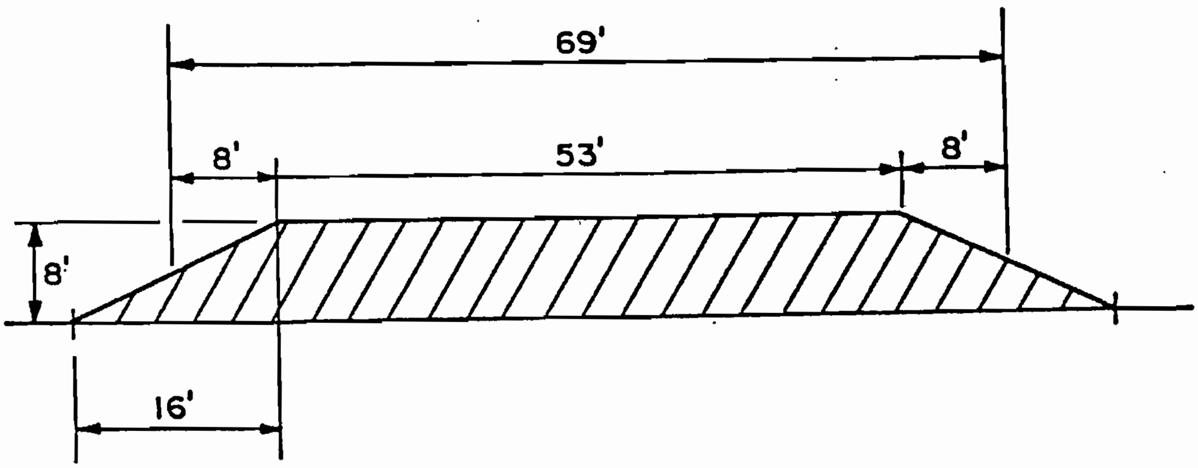
Average square dimensions =

69' x 69' of daily lift

TYPICAL SECTION OF DAILY FILL

BASED ON 2:1 SLOPE

AVERAGE AREA OF FILL



Top area of fill = $(53')^2$ = 2809 S.F.

Sides of fill = $(16^2 + 8^2)^{1/2}$ = 18'

Average length of side = 69'

Average area of one side - 18' x 69' = 1242 S.F.

Area of cover required for initial cell = 2809 + (4 x 1242) = 7777 S.F.

Area of cover required with 2 sides in place = 2809+(2x1242) = 5293 S.F.

Allow an average of 5300 S.F.

Volume of daily cover @ 6" thickness = 5300 S.F. x .5/27 = 98 c.y.

Daily cover = 98/1400 = 7% of compacted volume

Final cover = 2 ft. thickness over net area for an average of 2.5 lifts

Final cover ratio = $\frac{2}{2.5x8}$ = 10% of refuse

Total cover = 7% Daily + 10% Final = 17% (use 20%)